AA2012-3

AIRCRAFT ACCIDENT
INVESTIGATION REPORT

Japan Coast Guard

J A 6 7 9 6

March 30, 2012

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.

Norihiro Goto
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

JAPAN COAST GUARD
BELL 412 EP (ROTORCRAFT), JA6796
NEAR SANAGIJIMA, TADOTSU- CHO, NAKATADO- GUN, KAGAWA PREFECTURE, JAPAN
AROUND 15:10 JST, AUGUST 18, 2010

March 9, 2012

Adopted by the Japan Transport Safety Board

Chairman	Norihiro Goto
Member	Shinsuke Endo
Member	Toshiyuki Ishikawa
Member	Sadao Tamura
Member	Yuki Shuto
Member	Toshiki Shinagawa

1. PROCESS AND PROGRESS OF THE INVESTIGATION

1.1 Summary of the Accident

On August 18 (Wednesday), 2010, the Bell 412EP, registered JA6796, operated by the Japan Coast Guard, took off from Hiroshima Airport for patrolling flight in the eastern part of the Seto Inland Sea at 13:47 Japan Standard Time (JST; UTC+9h, unless otherwise stated, all times are indicated in JST and 24-hour clock.). While flying near Sanagijima, Tadotsu-cho, Nakatado-gun, Kagawa Prefecture, the aircraft hit overhead wires extended between Sanagijima and Oshima, and crashed into the sea around 15:10.

There were five persons on board the aircraft, consisting of the pilot in command and four others, and all of them suffered fatal injuries.

The aircraft was destroyed, but no fire broke out.

1.2 Outline of the Accident Investigation

1.2.1 Investigation Organization

On August 18, 2010, the Japan Transport Safety Board designated an investigator- in-charge and two other investigators to investigate this accident.

1.2.2 Representatives from Foreign Authorities

An accredited representative of Canada, as the State of Manufacture of the aircraft involved in this accident, participated in the investigation. This accident was notified to the United States of America, as the State of Design of the aircraft. But no accredited representative was designated.

1.2.3 Implementation of the Investigation

August 19 to 22, 2010	On-site examination, aircraft examination and interviews
October 4 to 8, 2010	Interviews, investigation of severed overhead wires and obstacle light visual detection test flight

1.2.4 Comments from Parties Relevant to the Cause of the Accident

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

1.2.5 Comments from the Participating States

Comments on the draft report were invited from the participating States.

2. FACTUAL INFORMATION

2.1 History of the Flight

On August 18 (Wednesday), 2010, the Bell 412EP, registered JA6796 (hereinafter referred to as "the Aircraft"), operated by the Japan Coast Guard (hereinafter referred to as "the Coast Guard"), took off from Hiroshima Airport at 13:47, with the pilot in command (PIC) seated on the left side, the co-pilot on the right side and two mechanics and one radio operator on cabin seats, for a patrolling flight in the waters in the eastern part of the Seto Inland Sea*1. This flight was also flown as a demonstration flight*2, a hulk investigation*3 and a co-pilot's captain training (hereinafter referred to as "the Captain Training").

The outline of the flight plan for the Aircraft was as follows:

Flight rules:	Visual Flight Rules (VFR)
Departure aerodrome:	Hiroshima Airport
Estimated off-block time:	13:30
Cruising speed:	100kts
Cruising altitude:	VFR
Route	Mihara — Teshima — Mukuchijima — Hiroshima — Takamijima — Mukuchijima — Mihara
Destination aerodrome:	Hiroshima Airport
Total estimated elapsed time:	2 hr and 30 min
Fuel load expressed in endurance:	3 hr and 10 min
Persons on board:	5

The history of the flight of the Aircraft from its take-off from Hiroshima Airport to the occurrence of the accident was summarized as below according to the flight records left in a hard drive of the aircraft data power line steel unit (hereinafter referred to as "the Flight Data") and the statement of a witness. Incidentally, there were no records available for the Aircraft's whereabouts after its location as of 15:10:04 (hereinafter referred to as "the Recorded Final Location").

2.1.1 Flight Data

Time	Altitude (ft)	Speed (kts)	Location and maneuver
14:12:16	About 1,024	About 90	Northwest of Kamimizushima, East-southeastward flight
14:15:47	About 1,039	About 88	About 1 km southwest of Kamimizushima, Start of descent
14:18:00	About 139	About 73	About 1.5 km southwest of Kamimizushima, end of descent, followed by a flight to Mukuchijima
14:20:56	About 169	About 93	Northwest of Mukuchijima, flight to

*1 The waters in the eastern part of the Seto Inland Sea is an area designated by the Coast Guard for its operations, which covers off the coasts of Okayama Prefecture and Kagawa Prefecture.

*2 The demonstration flight literally means a flight for the sake of flight demonstrating. In this case, the aircraft flew along a Coast Guard ship on which people were on board experiencing the cruise.

*3 The hulk investigation means a survey flight aimed at aerially investigating deserted ships and wasted materials in ports or on the sea.

			demonstration flight area
14:21:56	About 129	About 51	Demonstration flight
14:31:06	About 216	About 45	Teshima, hulk investigation
14:47:57	About 492	About 51	Hiroshima, hulk investigation
15:03:40	About 376	About 43	Takamijima, hulk investigation
15:08:30	About 375	About 86	Northern tip of Takamijima, eastward flight
15:08:55	About 364	About 86	Northeast of Takamijima, westward flight (to Oshima) after a left turn there
15:09:25	About 328	About 103	Eastern tip of Oshima, fly-by
15:09:57	About 227	About 100	South of Oshima, flight along the coast line
15:10:04	About 238	About 89	Southwestern tip of Oshima, a right turn

2.1.2 Statement of Witness (The Captain of the Ferry Boat Which was Passing near the Accident Site)

Weather was fine and visibility was good on the day of the accident. The ferry boat left Nagasaki Port in the northern part of Sanagijima at 15:05 and it was navigating for Sanagi Port in the southern part of the same island. The ferry boat was helmed to the southeast after its departure. When it was navigating toward the eastern tip of Oshima, the captain saw a helicopter flying from the east to the west on the eastern side of Oshima. The helicopter, while lowering its altitude with its nose slightly down at a place east of Oshima, disappeared behind for a while and then, came out from the western side of it and flew toward the ferry boat. Therefore, the captain looked at the helicopter through binoculars for fear that it might hit overhead wires. Just then, he saw it hit the overhead wires from its nose and they burst the overhead wire. After that, while lowering its nose and apparently losing its speed, it fell into the water in a steep angle from the back. He immediately reported the accident to the Coast Guard and helmed the ferry boat to the accident site. The time was around 15:10. The Aircraft severed the overhead wires just about 10 seconds after it was seen just ahead of the ferry boat. He was not sure how far apart the Aircraft was flying along the coastline of Oshima.

The accident occurred around 15:10 on the sea about 750 m east-northeast (a true bearing of about 63º) of the No. 9 breakwater lighthouse at Sanagi Port in Tadotsu-Cho, Nakatado-Gun, Kagawa Prefecture (34°20'18" N, 133°38'16" E).

(See Figure 1 Estimated Flight Route, Figure 4 Sanagi Lines Schematic, Photo 1 Distant View of Oshima and Sanagijima)

2.2 Injuries to Persons

The five persons aboard the Aircraft suffered fatal injuries.

2.3 Damage to the Aircraft

2.3.1 Extent of Damage

Destroyed

2.3.2. Damage to the Aircraft Components

Fuselage and cockpit: Broken

Main rotor blades (hereinafter referred to as "MRBs"):
All of the four blades were found broken.

Engines: Both No. 1 and No. 2 engines damaged

Tail boom: Detached from the joint with the fuselage

Tail rotor blades (hereinafter referred to as "TRBs):
Of the two blades, the red TRB*4 was found fractured at a point about halfway.

(See Photo 2 Accident Aircraft, Photo 3 Detached Tailboom)

2.4 Information about Damage to Objects Other Than the Aircraft

Shikoku Electric Power Co. Inc.'s three overhead wires extended between Oshima and Sanagijima in Tadotsu-Cho, Nakatado-Gun, Kagawa Prefecture (hereinafter referred to as the "Sanagi Lines") were all severed.

Following the disconnection of the Sanagi Lines, 577 households in the area suffered power outage. It was at 19:43 on the same day when the power supply to the area was fully recovered.

2.5 Personnel Information

(1) PIC Male, Age 41

Commercial pilot certificate (Rotorcraft)	June 6, 1990
Type rating for Bell 212	August 9, 2000
Class 1 aviation medical certificate	
Validity	May 29, 2011
Total flight time	3,205 hr and 03 min
Flight time in the last 30 days	29 hr and 25 min
Total flight time on the type of aircraft	226 hr and 10 min
Flight time in the last 30 days	13 hr and 30 min

(2) Co-pilot Male, Age 38

Commercial pilot certificate (Rotorcraft)	November 6, 2000
Type rating for Bell-212	June 20, 2001
Class 1 aviation medical certificate	
Validity	October 18, 2010
Total flight time	3,379 hr and 55 min
Flight time in the last 30 days	13 hr and 35 min
Total flight time on the type of aircraft	23 hr and 50 min
Flight time in the last 30 days	9 hr and 20 min

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2.6 Aircraft Information

2.6.1 Aircraft

Type	Bell 412EP
Serial number	36121
Date of manufacture	February 27, 1996
Certificate of airworthiness	Tou-22-193

*4 The two TRBs of the Aircraft had been color-coded in red and white to distinguish them from each other. The red TRB is the blade with a red marking.

Validity	July 11, 2011
Category of airworthiness	Rotorcraft, Transport TA, TB or Special X
Total flight time	6,992 hr and 50 min
Flight time since last periodical check (A Check on August 17, 2010)	0 hr and 00 min

(See Figure 2 Three angle view of Bell 412EP)

2.6.2 Engines

	No.1 Engine	No.2 Engine	Reduction Gear Box
Type	PT6T-3D 3117400-0	PT6T-3D 3117400-1	PT6T-3D 3117180-01
Serial number	CP-PS140199	CP-PS140200	CP-GB11101
Date of manufacture	October 26, 1995	October 26, 1995	October 26, 1995
Total time	4,852 h 50 min	4,852 h 50 min	4,852 h 50 min

2.6.3 Weight and Balance

When the accident occurred, the Aircraft's weight was estimated to have been 10,800 pounds and the center of gravity (CG) was estimated to have been 137.8 ins. aft of datum line in longitudinal direction and 0.0 in. left in lateral direction, both of which were estimated to have been within the allowable ranges (the maximum takeoff weight of 11,900 lb, and the CG range of 133.4 to 143.3 ins. in longitudinal direction, 4.5 ins. left to 4.5 ins. right in lateral direction corresponding to the weight at the time of the accident).

2.6.4 Fuel and Lubricating Oil

Fuel was an Aviation Jet A-1, and lubricating oil was Mobil Jet Oil.

2.7 Meteorological Information

2.7.1 General weather outlook

Takamatsu Local Meteorological Observatory issued the outlook for Kagawa Prefecture at 10:35 on August 18, 2010 as follows:

Weather in the Shikoku region is generally fine as the region is covered with a high pressure.

As for the weather condition in Kagawa Prefecture from August 18 to 19, it will be generally fine, because the area will be covered with a high pressure, but the atmospheric condition will become unstable in the afternoon due to the influence of strong sun lights and as a result, rain or thunderstorms should be observed at some places.

2.7.2 Meteorological observations

The automated meteorological data acquisition system at Tadotsu, Kagawa Prefecture, recorded the weather condition as follows:

15:00: Wind direction: north, Wind velocity: 3.8 m/s, Temperature: 33.9 ºC, Precipitation: 0 mm

2.8 Information about Air Navigation Facilities

Obstacle Lights had been installed at the tops of the power line steel towers on Sanagijima (hereinafter referred to as "the Sanagijima Tower") and Oshima (hereinafter referred to as "the

Oshima Tower"), specifically a medium intensity white obstacle light*5 on the former (hereinafter referred to as "the Sanagijima Obstacle Light") and a high intensity obstacle light*6 on the latter (hereinafter referred to as "the Oshima Obstacle Light"). According to Shikoku Electric Power Co., Inc. (hereinafter referred to as "the Electric Power Company"), both of the power line steel towers had lacked a structural strength for supporting overhead wires installed with obstacle markings*7. Therefore, in accordance with Article 127, paragraph (1), item (vii), of the Ordinance for Enforcement of the Civil Aeronautics Act as well as the Interpretation and the Enforcement Procedure concerning the installment of obstacle lights and obstacle markings, a high intensity obstacle light had been installed on the higher Oshima Tower and a medium intensity white obstacle light on the lower Sanagijima Tower, instead of obstacle markings.

The performances of the obstacle lights have been constantly monitored by the Electric Power Company. There were no data indicating anomalies on the day of the accident.

There are no overhead wires linking Teshima, Hiroshima and Takamijima, meaning no obstacle lights or obstacle markings on these islands.

2.9 Information regarding Communication

After the take-off, the Aircraft maintained communication with Hiroshima Air Station (hereinafter referred to as "the Station") of the 6th Regional Coast Guard Headquarters (hereinafter referred to as "the 6th Regional Headquarters") and the patrol boat "Mizunami" (hereinafter referred to as "the Boat") as the cruise experience ship. Their communication records were as follows:

Time of communication	Partners communication	Contents of communication
About 13:49	From the Aircraft to the Station	Departure, at 13:45
	From the Station to the Aircraft	Roger
About 14:01	From the Aircraft to the Station	Tajima, operation normal
	From the Station to the Aircraft	Roger
About 14:05	From the Boat to the Aircraft	Left Mizushima Port 5 minutes ahead of schedule
	From the Aircraft to the Boat	Roger. Now over Tajima
About 14:13	From the Aircraft to the Base	Mukuchijima, operation normal.
	From the Station to the Aircraft	Roger
About 14:20	From the Aircraft to the Boat	We will soon arrive, but are you ready? Request current weather condition.
	From the Boat to the Aircraft	Just a moment. Currently, winds from the south at 6 kts. We are ready.

*5 The medium intensity white obstacle light emits a white flashing light 20 to 60 times per minute with a maximum effective intensity value of 25,000 candela or less.

*6 The high intensity obstacle light means emits a white flashing light 40 to 60 times per minute with a maximum effective intensity value of 250,000 candela or less.

*7 Obstacle markings are facilities which must be installed pursuant to the provisions of the Civil Aeronautics Act for objects which are considered difficult to be perceived from aircraft under daylight condition and are at the height of 60 m or more above the ground or the waters. The obstacle markings shall be of coated colors, flags or marking.

About 14:30	From the Boat to the Aircraft	The first round ends now. We will head for the base (Mizushima Port)
	From the Aircraft to the Boat	Roger
About 14:35	From the Aircraft to the Station	Currently hulk investigation over Teshima
	From the Station to the Aircraft	Roger
About 15:01	From the Aircraft to the Station	Currently hulk investigation over Takamijima
	From the Station to the Aircraft	Roger
About 15:03	From the Boat to the Aircraft	Left the base (Mizushima Port) as scheduled
	From the Aircraft to the Boat	Roger

2.10 Information about Accident Site and Wreckage

2.10.1 Condition of Accident Site

(1) Accident site

The accident site was on the sea about 750 m east-northeast of Sanagi Port on Sanagijima of Tadotsu-Cho, Nakatado-Gun, Kagawa Prefecture. The perimeter of Sanagijima is about 3.8 nm (about 7 km), and that of Oshima is about 1.1 nm (about 2 km). The distance between the two islands is about 0.5 nm (about 1 km). The distance from the vicinity of Takamijima, Oshima and Sanagijima to the airspace for the demonstration flight is about 8.1 nm (about 15 km).

The Sanagi Lines consisted of three overhead wires extended east and west between Sanagijima and Oshima (All the three lines are for power distribution. No ground wire was installed.) with a horizontal distance of about 1,179 m.

The Sanagijima Tower, with a height of about 22 ft (about 6.8 m), stands at an elevation of about 216 ft (about 65.9 m) near the center of the eastern slope of Sanagijima . The Oshima Tower, with a height of about 23 ft (about 6.9 m), stands at an elevation of about 429 ft (about 130.7 m) near the center of the western slope of Oshima. Therefore, the elevation of the top of the Sanagijima Tower was about 239 ft (about 72.7 m) and the elevation of the top of the Oshima Tower was about 451 ft (about 137.6 m), meaning that the overhead wires extend downward from Oshima to Sanagijima. The height of the lowest slack of the Sanagi Lines from the sea level (hereinafter referred to as "the Lowest Overhead Wire Height from the Sea Level") was about 154 ft (about 47.0 m)

(2) Wreckage dispersion

The Aircraft was found submerged with its fuselage overturned orienting to the southwest on the seabed about 11 m deep. The tail boom had been detached from the fuselage and was found floating on the sea near the crash site.

(3) Severed Sanagi Lines

Each overhead wire of the Sanagi Lines is seven-strand steel wire with an aluminum coating with a diameter of about 12.6 mm. The actually measured length*[8] and the horizontal distance of each of the three overhead wires from the Oshima Tower to the points

*8 The actually measured length means the combined length of the length of the actually measured parts of the recovered overhead wires and the length of the part calculated by dividing the weight of the recovered overhead wires with the weight per unit length.

severed and the height of them from the sea level were as follows:

Name of overhead wire	Actually measured length	Horizontal distance	Height
Overhead wire in the south	About 388 m	About 387 m	About 249 ft (about 76 m)
Overhead wire in the center	About 389 m	About 387 m	About 253 ft (about 77 m)
Overhead wire in the north	About 385 m	About 384 m	About 249 ft (about 76 m)

Conspicuous bends, curves, traces of abrasion and deformation were found on each overhead wire in sections about 10 m long from the severed points toward Sanagijima Tower.

(4) Detection times of Sanagi Lines' anomalies and instant ground fault

Electric Power Company's power distribution system recorded the times of Sanagi Lines' anomalies at 15:10:17 and the instant ground fault at 15:10:18 with one to three seconds of delay between detection and recording. Therefore, with assumption of two second delay, the actual anomalies are estimated to have been detected around 15:10:15 and the instant ground fault around 15:10:16.

The straight distance from the Recorded Final Location to the severed sections of the Sanagi Lines was about 500 m.

(See Figure 4 Sanagi Lines Schematic, Figure 5 Sanagi Lines Schematic and Aircraft's Flight Route, Photo 6 Severed and Deformed Sanagi Lines, Photo 7 Severed Section of Sanagi Lines)

2.10.2 Damage to Aircraft Components

The Aircraft was recovered from the sea on August 19, 2010, and its condition was examined at Tadotsu Port. Details of damage to components of the Aircraft were as follows:

(1) Fuselage and Landing Gear

The fuselage was severely damaged and none of the original form remained.

Forward and aft cross tubes were fractured from the airframe attaching points. A 35 cm long abrasion were found on the right side of the forward cross tube extending from the skid connecting point to the step. A part of the abrasion formed a groove of about 5 cm long by about 3 cm wide with a depth of 5 mm.

(2) MRBs

The green MRB*9 was damaged in an area about 3 m long on the trailing edge near the central part of the blade. Wrinkles were created at seven places on the leading edge. The leading edge had a cut about 3 cm wide and about 10 cm long at a place 50 cm from the tip. The leading edge of the yellow MRB was damaged in an area about 2 m wide from the tip exhibited broom-like looseness. The red MRB had wrinkles at six places on the leading edge while its trailing edge near the center had about 3 m-long fracture. The blue MRB had about 3 m-long fracture originating from the root.

(3) Engines

Both the No.1 and No.2 engines and their accessory gear boxes were compressed

*9 The four MRBs of the Aircraft are color-coded in red, blue, orange and green to distinguish them from each other. The green MRB is the blade marked with a green marker and hereinafter, the same applies to other blades.

longitudinally. On the exterior, the exhaust duct, the fire wall and other parts had deformation; however, there was no trace of abnormal combustion.

(4) Power line steel and Main Mast

The power line steel support case was damaged and detached from the airframe. There was no damage to the main mast.

(5) Main Drive Shaft

The main drive shaft was found broken, as if being wrenched off, at the point about 50 cm from the input quill on the power line steel side.

(6) Tail Rotor Drive Shafts

The tail rotor drive system consists of six shafts. The second drive shaft was fractured at its coupling and sixth drive shaft was fractured, just like being wrenched off, near the central portion of the shaft.

(7) Tail Boom

The tail boom was found detached from the area where it is connected to the airframe. The vertical stabilizer and part of the right horizontal stabilizer had been broken.

(8) TRBs

Of the two TRBs, the red blade was broken around the middle section; however, there was no major damage to the white blade.

(See Figure 3 Damaged Area Schematic, Photo 2 Accident Aircraft, Photo 3 Detached Tailboom, Photo 4 Traces of Abrasion on Cross Tube, Photo 5 Wrinkles on Main Rotor Blade)

2.10.3 Indications of Aircraft Instruments, and Places of Switches and Levers

On the fuel control and hydraulic pressure control panels, switches for both the No.1 and No.2 engines were in “AUTO”, “NORM” or “ON” as in the normal flight positions; however, No.1 engine FUEL switch position was not determined due to its damage.

2.11 Medical Information

According to the autopsy report presented by the 6th Regional Headquarters, the PIC’s cause of death was a rupture of the heart due to a blow on the left chest while that for the Co-pilot was a cranium base fracture. Both pilots tested negative for alcohol or addictive drugs.

The causes of death for the two mechanics and the radio operator were blows on the whole body and cranium fractures.

2.12 Information on Search and Rescue

According to the 6th Regional Headquarters, search and rescue were made as mentioned below:

Time	Summary
About 15:13	The 6th Regional Headquarters received a 118 call*10 that a helicopter crashed into the sea south of Sanagijima, and then notified it to the Station. Upon receiving the message, the Station immediately tried to establish a radia contact with the Aircraft, but there was no responsel.
About 15:23	The Station received information from the Takamatsu Airport Office of the Osaka Civil Aviation Bureau that a helicopter has crashed after hitting the

*10 The 118 is a telephone number designated by the Japan Coast Guard for reporting marine accidents and cases.

	overhead wires between Sanagijima and Oshima.
About 15:50	A patrol boat found a vacant lifeboat and floating oil near the crash site.
About 16:10	The patrol boat found the wreckage of the Aircraft on the sea bottom about 10 m deep and confirmed the tail boom of the Aircraft floating nearby.
About 16:50	Later, the patrol boat rescued four crewmembers and transported them to Tadotsu Port, then to Kagawa Rosai Hospital.

The last crewman was found near the accident site around 06:30 on August 21, rescued and transported to Takamatsu Coast Guard Office.

Ships and aircraft mobilized for the search and rescue operation included nine ships and six helicopters of Japan Coast Guard, one helicopter of the Kagawa Prefecture Police Aviation Unit, one Fire and Disaster Prevention Helicopter of Kagawa Prefecture and 10 fishing boats.

2.13 Visual Detection Tests

Obstacle light visual detection test for Sanagijima Obstacle Light and Oshima Obstacle Light was done from 10:00 to 12:00 on October 7, 2010 with a helicopter. At the same time, the visual detection of overhead wires of a similar specification extended between Ogishima and Megishima (hereinafter referred to as "the Ogi-Megi Lines") was confirmed. When the helicopter was flying northward along the western coast of Takamijima, both Oshima and Sanagijima were in sight ahead on the left side.

(1) Weather

It was fine on the day of the tests. Meteorological observations according to the automated meteorological data acquisition system at Tadotsu, Kagawa Prefecture, were as follows:

11:00: Wind direction: north, Wind velocity: 4.2 m/s, Temperature: 23.5 ºC, Precipitation: 0 mm

(2) Test procedure

The helicopter flew at about 30 kts in a rectangular airspace south of Oshima and southeast of Sanagijima six times from the east to the west with an interval of four seconds of latitude (about 124 m) at about 200 ft. Furthermore, the helicopter traced the Aircraft's estimated flight route at about 230 ft as its lowest flying altitude.

(3) The findings

a. The flight at an altitude of about 200 ft in the rectangular area mentioned above revealed that there are three areas in terms of visual confirmation:

・an area where a visual confirmation of the Sanagijima Obstacle Light is possible (hereinafter referred to as "the Area A"),

・an area where it is impossible due to the obstruction of Oshima (hereinafter referred to as "the Area B") and an

・an area where visual confirmation is blocked by obstacles (hereinafter referred to as "the Area C").

b. On the Aircraft's estimated flight route (at an altitude of about 230 ft), there were zones where the visual confirmation of Sanagijima Obstacle Light is possible (hereinafter referred to as "Zone 1, Zone 3, Zone 5 and Zone 7") and zones where visual confirmation is impossible (hereinafter referred to as " Zone 2, Zone 4 and Zone 6").

In Zone 1, the obstacle light comes into view when a pilot is looking ahead. In Zone 2 the light cannot be visually confirmed because it is behind Oshima.

The table listed below shows the distance of each section, the flying speed and

whether the Sanagijima Obstacle Light was visible or not.

The flying speed in each zone mentioned in the table is the average flying speed on the Aircraft's estimated flight route.

The time for visual confirmation is equal to the flight time for each zone as calculated from the Aircraft's average flying speed in each zone and the zone distance. Zone 6 and Zone 7 are on the Aircraft's originally planned flight routes for which actual flight data are not available. Therefore, the average speed for these zones was calculated at about 88 kts by using the Recorded Final Location/time, the time of abnormality detection and the straight distance between the Recorded Final Location and the place where the overhead wires were severed.

Zone	Distance	Flying Speed (Average Speed)	Required Time Visible or Not
Zone 1	About 0.79 nm (about 1,460 m)	About 100 kts	About 28 seconds Visible
Zone 2	About 0.63 nm (about 1,160 m)	About 100 kts	About 23 seconds Not visible
Zone 3	About 0.21 nm (about 380 m)	About 100 kts	About 8 seconds Visible
Zone 4	About 0.12 nm (about 220 m)	About 97 kts	About 4 seconds Not visible
Zone 5	About 0.10 nm (about 180 m)	About 91 kts	About 4 seconds Visible
Zone 6	About 0.12 nm (about 220 m)	About 88 kts	About 5 seconds Not Visible
Zone 7	About 0.15 nm (about 280 m)	About 88 kts	About 6 seconds Visible

c. Oshima Obstacle Light (an elevation of about 451 ft) sits higher than the Aircraft's altitude (about 230 ft) on the estimated flight route by about 221 ft. Therefore, when the Aircraft came close to the obstacle light, the pilot had to look up to see it. As a result, the Oshima Obstacle Light could not be seen even from the Zone 5 and Zone7 where the Sanagijima Obstacle Light visible, in cases where the pilot has taken a normal operational posture. The Aircraft's altitude against the Oshima Obstacle Light in those zones was lower than the altitude where obstacle light should be visually confirmed from all the directions (upwards from 5° below horizontal plane comprising the light source center) as stipulated in the installation standards for aeronautical obstacle lights in Article 127 of the Ordinance for Enforcement of the Civil Aeronautics Act, to be described in 2.14.3 (1) c.

d. It was revealed that the trees around the tower on Sanagijima were responsible for prohibiting the visual confirmation from the Area C. It was also confirmed that the same applies to the Oshima Tower.

e. As to the visual detection of the Ogi-Megi Lines, flying near the overhead wires at almost the same altitude as the top of the power line steel towers revealed the visual detection of them very difficult. An obstacle light was installed on the top of each power line steel tower; however, obstacle markings were not installed on the overhead wires.

(See Figure 6 Airspace Layout on Visual Recognition of Sanagijima Obstacle Light, Photo 8 Towers and Obstacle Lights on Oshima and Sanagijima, Photo 9 Discerning Sanagijima Obstacle Light)

2.14 Additional Information

2.14.1 Fields of View from Top of Sanagijima Tower

Details of the field of view from the top of Sanagijima Tower in the pictures shot on September 6, 2010 were as follows (directions measured from 0º on the north):

By comparing the examinations results on problematic trees around the Sanagijima Tower described in 2.13 and trees seen from the top of the same power line steel tower, it became clear that the trees in front of the power line steel tower (25 to 35 m southeast (110° to 135°) of it) was responsible for blocking the obstacle light when the Aircraft was on the estimated flight route.

To the east (90º to 110º)	Because trees were lower than the view point, areas down to the sea was visible.
To the southeast (110º to 135º)	Because the tree tops to the right were higher than the view point, more than half of the field of view to the right was blocked.
From the southeast to the south (135º to 180º)	The field of view was blocked by trees higher than the view point.
From the south, to the west, the north and the northeast (180º to 45º)	Field of view was blocked by the slope behind the tower.
From the northeast to the east (45º to 90º)	Due to the higher view point than trees, nothing blocked the field of view.

(See Photo 1 Distant View of Oshima and Sanagijima, Photo 8 Towers and Obstacle Lights on Oshima and Sanagijima, Photo 10 Blocked Field of View at Sanagijima Tower)

2.14.2 Maintenance and Administration of Distribution Facilities

The Electric Power Company, being responsible for installing and maintaining electric power distribution facilities (power line steel towers, overhead wires and obstacle lights) has maintained them by establishing the Distribution Maintenance Procedure and the Distribution Equipment Maintenance Standard. Their maintenance was done per prescribed patrol frequency and inspection procedures. The obstacle lights had been inspected from the ground as a standard procedure. There were no record of on-power line steel tower inspection after the obstacle lights were installed on March 31, 2008.

(1) The Distribution Maintenance Procedure and the Distribution Equipment Maintenance Standard included the following remarks regarding the maintenance of electric power distribution equipment: (Excerpt)

a. Distribution Maintenance Procedure

Chapter 1 General Rules

(Scope)

1.2 This Procedure shall apply to maintenance jobs performed by the distribution division, such as patrolling, inspection, measurement, processing of electric accidents and disaster-related measures, as well as survey jobs for general-use electric structures. (Omitted)

(Omitted)

Chapter 2 Patrolling, Inspection and Measurement

(Omitted)

(Operation of Jobs)

1.5 Jobs related to distribution maintenance shall be operated in accordance with pertinent laws, regulations and rules and this procedure.

(Omitted)

2.2 Patrols are done periodically or temporarily.

(1) Periodic patrols shall be done once in five years or, if need be, more frequently considering the regional characteristics, circumstance changes and other factors. Patrols shall be performed mainly from the ground to visually check the condition of electric structures and surrounding objects.

(Omitted)

(Division of Inspection Jobs and Range of Application)

2.3 Inspections are done periodically or temporarily.

(1) Periodic inspections shall be performed in the following manner at a determined frequency.

a. General inspection of Lines shall be performed mainly from the ground to visually check electric structures' deterioration and damage. Their relative conditions with surrounding objects shall be checked simultaneously and if necessary, the structures shall be inspected by climbing them up.

(Omitted)

b. Electric Power Distribution Equipment Maintenance Standard

(Type and frequency)

2.2.1 The type and frequency of patrolling, inspection and measurement shall be as mentioned below:

Type				*Frequency*
Patrolling	*Periodic inspection*	*Specially designated areas*	*Areas of frequent changes of circumstance.*	*Once in 2 years*
			Areas of frequent cut down of vegetation.	*Once or twice a year*
		General areas	*Areas other than those mentioned above*	*Once in 5 years*

Chapter 2 Patrolling

(Type and Method of Patrolling)

2.2.1 (1) Periodic patrolling shall be done from the ground by visually confirming the electric structures' condition against other objects, and the condition of the facilities.

(Omitted)

2.3.1 (1) Periodic inspection shall be done from the ground by visually confirming the electric structures' deterioration, damage, and if need be, on-structure close inspection.

While doing above, the surrounding conditions shall be inspected.

(Omitted)

(2) Patrol of Electric Power Distribution Line Facilities and Felling Control

a. Frequency of Patrol

Fiscal year 2009

June 11, 2009 Sanagijima

June 17, 2009 Oshima

Fiscal 2010

May 31, 2010 Oshima and Sanagijima

August 6, 2010 Oshima

b. Felling control

Fiscal 2009

August 19, 2009 Sanagijima

Cutting branches around the power line steel tower and the wires and clearing undergrowths around the power line steel tower

September 8, 2009 Oshima

Cutting branches around the power line steel tower and the wires

February 23, 2010 Oshima

Clearing undergrowths around the power line steel tower

February 23, 2010 Sanagijima

Cutting trees around the wires and clearing undergrowths around the power line steel tower

2.14.3 Installation and Administration of Obstacle Lights

Descriptions about the installation and maintenance of obstacle lights in the Civil Aeronautics Act, the Ordinance for Enforcement of the Civil Aeronautics Act, a notice and such are as follows: (Excerpt)

(1) Civil Aeronautics Act

a. *Article 51, Civil Aeronautics Act (Obstacle Lights)*

(1) to (4) (Omitted)

(5) The Minister of Land, Infrastructure, Transport and Tourism and any person who has installed obstacle lights pursuant to the provision of paragraph (1) or (2) shall administer such aeronautical obstacle lights in accordance with the methods specified by Ordinances of the Ministry of Land, Infrastructure, Transport and Tourism.

b. *Article 51-2, Civil Aeronautics Act (Obstacle Markings)*

Any person who has installed a chimney, steel Power line steel tower or any other object specified by Ordinances of the Ministry of Land, Infrastructure, Transport and Tourism, which is considered difficult to be perceived from aircraft in the light of day and is also at the height of 60 m or more above the ground or the water, shall install obstacle markings upon such object pursuant to the provision of Ordinances of the Ministry of Land, Infrastructure, Transport and Tourism.

(Omitted)

c. *Article 127, Ordinance for Enforcement of the Civil Aeronautics Act (Types and Administration Standards of Obstacle Lights)*

The standards for administering aeronautical lights installed pursuant to the

provision of paragraphs (1) and (2) of Article 51 of the Act (including a case where said provision shall apply mutatis mutandis in compliance with the provision of paragraph (2) or (3) of Article 55-2 of the Act) shall include high intensity obstacle lights, white medium intensity obstacle lights, (Omitted) *and the standards for installing them shall be as listed below:*

(a) High intensity obstacle lights

1. The lamp light shall be flashing lights in white and visible from all the directions upward from 5 degrees below horizontal plane comprising the light source center.

(Omitted)

(b) Medium intensity white obstacle lights

1. The lamp light shall be flashing lights in white and visible from all the directions upward from 5 degrees below horizontal plane comprising the light source center.

(Omitted)

(vii) For the objects listed in paragraph (1) item (iii) of Article 132-2, on top of a supporting object (excluding the case where installing a high intensity obstacle light is deemed inappropriate by the Minister of Land, Infrastructure, Transport and Tourism because of the topological conditions, relationships with existing objects or installed conditions of said object) instead of said object, one of more high intensity obstacle light(s) in order to allow aircraft in all the directions to recognize said object. However, in the case where the spacing of said objects (limited to those having a height less than 150 m) are 1,200 m or less and deemed proper by the Minister of Land, Infrastructure, Transport and Tourism, one or more medium intensity white obstacle light(s) shall be installed on top of said object in order to allow aircraft in all the directions to recognize said object.

(Omitted)

d. Article 128, Ordinance for Enforcement of the Civil Aeronautics Act ((Methods of Administering Obstacle Lights)

(i) (Omitted)

(ii) When the functions of obstacle lights may be affected by other objects including building structures and vegetation, necessary measures such as removal of said objects shall be taken.

e. Article 132-2, Ordinance for Enforcement of the Civil Aeronautics Act (Objects Installed with Obstacle Markings)

The objects required to be installed with obstacle markings pursuant to the provision of paragraph (1) of Article 51-2 of the Act, shall be as listed below. (Omitted)

(i) and (ii) (Omitted)

(iii) Overhead wire stipulated and notified by the Minister of Land, Infrastructure, Transport and Tourism

(Omitted)

(2) Notice

Ministry of Land, Infrastructure, Transport and Tourism Notice No. 1478 (Effective on December 26, 2005)

A Notice for stipulating overhead wire for which obstacle markings must be

established pursuant to the provision of paragraph (1) item (iii) of Article 132-2 of the Ordinance for Enforcement of the Civil Aeronautics Act (Ministry of Transport Ordinance No. 56, 1952) shall be as below.

A Notice for stipulating overhead wire for which obstacle markings must be established

1. Overhead wire which shall fall under a category designated by the Notice pursuant to the provision of paragraph (1) item (iii) of Article 132-2 of the Ordinance for Enforcement of the Civil Aeronautics Act (hereinafter referred to as "the Ordinance") shall be those mentioned in the following paragraphs:

a. (Omitted)

b. Overhead wire on the sea

(3) Commentary and Implementation Guidelines

The Commentary and Implementation Guidelines regarding the installment and others of obstacle lights/obstacle markings.

(Visual Aids and Electrical System Office, Civil Aviation Bureau (CAB)*, Ministry of Land, Infrastructure, Transport and Tourism, October 2009)*

(1) and (2) (Omitted)

(3) Methods for Installing Obstacle Markings

Obstacle markings must be established in different methods (color of coatings, flags and marking means), depending on the type of objects. These markings can be partially omitted, depending on the objects involved, their shape, the condition of the location for installment (relationships with objects in surrounding areas) and other matters. The methods can be outlined as follows:

a. and b. (Omitted)

c. Marking means (spherical marking means)

Overhead wire which will be stipulated by the Notice must have a solid red or solid yellow-red marking means and a solid white marking means, each in a globular shape with a diameter of 0.5 meter or larger, established alternately with an equal spacing of 45 m.

When a high intensity obstacle light or a medium intensity white obstacle light has been established for a supporting structure, there is no need to install an obstacle marking.

2.14.4 Japan Coast Guard Aircraft Operation Manual and Related Procedures

The Aircraft was operated in accordance with the Patrol Flight Procedure and the Low-level Flight Procedure stipulated in Chapter 8 Operation Flight Procedure of the Japan Coast Guard Aircraft Operation Manual (hereinafter referred to as "the Operation Manual") and the Japan Coast Guard Aircraft Operation Safety Manual (hereinafter referred to as "the Safety Manual") as well as the Operation Procedure for the Aircraft Operation Safety Manual, the Station of the 6th Regional Coast Guard Headquarters (hereinafter referred to as "the Operation Procedure"). Excerpts from the Patrol Flight Procedure and the Low-level Flight Procedure in the Operation Manual, the Safety Manual and the Operation Procedure are as listed below. The procedures and other documents mentioned above had no descriptions about obstacle flight and the 6th Regional Obstruction Layout Map (hereinafter referred to as "the Obstruction Map") to be described later in 2.14.7. (Excerpts)

(1) Monitoring Service Flight Procedure

(1) General

(Omitted)

(2) Flights at Minimum Safety Altitude or Less

Before an aircraft descends below minimum safety altitude, the captain shall report to the Station about "a flight below the minimum safety altitude" considering the radio coverage, and after returning to the altitude where radio communication is possible, he shall so report to the Station.

(2) Low-level Flight Procedure

2. Specific Setting for the Flight

(2) Low flying altitude zone

a. An altitude zone from 500 ft to 300 ft shall be referred to as the "Low Flying Airspace" and an altitude zone 300 ft or below the "Very Low Flying Airspace."

(Omitted)

c. When the aircraft maneuvers at low altitude, the captain shall (Omitted) *start a descent after informing all crewmembers of the maneuver.*

(Omitted)

4. Safety Measures in Low-level Flight

(1) (Omitted)

*(2) Confirmation of safety by the PF*11 and the PM*12 in the Very Low Flying Area*

a. When the aircraft descends to the Very Low Flying Area, a PF shall provide a crew briefing and (Omitted)

b. When the aircraft descends to the Very Low Flying Area, a PF shall reconfirm the individual duty assignment before the start of the descent. (Omitted)

(3) Crew Briefing by PF

a. Outlined job description (Picture taking (including evidence collection), (Omitted) *confirmation of situation)*

(Omitted)

e. Ingress and egress routes

(Omitted)

i. Lowest Descent Altitude

(Omitted)

(3) Safety Manual

(Minimum Safety Altitude)

Article 11 When flying under VFR, the captain must keep an altitude 300 m or more above the top of the highest obstacle within a horizontal range of 600 m around the aircraft. But this shall not apply when otherwise mentioned as necessary for performing duties.

(Watch)

Article 18 Aircraft crewmember must maintain outside watch during the flight to avoid a collision with other aircraft or obstacles.

(4) Operation Procedure

(Preparation of Checklists)

Article 3 The flight team leader must prepare the following checklists aboard the aircraft:

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*11 The PF means the pilot in charge of flying the aircraft, according to the Operation Manual.

*12 The PM means the pilot not flying (PNF) also in charge of monitoring instruments and others.

(1) A checklist for aircraft operations (including emergency operations)

(2) A checklist for onboard duties (Omitted)

(Briefing before Departure)

Article 6 The captain must brief to the station manager and crewmembers on the outline of the flight plan, safety issues and other necessary matters before departure and at the same time, clarify each crewmember's duty.

2. The captain, prior to the briefing mentioned in Clause 1, shall have a full discussion with the flight team leader and the person in charge of operation support.

(Minimum Safety Altitude)

Article 10 The captain, when he flies at a lower altitude than an altitude specified in Article 11 of the Safety Manual due to the job necessity, must notify the Station of the scheduled time for the end of the flight and the altitude. (Omitted) *The same applies when its job ends and the aircraft climbs to the minimum safety altitude.*

2. The person in charge of operation support, with a reception of a report provided by the captain in accordance with Article 11 of the Safety Manual, must pay attention to the aircraft's operation and in case of no report of its climb to the minimum safety altitude even after the scheduled time, must immediately take necessary measures, such as making a radio contact.

(Person in Charge of Operation Support)

Article 12 The flight team leader shall appoint a person who satisfies the following requirements as the person in charge of operation support: (Omitted)

4. The person in charge of operation support shall perform duties listed in Attached Table 2 in the operation control room.

5. The person in charge of operation support must precisely grasp the situation of duties performed by the aircraft while actively providing necessary information. At the same time, he shall act as a liaison and make adjustments with related organizations to ensure its safe and efficient activities.

(5) Duties for the Person in Charge of Operation Support (Attached Table 2)

1. Grasping the Aircraft's Status

(1) The aircraft location

(2) The status of duty performance

(3) The status of the aircraft performing duties at altitude lower than minimum safety altitude.

2. Grasping Meteorological Condition (Omitted)

2.14.5 Japan Coast Guard Aircraft Training Manual

The Co-pilot was receiving the Captain Training during the flight at the time of the accident in accordance with the Japan Coast Guard Aircraft Training Manual (hereinafter referred to as "the Training Manual") designated by the Coast Guard. The Training Procedure stipulated in Chapter 1 is as follows. (Excerpt)

(Training Procedure)

1-0-2 Crew Configuration and Division of Duties according to the Type of Flight

1. to 3. (Omitted)

4. Captain Training/Co-pilot training

(1) (Omitted)

(2) Captain Training

The trainee shall receive training in the right seat and (Omitted) *perform operations for a PF.*

(Omitted)

2.14.6 Permission for Flights on Altitudes at Minimum Safety Altitude or Less

The Station had filed an application for permission for flights below Minimum safety altitude (MSA) to the Civil Aviation Bureau of the Ministry of Land, Infrastructure, Transport and Tourism (the Takamatsu Airport Office, the Osaka Civil Aviation Bureau) on June 1, 2010, and received the permission on June 23, 2010. The purpose of the flights was coast guard service. The following remarks were added as matters of reference: (Excerpt)

Concerning the Article 81, Civil Aeronautics Act,

(1) A flight shall be made only under VMC (daytime only) condition.

(2) A flight shall be made after confirming the absence of obstacles and ships in the nearby waters.

(3) An application shall be filed for under the jurisdiction of Takamatsu Airport Office within that of the 6th Regional Coast Guard Headquarters.

(Omitted)

2.14.7 Obstruction Map

Pilots at the Station used the Obstruction Map which describes the locations and altitudes of power line steel towers, overhead wires and other obstacles in the waters covered by the Station. They carried it when they flew. It was on board the Aircraft when this accident occurred.

In order to grasp the locations and heights of overhead wires which are not included in the data provided by the Civil Aviation Bureau, the Station had produced the map adding data about the altitudes of inter-island overhead wires by obtaining information from the Hydrographic and Oceanographic Department of the Coast Guard.

The height of inter-island overhead wires on the Obstruction Map was not the higher top height of the power line steel tower on either end of the lines. It was obtained by adding 100 ft to the height of the Lowest Overhead Wire Height from the Sea Level which was released by the Electric Power Company. Therefore, in case of a longer span of overhead wires the middle part sag more and areas closer to the power line steel towers are considerably higher than the lowest part. In the case of the overhead wires hit by the Aircraft, the altitude of the overhead wires above the sea closer to the Oshima Tower was higher than described on the Obstruction Map.

(See Figure 7 Obstruction Map)

2.14.8 Outlines of Briefing on the Day of Accident at the Station and Flights

The outlines of a pre-flight briefing and that of the way to perform low altitude flights were as follows according to the statements of the General Service Director and the Flight Team Leader.

(1) Statement of the General Service Director

The pre-flight briefing was held for five minutes from 13:25. Participants were a total of 10 persons: five persons abroad, the Station Manager, the General Service Director and three others. The PIC presided the briefing. The briefing developed in line with the flight plan for the day: the hulk investigation in the eastern part of the Seto Inland Sea; the demonstration flight for the Boat as part of the experience cruise; and the Captain Training. The demonstration flights were scheduled to be performed during the two rounds of the Boat cruise (the first round from 14:00 to 14:50 and the second round from

15:00 to 15:50). Specifically, the first flight was scheduled to be near the end of the first cruise and the second flight after the second group sail-out, by maintaining the Aircraft-to-Boat radio contact. It takes about 25 minutes for the Boat to cruise from Mizushima Port to the demonstration flight area. The hulk investigation was planned to be carried out in the course of the demonstration flight. The participants discussed the need to pay attention to floating oil and breach fishing operations as well. They also confirmed that the route to be non-problematic with favorable weather, while the aircraft and communication equipment had no anomalies, either. As there were no opinions expressed by other supporters, the preflight briefing ended. The PIC did not remind the participants of overhead wires.

(2) Statement of Flight Team Leader

Because the day was a legal holiday, the Flight Team Leader went to the Station upon receipt of the accident report. Therefore, he did not participate in the preflight briefing and had no knowledge about details of the briefing. But he was informed that the flight on the day had been aimed at performing a hulk investigation, the Captain Training and a demonstration flight and that the PIC had not reminded the participants of the obstacles.

A demonstration flight is performed at a slightly lower altitude because the aircraft flies along the cruising ship and sometimes, hovers behind the ship. In a hulk investigation, the aircraft flies to find hulks and wasted objects under the tree foliage while keeping a certain distance and altitude along the coastlines. The aircraft flies higher in areas where there are ports or houses for noise abatement. The direction of circling in these missions is clockwise because a PIC occupies the right seat.

The Station has obtained permissions under the Civil Aeronautics Act for flights at altitudes equal to or below the Minimum Safety Altitude (hereinafter referred to as "MSA"). As safety measures for low altitude flights, when the altitude will be below MSA, a pilot is required to lower the altitude only after reporting this to the Station with radio. When flying below MSA, including at a very low altitude, he is required to determine the lowest descent altitude while in a safe altitude, he/she must provide an in-flight briefing for the safety confirmation and mutual understanding. But there was no radio communication about descending below the MSA at the time of the accident. The Flight Team Leader was not sure whether this practice had been always abided by in the flights preceding the accident flight.

The Flight Team Leader had not given lessons to individual pilots on how to clear linear obstacles. They have obtained knowledge from senior pilots about the need to confirm power line steel towers or fly parallel to overhead wires during maritime search missions. Therefore, pilots are aware of the need to fly over a power line steel tower, not over overhead wires, as common sense.

Areas ahead of the aircraft are usually watched by the pilots and areas behind on both sides by a mechanic or crewmembers. Aircraft sometimes have to fly over straits or between islands (hereinafter referred to as "Inter-Island Flights") in its jurisdiction. Overhead wires are extended at some of those locations. So the Flight Team Leader recognizes that the Inter-Island Flight over linear obstacles is a kind of peculiar features of its jurisdiction, compared to other Regional District Areas. Therefore, pilots perform Inter-Island Flights while reminding themselves that there may be obstacles such as overhead wires. But the Station has no specific reference material for Inter-Island Flights

or accompanying remarks.

Altitudes are described on the Obstruction Map, but they only serve as rough altitudes, not actual heights of overhead wires. Pilots use the Obstruction Map; however, none of them interprets it safe to fly at the described altitude on the map. They understand that there may be power line steel towers or overhead wires at higher places than those described on the map and none of them takes them as a safe altitude. But the correct interpretation of the altitudes described on the Obstruction Map has not been provided at the Station.

An Inter-Island Flights starts after confirming the obstacles, by keeping a certain distance from the islands, or after confirming the surrounding situation by, for example, passing well above the area keeping an altitude higher than the elevation of the islands.

The Captain Training for the Co-pilot was the third of its kind. The Co-pilot had obtained a PIC status for different types of aircraft. He had experience in hulk investigations and patrolling. He could manage himself as a PIC. The Captain Training in the latest flight was aimed at better assimilation to the Aircraft and its flight characteristics.

The latest series of hulk investigation started in June 2010. In the latest flight, a hulk investigation was planned for Teshima and Takamijima. However, because no hulk investigation had been done for Oshima and Sanagijima, it seems that the Aircraft have attempted to cover these islands, too.

2.14.9 Flight Operations Performed by the Station

According to a statement made by one Station pilot (hereinafter referred to as "the Pilot A"), the Station's interpretation of low altitude flights for missions such as hulk investigation and concerning overhead wires are summarized as follows:

One of the peculiarities of the 6th Regional Area is that the jurisdicton is dotted with many islands of high elevation. In addition, some of them are spanned with overhead wires and bridges. The Pilot A himself carries and uses the Obstruction Map, and when he was not fully experienced with his activities, he consulted it beforehand. But this does not mean the Map guarantees the safety. Because there are overhead wires at low altitudes which are not depicted on the map, pilots always perform Inter-Island Flights reminding themselves that there may be obstacles ahead. Obstacle related matters are not entirely covered in a preflight briefing. It all depends on the nature of duties.

Peculiar aspect of overhead wires extended between islands in the Seto Inland Sea is that undersea cables and overhead overhead wires between power line steel towers are combined in some cases. Underwater cables coming out of the sea onto an island are extended to the next island via power line steel towers and a span of suspended overhead wires. The overhead wires on the next island are linked to submerged cables for further extension. This being the case, there is no linear continuity as overhead wires in the mountainous area. The span of overhead wires is also long because they have to link islands. Furthermore, as overhead wires themselves are difficult to be seen pilots try to find power line steel towers. But not all power line steel towers are equipped with obstacle lights and there are low power line steel towers without obstacle lights. Not assuming that obstacle lights are always installed on power line steel towers, but with suspicion of obstacles, they always try to detect them by reducing the speed or hovering for confirmation.

Pilots perform hulk investigations trying to be careful not to cause trouble on the ground

or to abate noise considering the nature of the flight. As far as objects on or just above the water, such as abandoned rafts are concerned, aircraft sometimes lower the altitude or reduce the speed at the PIC's discretion. When targets are spotted, a crewmember takes pictures.

2.14.10 Sun Altitude and Azimuth

The sun altitude and the azimuth at the time of the accident were as follows:

At 15:00, August 18 Sun altitude: 46.3 degrees, Azimuth: southwest

3. ANALYSIS

3.1 Qualifications of Personnel

The PIC and the Co-pilot had both valid airman competence certificates and valid aviation medical certificates.

3.2 Airworthiness Certificate of the Aircraft

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

3.3 Relations to Meteorological Phenomena

It is highly probable that the weather condition at the time of the accident had no bearing with the occurrence of this accident.

The sun altitude and the azimuth were as described in 2.14.10, and because the Aircraft was almost in a level flight heading west or north, it is highly probable that the sunshine had no influence on the operation of the Aircraft and the visual recognition of Sanagi Lines and the obstacle lights.

3.4 Engines and Airframe of the Aircraft

As described in 2.10.2, the engines of the Aircraft were seriously damaged, but there were no signs of abnormal combustion in the areas including an exhaust duct. The main drive shaft which connects to the output shaft for both engines was broken in the rotational direction. Based on these findings, it is highly probable that the engines of the Aircraft were normally functioning until the time of the Aircraft's crash.

As described in 2.1.1, the Flight Data did not contain peculiar data that indicates an abnormal flight in terms of altitude or speed. The statement described in 2.1.2 also suggests no abnormal sign for the Aircraft until it hit the overhead wires. Therefore, it is highly probable that the Aircraft was flying in a normal condition with no anomalies for its airframe until the occurrence of the accident.

3.5 Management of Electric Power Distribution Equipment

Because the Electric Power Company's monitoring equipment stored no abnormal data for obstacle lights on Oshima and Sanagijima at the time of the accident as described in 2.8 and their function after the accident was normal, it is highly probable that the lights were normally functioning at the time of the accident.

As described in 2.14.2, the Electric Power Company checked the power line steel towers, lines and its surrounding situation from the ground every year. Undergrowth and tree branches were cut as part of the check. But there were no on-tower inspection records. Therefore, it is cleared and highly probable that its workers had not climbed up the power line steel towers to confirm the light's field of view, so that they were not aware that it had been blocked by trees. Therefore, it is highly probable that the Sanagijima Obstacle Light could not be visually confirmed from an airspace on the southern side of Oshima at an altitude lower than the elevation of the top of the Sanagijima Power line steel Tower, so that the Electric Power Company failed to administer the facilities as stipulated in Article 51 of the Civil Aeronautics Act and Article 128, item (ii) of the Ordinance for Enforcement of the Civil Aeronautics Act described in 2.14.3 (1).

3.6 Aircraft's Flight into Sanagi Lines

As described in 2.1.1, the Aircraft flew eastward at about 86 kts near the northern tip of Takamijima at about 375 ft around 15:08:30. Then, while making a left turn to the west it gradually lowered altitude around 15:08:55 and entered an airspace southern side of Oshima around15:09:57 at around 227 ft at about 100 kts. It started a right turn later. Around 15:10:04 it was flying at about 238 ft at about 89 kts. No flight data since then until the wire strike was stored in the recording device. But as described in 2.13 (3) b, the average speed during this period was estimated to be about 88 kts. As described in 2.10.1 (3), the average height of the severed points of the Sanagi Lines above the sea surface was about 250 ft.

Based on the findings above, it is highly probable that the Aircraft crashed after hitting the Sanagi Lines while flying at about 88 kts from the south to the north between Oshima and Sanagijima at about 250 ft.

The Sanagi Lines exhibited conspicuous bends, curves and traces of abrasion in the areas involved, as described in 2.10.1 (3). On the other hand, the Aircraft's forward cross tube had a conspicuous abrasion and a groove on its right side and a MRB had wrinkles on its leading edge as described in 2.10.2 (1) and (2). Therefore, it is highly probable that the Aircraft hit the wires with the cross tube and the MRB, and then the lines were severed as a result of the Aircraft's push along its flight path.

3.7 Changes in Flight Plan and Demonstration Flight

According to the statement in 2.14.8 (1), the PIC presided a pre-flight briefing about the hulk investigation and other matters in line with the flight plan. But he did not mention the overhead wires. It is highly probable that one reason for the lack of his reference to overhead wires is the fact that Oshima and Sanagijima had not been registered in the planned route, as described in 2.1, and another reason is that there were no overhead wires extended among Teshima, Hiroshima and Takamijima, as described in 2.8.

As described in 2.9, the Aircraft obtained information from the Boat with radio around 15:03, when it was performing a hulk investigation, that the Boat had left the port at 15:00 as scheduled for the second round of experience cruise. After that, as described in 2.1.1, the Aircraft passed near the northern tip of Takamijima around 15:08 and then, after changing its direction to the west, it was flying toward Oshima and Sanagijima.

According to 2.10.1 (1), the distance from Takamijima to the demonstration airspace is about 8.1 nm. It takes about five minutes to cover this distance by flying at about 100 kt. Therefore, assuming that the Aircraft was flying toward the airspace as scheduled after finishing a hulk investigation over Takamijima, it is highly probable that there was a leeway of about 12 minutes until the scheduled rendezvous with the Boat at 15:25, (estimated time of rendezvous around 15:13). After the hulk investigation over Takamijima, the Aircraft was flying toward Oshima and Sanagijima. As the flying speed for the hulk investigation is about 50 kt and the circumference of Oshima and Sanagijima combined is about 5.4 nm as described in 2.1.1 and 2.10.1 (1), the hulk investigation for the islands requires about seven minutes. With the assumption that the Aircraft flew at 100 kt to the rendezvou point about 8.1 nm away, flight time would be five minutes. Therefore, with the fact that the Aircraft flew past the eastern tip of Oshima around 15:09, even assuming that the Aircraft flew toward the airspace for the demonstration after finishing the hulk investigation of both islands, it is highly probable that it had a leeway of about four minutes (rendezvou with the Boat around 15:21) until the rendezvous with the Boat at 15:25.

Based on the findings mentioned above, even if the Aircraft had flown toward Oshima and Sanagijima and for hulk investigation, it is somewhat likely that it had not deviated greatly from

the original return route and there had been a leeway in the time for the demonstration flight. Also because it was possible for the Aircraft to contact the Boat by radio, it is somewhat likely that the Aircraft had changed its flight plan and flown toward a hulk investigation of Oshima and Sanagijima where no hulk investigation had been done. It is somewhat likely that the flight plan was changed to perform a hulk investigation of the two islands after the monitoring of the radio message from the Boat at 15:03 as described in 2.9, and after the two islands came into view while it was investigating the western coast of Takamijima. However, because there was a leeway in the time for the Aircraft, it is highly probable that the Aircraft was not in a situation where the unscheduled hasty hulk investigation had to be done.

3.8 Changes in Flight Plan and PIC and Co-Pilot's Awareness of Obstacles at the Time of Accident

As mentioned in the statements described in 2.14.8 (2) and 2.14.9, pilots at the Station, when performing an Inter-Island Flight at low altitudes, always remind themselves that there may be obstacles such as overhead wires considering the characteristics of their jurisdiction. Therefore, it is probable that the PIC and the Co-pilot had same awareness of such possibilities for Inter-Island Flight at low altitudes. But according to the statements in 2.1.2 and 2.14.8 (2), when the Aircraft approached the area between Oshima and Sanagijima, it flew just like moving along the coasts of Oshima keeping a certain distance from it. It is highly probable that the Aircraft did not paid attention to obstacles on the flight path, not to have confirmed hidden danger by hovering before entering the inter-island waterway or flying at an altitude higher than the elevations of the islands. As a result, because there were no overhead wires between Teshima and Takamijima as described in 2.8, it is somewhat likely that the both pilots continued the Inter-Island Flight with the same awareness as before and it is somewhat likely that they had lacked awareness about obstacles in the low altitude flight between the two islands.

As described in 2.1.1 and 2.13(3) b, the Aircraft was continuing its flight from the Low Flying Airspace to the Very Low Flying Airspace at high speed (an average of about 100 kts) from 15:08:30 on, without performing hovering or turning flight. Therefore, it is somewhat likely that they did not confirm safety before descending to the Very Low Flying Airspace near the islands after the end of the hulk investigation at Takamijima. Therefore, it is somewhat likely that they moved toward Oshima and Sanagijima for hulk investigation without confirming the existence of obstacles which may influence the Aircraft's future flight by using their Obstruction Map or other materials.

3.9 Flying Method near Obstacles and Obstruction Map

According to the statement described in 2.14.8 (2), pilots at the Station had awareness about the existence of obstacles when they perform Inter-Island Flight at low altitudes and they were using their Obstruction Maps. However, as described in 2.14.4, the Operation Manual and other documents had no provisions about inter-island maneuvers or near-obstacle flight as well as the map's carry-on status and its use. Therefore, it is highly probable that Station pilots clear linear obstacles following individual method considering the knowledge they have obtained from senior pilots, as described in 2.14.8 (2). The locations of obstacles can be confirmed on the Obstruction Map; however, the definition of its altitude indications was vague; as a result, obstacles existed in areas higher than the indicated altitude. Therefore, it is highly probable that the map served only as a supplementary material and pilots carried it and used it at their discretion.

3.10 Field of View of Sanagijima Obstacle Light

As described in 3.5, it is highly probable that the obstacle lights on Oshima and Sanagijima were normally functioning at the time of the accident.

As described in 2.13 (3) a, b and d, it was confirmed that there are some portions on the Aircraft's flight path south side of Oshima from which the visual detection of flashing light of the Sanagijima Obstacle Light was impossible. Some of them were blocked by Oshima but the remaining portions were blocked by felling (trees) around the tower on Sanagijima. On the other hand, as described in 2.14.1, in the field of view research from the top of the Sanagijima Tower, in the direction to Oshima, the surface of the sea and distant islands to the south of Oshima was visually confirmed looking down from the top of the tower in a range of 90º to 110º in the southeast quadrant (from 90º to 180º), but the view ahead was blocked by tree foliage in a range of 110º to 180º. These trees, when facing the east from the tower, stood at an angle to the right ahead and they were blocking the flashing light to the Aircraft on the estimated flight route.

Based on the findings mentioned above, it is highly probable that the field of view of the flashing light of Sanagijima Obstacle Light was blocked by the trees at an angle to the right ahead of the tower when it was seen from an airspace on the southern side of Oshima below the horizontal plane comprising the top of Sanagijima Tower.

3.11 Visual Detection of Obstacle Lights and Overhead Wires by Pilots

As a result of the visual detection test as described in 2.13 (3), the Sanagijima Obstacle Light could be visually detected in Zone 1, Zone 3, Zone 5 and Zone 7. In addition, as indicated by meteorological observations described in 2.7.2, there was no big difference between the meteorological conditions on the day of testing and those at the time of the accident, in terms of the wind direction, the wind velocity and other factors. Moreover, as described in 3.5, it is highly probable that the obstacle lights on Oshima and Sanagijima were normally functioning at the time of the accident. Based on the findings above, it is probable that the PIC and the Co-pilot could visually confirm Sanagijima Obstacle Light from the same zones as mentioned in the results of the visual detection test.

The obstacle light was seen for about 28 seconds in Zone 1 when a testing aircraft flew at the same speed as that of the Aircraft. In this zone the light naturally came into view when one is looking ahead in the cockpit. In Zone 3, Zone 5 and Zone 7, the obstacle light was seen only for four to eight seconds and it was difficult to visually confirm the flash light of the obstacle light blocked by the trees as described in 3.10. But, as described in 3.8, the PIC and the Co-pilot had been aware of the possible existence of obstacles in inter-island flight at low altitude. Therefore, it is probable that they would be able to aware the obstacle if they had visually confirmed the obstacle light even for a short period of time. Therefore, it is probable that the PIC and the Co-pilot did not have visual confirmation of Sanagijima Obstacle Light, as mentioned above, after leaving Takamijima. However, it could not be determined why they failed the visual confirmation of the Sanagijima Obstacle Light.

As to whether the PIC and the Co-pilot were able to have visual detection of the Sanagi Lines under no obstacle marking condition, it is highly probable that neither of them could visually aware the lines in light of the visual detection test result for the Ogi-Megi Lines as described in 2.13 (3) e.

3.12 Rules about Flights at Lower Altitudes Than MSA and Flights Near Obstacles

As described in 2.14.4 (3), the Coast Guard has established a flying method at MSA or below in the Safety Manual. As described in 2.14.4 (1) (2) and (4), the Operation Manual and the Operation

Procedure require a PIC to report to the Station beforehand when the aircraft flies at the MSA or below and when the aircraft descends to the Low Flying Airspace with an altitude of 500 ft or below, he informs all crewmembers of the lowest descent altitude and furthermore, the PF has to provide a crew briefing when the aircraft descends to the Very Low Fling Airspace with an altitude of 300 ft or below. As the obstacle near Oshima (Oshima Tower (top elevation : 450 ft) and lines) exceeds 300 ft, it is highly probable that the PF's in-flight briefing at 300 ft becomes useless because the Aircraft has already been below the elevation of the obstacles. As described in the statement in 2.14.8 (2), when an aircraft flies at the MSA or lower (very low altitudes inclusive), it is explained that in order to determine the lowest descent altitude before the start of a descent, a pilot provides a necessary in-flight briefing at a safe altitude. But there is no such provision in the Operation Manual.

Based on the findings above, the altitude-specific instructions stipulated in the Operation Manual are considered to be only appropriate for vast airspaces on the sea with no obstacles. But they are not necessarily considered to be appropriate for such situations where aircraft have to have a low altitude Inter-Island Flight in such airspaces as Seto Inland Sea where there are numerous obstacles with various heights.

3.13 Compliance with Rules and Safety Management System for Organizations

As described in 2.9 and 2.14.4, when the Aircraft started a flight below the MSA, it did not report to the Station as stipulated in the Operation Manual and the Safety Manual. The statement in 2.14.8 (2) suggests that this reporting requirement had not always been abided by before the accident. As described in 2.14.4, there was no clear provision on:

- the report to the Station in case of flight plan change;
- Inter-Island Flights and obstacle flights and ;
- carry-on of Obstruction Map and its use

As mentioned above, it is highly probable that the safety provisions were not enforced at the Station with the lack of clear provisions on important matters which are indispensable for the safe operations of aircraft, instead they are left to the individual pilot's discretion, suggesting the insufficient safety management.

3.14 Safety Actions

Based on the results of the analysis mentioned above, the measures as mentioned below are considered to be necessary to prevent a recurrence of accidents which are similar to the latest case. In the meantime, each of the organizations concerned has taken the measures as described in Chapter 5 "SAFETY ACTIONS" following the latest accident.

3.14.1 Operator

As described in 3.8 and 3.11, it is somewhat likely that with the same situation awareness to Inter-Island Flight for Teshima and Takamijima, the PIC and the Co-pilot continued to fly between Oshima and Sanagijimas, lacking the obstacle awareness in the low altitude flight between the latter islands. Therefore, it is somewhat likely that they did not confirm safety when the Aircraft descended to the Very Low Flying Airspace near Oshima and Sanagijima followed by the hulk investigation over Takamijima without confirming obstacles which may influence the Aircraft's operation on the route ahead, either, with their Obstruction Map or other materials. It is probable that both pilots did not have a visual confirmation of the obstacle light, which was seen for about 28 seconds in Zone 1 and for 4-8 seconds in other zones in the visibility testing, and their obstacle awareness was not been generated. Therefore, in case of an alteration of flight plan for a low

altitude flight between islands, a PIC should temporarily suspend a low altitude flight at safety altitude and resume the flight after confirming the route and obstacles ahead on the Map, giving an in-flight briefing on the safety at low altitude to share situation awareness with all occupants for thorough outside watch. In addition to these activities, a PIC should also report to the Station so that ground personnel in charge of operation support can grasp the aircraft situation and provide necessary information in an appropriate manner.

As described in 3.12, the altitude-specific instructions stipulated in the Operation Manual are considered to be only appropriate for vast waters with no obstacles; but, they are not necessarily considered applicable to such situations where aircraft have to have a low altitude Inter-Island Flight in such airspaces as Seto Inland Sea dotted with numerous obstacles with various heights. Therefore, the Coast Guard needs to review the related provisions. (See 5.1).

3.14.2 Installation Organization of Obstacle Lights

As described in 2.14.3 (1) a, the organization who have installed obstacle lights have to administer the facilities in accordance with the Civil Aeronautics Act; but Sanagijima Obstacle Light was not visually confirmed, blocked by trees from a certain direction in an airspace below the top height of the power line steel tower as suggested in the visibility confirmation flight mentioned in 2.13 and as described in 2.14.1. This fact demonstrates that as described in 3.5, the obstacle light was not properly administered as stipulated in the Civil Aeronautics Act. Therefore, the installation organization of obstacle lights should administer them in an appropriate manner by, for example, confirming the field of view from the top of the power line steel tower so that the functions of the obstacle lights can be properly maintained per the Civil Aeronautics Act. (See 5.2 and 5.3).

4. CONCLUSIONS

4.1 Findings

4.1.1 Influence of Weather and Condition of Aircraft

(1) The weather condition on the day of the accident had no bearing with the occurrence of this accident. The sunshine had no influence on the Aircraft's operation and the visual recognition of Sanagi Lines and the obstacle light considering the sun altitude and the azimuth.

(2) There were no anomalies with the engines and the airframe of the Aircraft until the accident occurrence.

4.1.2 Management of Distribution Equipment

It is highly probable that the obstacle lights on Oshima and Sanagijima were normally functioning at the time of the accident.

As the Electric Power Company had not checked the field of view of the obstacle lights by climbing up, it is highly probable that the Company was not aware that the field of view had been reduced by the tree foliage.

The Sanagijima Obstacle Light cannot be visually confirmed in certain airspace on the southern side of Oshima at an altitude lower than the elevation of the top of the Sanagijima Tower. It is highly probable that the Electric Power Company had not administered the obstacle lights in an appropriate manner as stipulated in Article 51 of the Civil Aeronautics Act and Article 128, item (ii) of the Ordinance for Enforcement of the Civil Aeronautics Act described in 2.14.3 (1).

4.1.3 Aircraft's Flight into Sanagi Lines and its Impact

It is highly probable that the Aircraft struck Sanagi Lines while flying at about 88 kts between Oshima and Sanagijima from the south to the north at about 250 ft.

As to the situation in which the Aircraft struck the Sanagi Lines, it is highly probable that the cross tube and an MRB struck the lines, pushing them in its flying direction and eventually the lines snapped.

4.1.4 Changes in Flight Plan

It is somewhat likely that the Aircraft had changed its flight plan to do a hulk investigation of Oshima and Sanagishim where no hulk investigation was done.

It is somewhat likely that the flight plan was changed after the radio message from the Boat at 15:03 and that the Aircraft spotted Oshima and Sanagijima while performing the hulk investigation along the western coast of Takamijima followed by the decision to perform the hulk investigation of the two islands.

4.1.5 Method of Near-Obstacle Flight and Awareness about Obstacles in Inter-Island Low Altitude Flights

(1) Because there were no inter-island overhead wires from Teshima to Takamijima, it is somewhat likely that the PIC and the Co-pilot had lacked obstacle awareness in the ensuing low altitude flight between Oshima and Sanagijima.

It is somewhat likely that they did not confirm safety before descending to the Very Low Flying Airspace near Oshima and Sanagijima after the hulk investigation around Takamijima. Therefore, it is somewhat likely that they moved toward the two islands for

hulk investigation without confirming the existence of obstacles which may influence the Aircraft's future flight by using their Obstruction Map or other materials.

(2) Because the definition of its altitude indications was vague, it is highly probable that the Obstruction Map served only as a supplementary material and pilots carried it and used it at their discretion.

4.1.6 Visibility of Sanagijima Obstacle Light and Visual Confirmation of Obstacle Lights and Overhead Wires by Pilots

(1) It is highly probable that the field of view of Sanagijima Obstacle Light was blocked by the trees at an angle to the right ahead of the tower when it was seen from an airspace on the southern side of Oshima and lower than the elevation of the top of the Sanagijima Tower.

(2) It is probable that the PIC and the Co-pilot did not have visual confirmation of Sanagijima Obstacle Light when they left Takamijima.

It is highly probable that neither of them spotted Sanagi Lines.

4.1.7 Operation Manual and Others Regarding Flights at Altitudes below MSA and Near Obstacles- Flight

The altitude-specific instructions stipulated in the Operation Manual are considered to be only appropriate for vast airspaces on the waters with no obstacles; however, they are not necessarily considered to be appropriate for such situations where aircraft flies a low altitude Inter-Island Flight in such airspaces as Seto Inland Sea where there are numerous obstacles with various heights.

4.1.8 Compliance with Rules and Safety Management System for Organizations

It is highly probable that the safety provisions were not enforced at the Station with the lack of clear provisions on important matters which are indispensable for the safe operations of aircraft, instead important safety matters are left to the individual pilot's discretion, suggesting the insufficient safety management.

4.1.9 Safety Actions

In order to prevent a similar recurrence, the measures mentioned below are considered to be necessary. In the meantime, each of the organizations concerned has taken the measures as described in Chapter 5 "SAFETY ACTIONS" following the latest accident.

In case of an alteration of flight plan for a low altitude flight between islands, a PIC should temporarily suspend a low altitude flight at safe altitude and resume the flight after confirming the route and obstacles ahead on the Obstruction Map, giving an in-flight briefing on the safety at low altitude to share situation awareness with all occupants for thorough outside watch.

A PIC should also report to his/her air station so that ground personnel in charge of operation support can grasp the aircraft status and provide necessary information in an appropriate manner.

The altitude-specific instructions stipulated in the Operation Manual are considered to be only appropriate for vast waters with no obstacles; but, they are not necessarily considered applicable to such situations where aircraft have to have a low altitude Inter-Island Flight in such airspaces as Seto Inland Sea dotted with numerous obstacles with various heights. Therefore, the Coast Guard needs to review the related provisions.

It is highly probable that the obstacle light was not properly administered as stipulated in the Civil Aeronautics Act. Therefore, the installation organization of obstacle lights should administer

them in an appropriate manner by, for example, confirming the field of view from the top of the power line steel tower so that the functions of the obstacle lights can be properly maintained per the Civil Aeronautics Act. (See Chapter 5)

4.2 Probable Causes

It is highly probable that the Aircraft, while maneuvering between Oshima and Sanagijima, struck the overhead wires spanned between them (the Sanagi Lines) and crashed.

As to the strike into the Sanagi Lines, it is somewhat likely that the PIC and the Co-pilot had lacked obstacle awareness for low altitude Inter-Island Flights and that they failed visual confirmation of the obstacle lights.

As a reason for their lack of obstacle awareness for low altitude Inter-Island Flights, it is somewhat likely that with no spanned overhead wires from Teshima to Takamijima, they continued the Inter-Island Flight with the same awareness as before. It is somewhat likely that the PIC and the Co-pilot had no visual confirmation of the obstacle light due to the reduced field of view of Sanagijima Obstacle Light by the trees at an angle to the right ahead of the power line steel tower.

5. SAFETY ACTIONS

5.1 Actions Taken by Japan Coast Guard

5.1.1 The Japan Coast Guard, in view of the seriousness of the accident, established a study group for aircraft safety measures, headed by the Japan Coast Guard Commandant, on August 23, 2010, and held its first meeting the same day. Based on the results of its study, the Coast Guard decided to take the following tentative emergency measures regarding aviation obstacles, such as power distribution lines, and instructed all regional headquarters to implement the measures:

(1) Reconfirmation of Aviation Obstacles in Each District Area

Improve the Obstruction Map by reviewing aviation obstacles such as power line steel lines, while creating a database on them with photos and power line steel tower schematics and such.

(2) Sharing Information about Aviation Obstacles in Pre-flight Briefing

A pre-flight briefing shall include aviation obstacle information along a planned route.

(3) Confirmation of Flying Method Near Aviation Obstacles

Make sure to keep safe altitude and a safe distance from aviation obstacles.

(4) Thorough Implementation of Watch for Aviation Obstacles

Pilots shall watch outside and confirm navigational obstacles. Remaining crewmembers shall join watch and all crewmembers shall have a mutual understanding.

5.1.2 The Station revised the Operation Procedure for Aircraft Operation Safety Manual, Hiroshima Air Station, the 6th Regional Coast Guard Headquarters in October 2010. Major revisions are as follows:

(1) Article 3 The Obstruction Map was added as an onboard material.

(2) Article 6 An Aircraft Operation Plan was added to share information among the parties concerned at a pre-flight briefing.

A PIC is required to send a report in case of changes of flight purpose, route and others.

(3) Article 10 The following mandatory measures were added:

- Aircraft's reporting of an expected airspace for a flight below MSA and;
- Information support by the person in charge of operation support on aviation obstacles and others.

(4) Article 11 A clause on outside watch was added.

5.1.3 The Japan Coast Guard, following the measures worked out at the first meeting of the study group for aircraft safety measures on August 23, 2010, adopted additional measures based on the discussions at the third meeting and instructed all regional headquarters on October 10, 2010 to implement the measures.

(1) The person in charge of operation support shall confirm aviation obstacles along the flight route before the flight.

(2) In case of a flight that requires a new flight route other than the planned one for which aviation obstacles had been confirmed in a pre-flight briefing, the person in charge of operation support shall make sure to provide information on aviation obstacles along the new route so that the crewmembers and persons involved can share related information.

5.1.4 The instruction (the Japan Coast Guard Instruction No. 8, April 28, 2011) for partially revising the Japan Coast Guard Aircraft Operation Safety Manual, the Japan Coast Guard Aircraft Operation Safety Manual was revised as follows:

(1) Article 6-2 (Obstacle Information)

Flight crew and the person in charge of operation support shall update and share obstacle information.

(2) Article 11 (Minimum Safety Altitude)

The following contents were added:

In case the above mentioned article cannot be abided by due to a method of near-obstacle flight or sea rescue operations and others, a PIC shall, without fail, make an in-flight safety briefing to crewmembers.

5.1.5 The interim report dated May 20, 2011 contains the following agenda discussed by the Study Group for Aircraft Safety Measures to address fundamental problems which derive from the Coast Guard's air aviation duties.

(1) Further Improvement of Safety Management System

Promotion of procedures for firm assimilation to the PDCA (Plan, Do, Check, Action) Cycle to gain continued improvement of safety management aiming the prevention of accident recurrence.

(2) Assimilation of All Aviation Personnel to CRM

Reconstruction of education system for continued qualified CRM education program for aviation personnel.

(3) Installation of Improved Equipment

Promotion of installing necessary equipment onto non-installed aircraft, which is indispensable to secure aviation safety: for instance, the cockpit voice recorder (CVR), the flight data recorder (FDR), the anti-collision warning system and others.

(4) Boosting of Aviation Safety Awareness

Improve visual safety recognition boosters covering case studies, near accident motion pictures, panel materials while keeping the lessons of the accident from fading.

5.1.6 On November 15, 2011, the Operation Flight Procedure and the Special Service Operation in Chapter 8, the Japan Coast Guard Aircraft Operation Manual were revised as described below.

(1) The provision "9. Flights below MSA" was inserted into the "Common Matters" in 8-1 "General Rules." The new insertion requires a PIC's report to the station and an in-flight briefing before starting descent below LAS.

(2) Following the revision mentioned above, the Patrol Flight Procedures and the Low-level Flight Procedure in the Service Flight Procedure were partially revised.

5.2 Actions taken by Civil Aviation Bureau

In order to prevent a recurrence of similar accident, the CAB has issued an investigation instruction for Regional CABs with the notice "Management Status of Obstacle Lights and Obstacle Markings Pertaining to Overhead Wires" (Koku-Ku-Ho No. 305, dated September 17, 2010). Each Regional CAB investigated the installment/management status of obstacle lights and markings on overhead wires by the installing organizations and ordered to correct problems when considered inappropriate. The investigations revealed that there were no obstacle lights with its field of view; however, there was a case where a part of obstacle markings (power line steel tower's coloring) was

hampered by foliage. The Regional CAB instructed to correct the problem and received a report of tree cut-down.

The CAB established a permanent "Obstacle Marking Coordination Committee" after an aircraft accident in March 2004 in Nagano Prefecture where a helicopter crashed after striking overhead wires. The meeting has continued studies on overhead wire obstacle markings, progress of obstacle marking installation and the small aircraft's actual flight condition. The committee has so far met four times since fiscal year 2005. The CAB intends to provide necessary advice to the facility installers through the committee for proper facility maintenance. The CAB also intends to continue providing relevant information to aircraft operators by obtaining overhead wire information (the location, elevation, span) from electric power companies.

5.3 Actions Taken by the Electric Power Company

The Electric Power Company explained that the cause for the field of view problem has been removed because the trees responsible for hampering the field of view of the obstacle lights on Oshima and Sanagijima have been cut down for recurrence prevention in November 2 and 3, 2010. The Electric Power Company intends to take enforced individual management of obstacle lights.

Figure 1　Estimated Flight Route

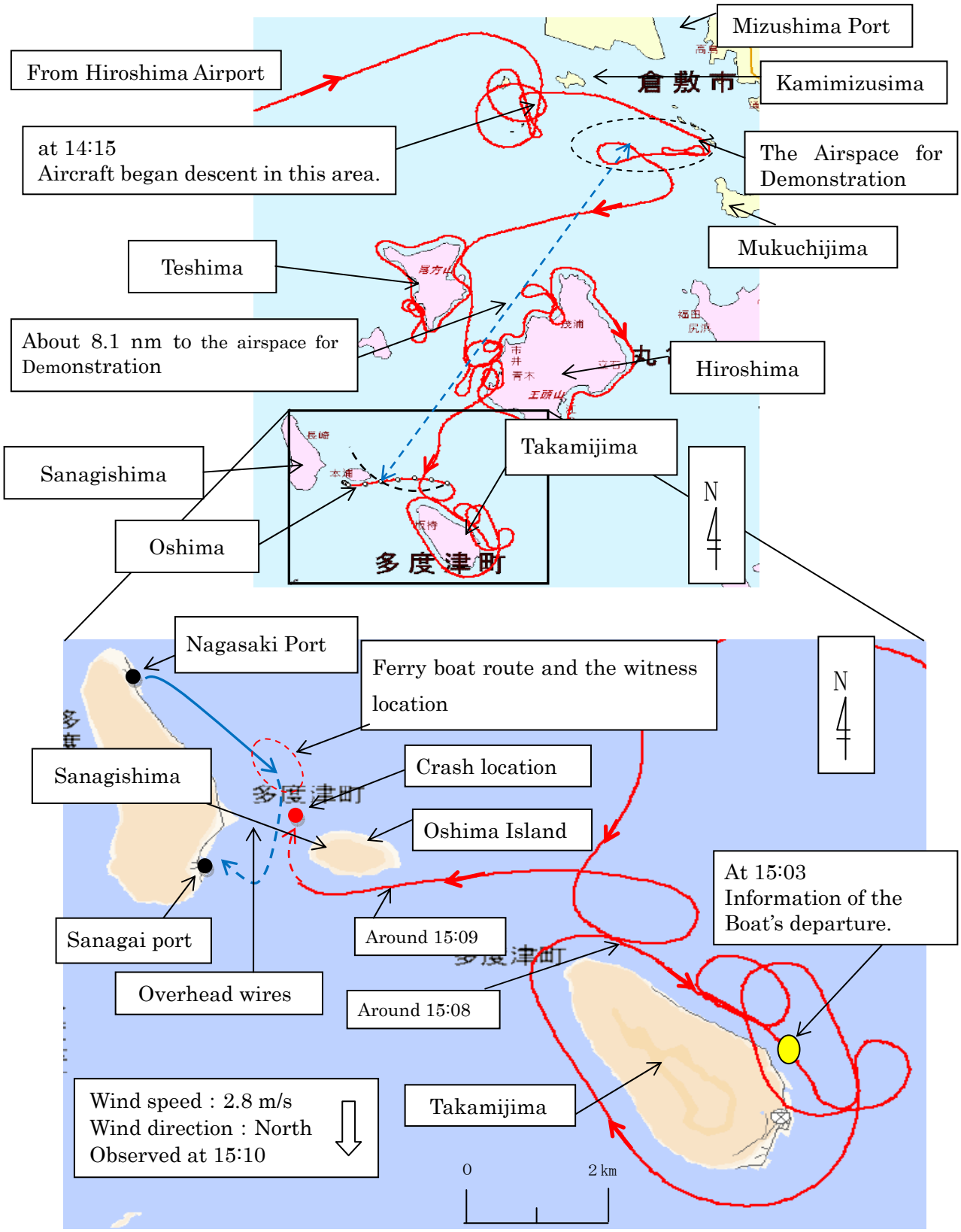
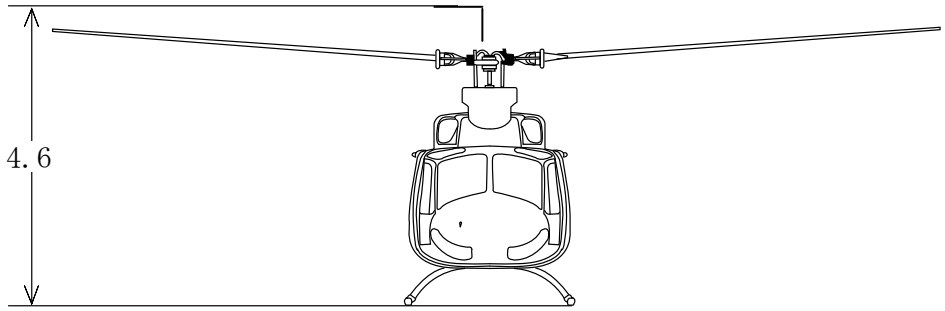
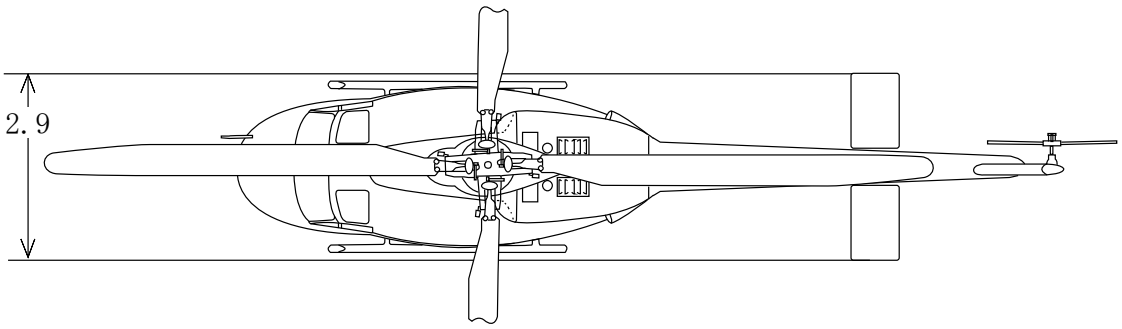


Figure 2　Three angle view of Bell 412EP

Unit : m





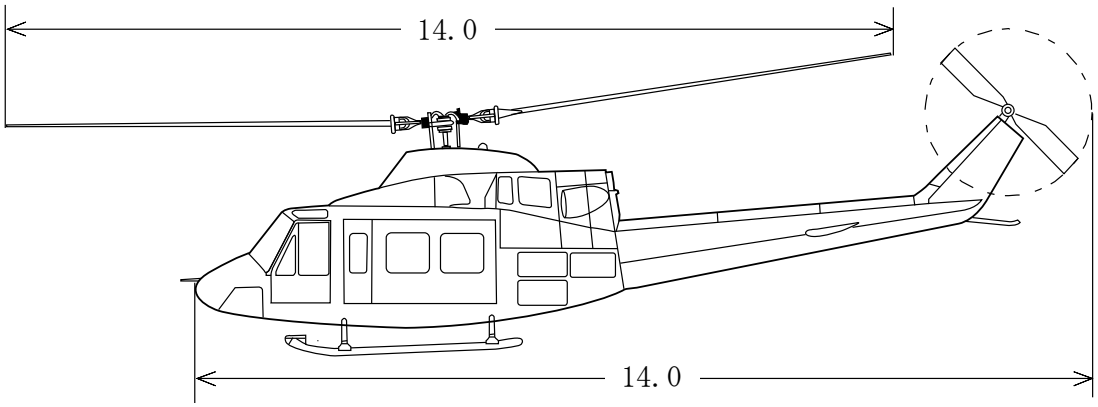


Figure 3　Damaged Area Schematic

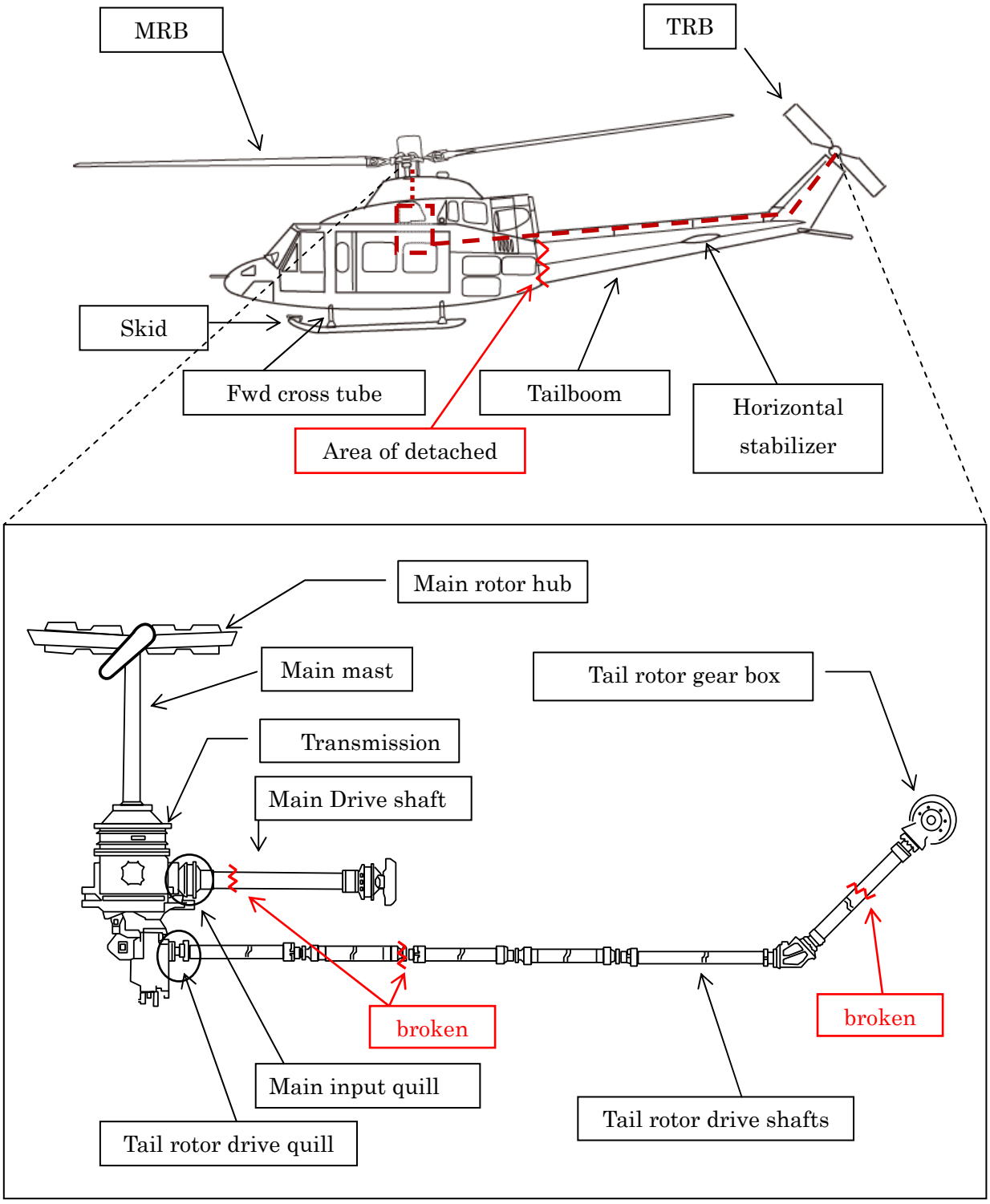


Figure 4　Sanagi Lines Schematic

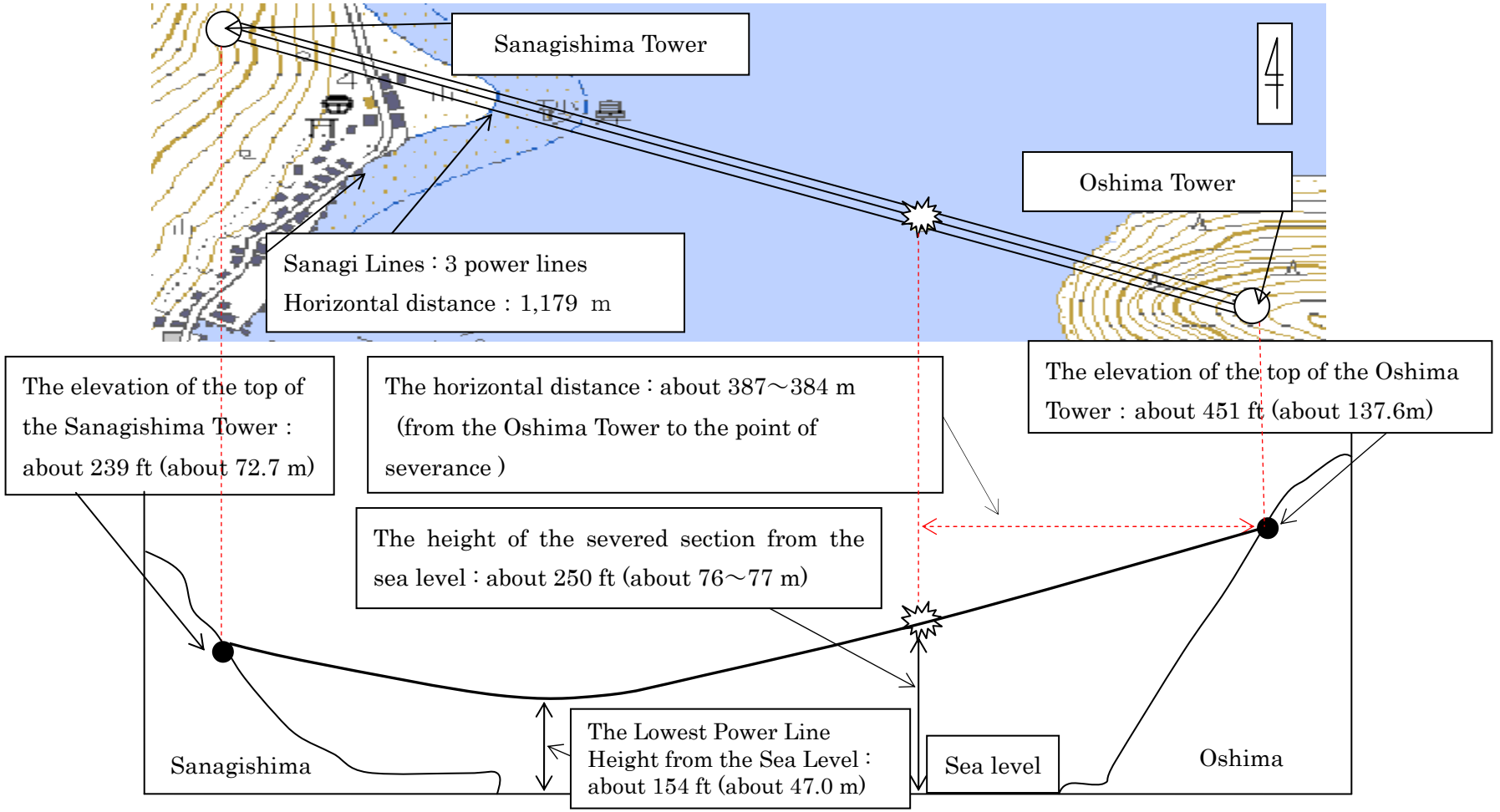


Figure 5　Sanagi Lines Schematic and the Aircraft's Flight Path

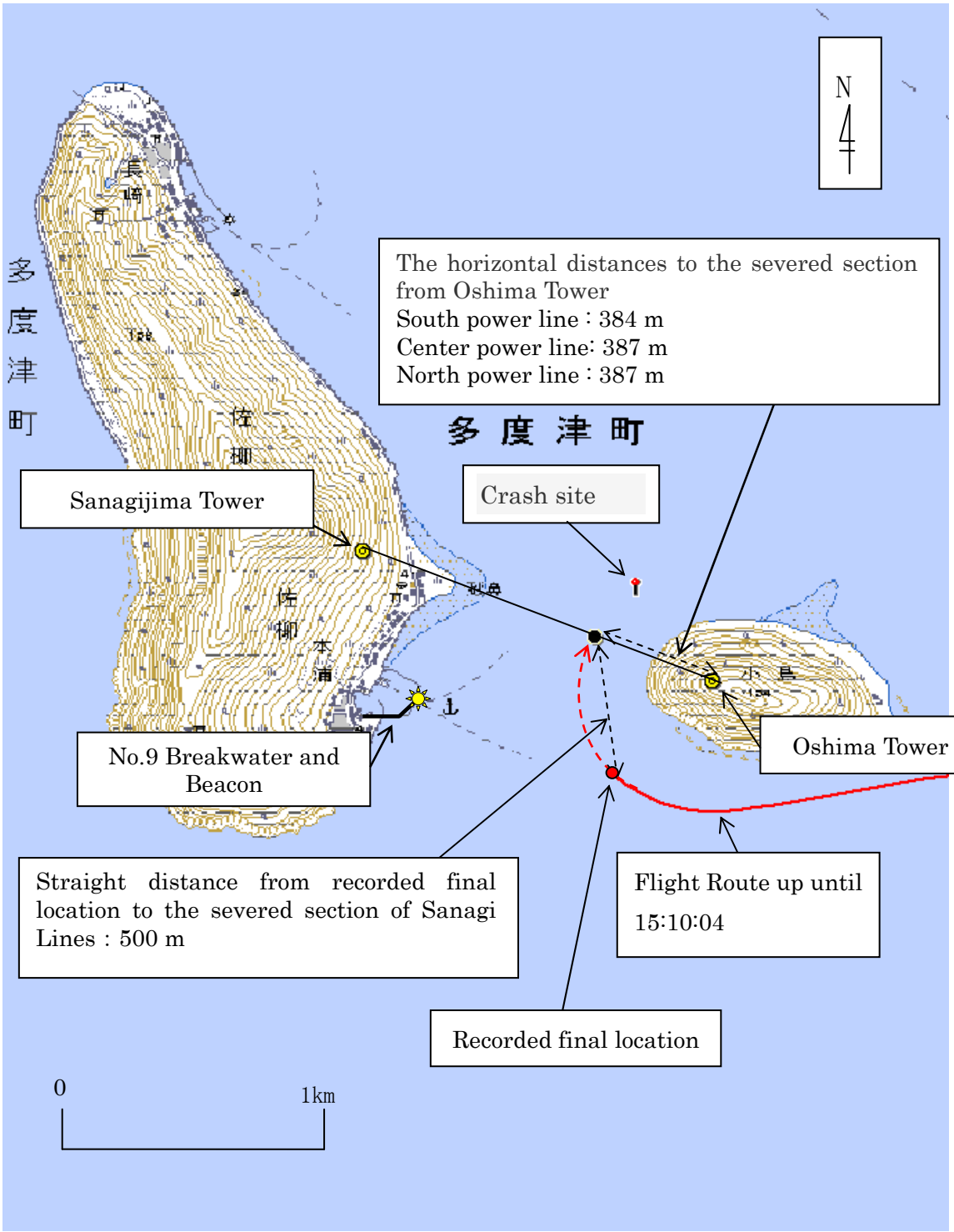


Figure 6　Airspace Layout on Visual Recognition of Sanagijima Obstacle Light

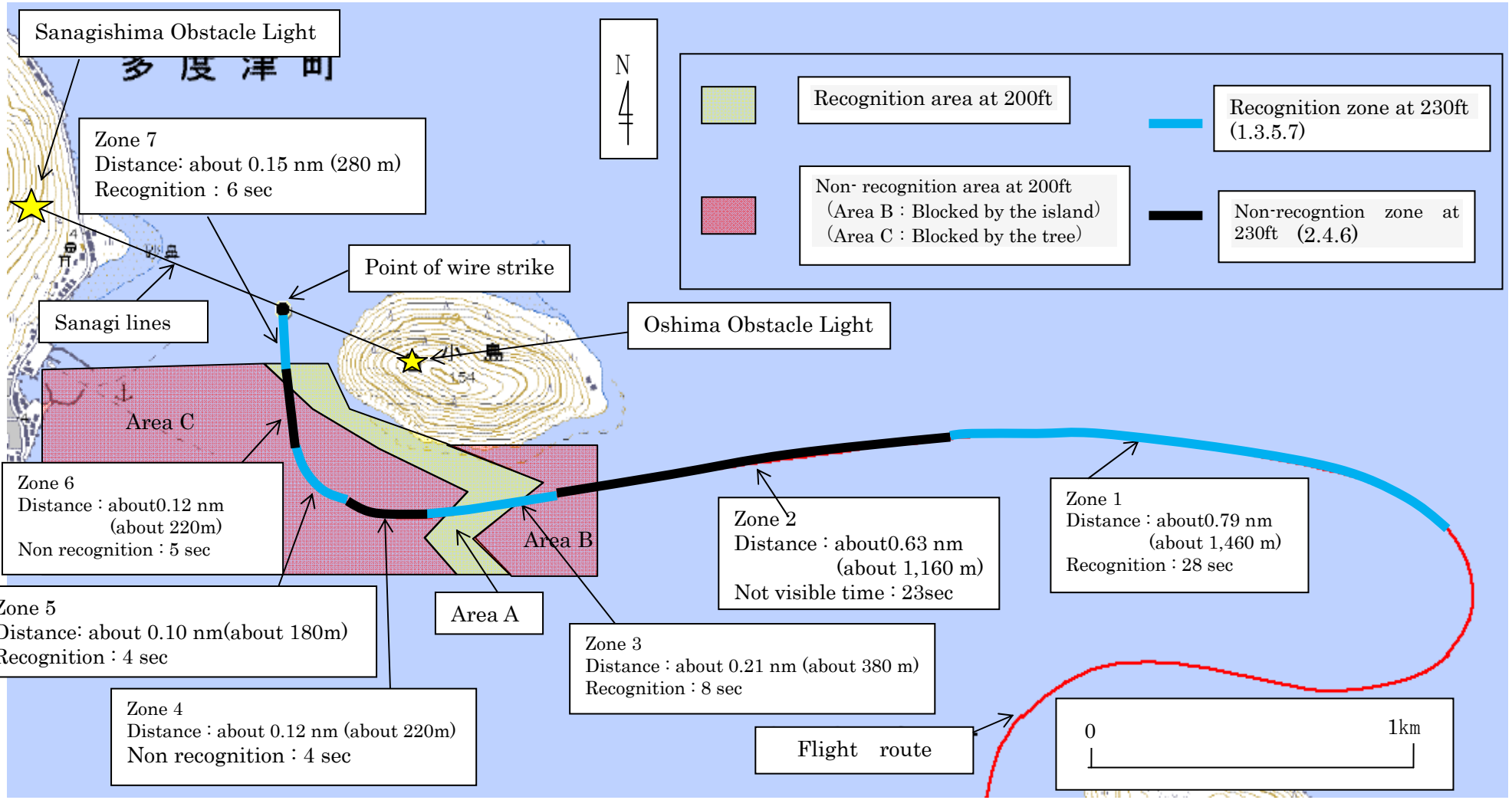
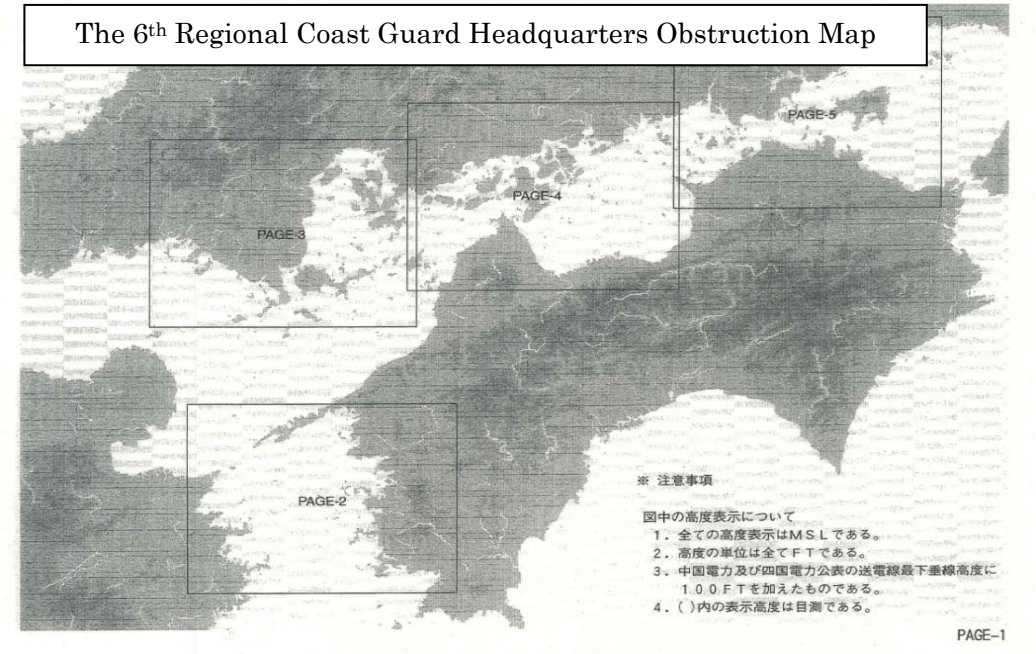


Figure 7　Obstruction Map

The 6th Regional Coast Guard Headquarters Obstruction Map



Blow-up for Oshima and sanagishima

260 ft is not the top elevation of a transmission tower. It includes added 100 ft to the elevation of Lowest Power Line Height.

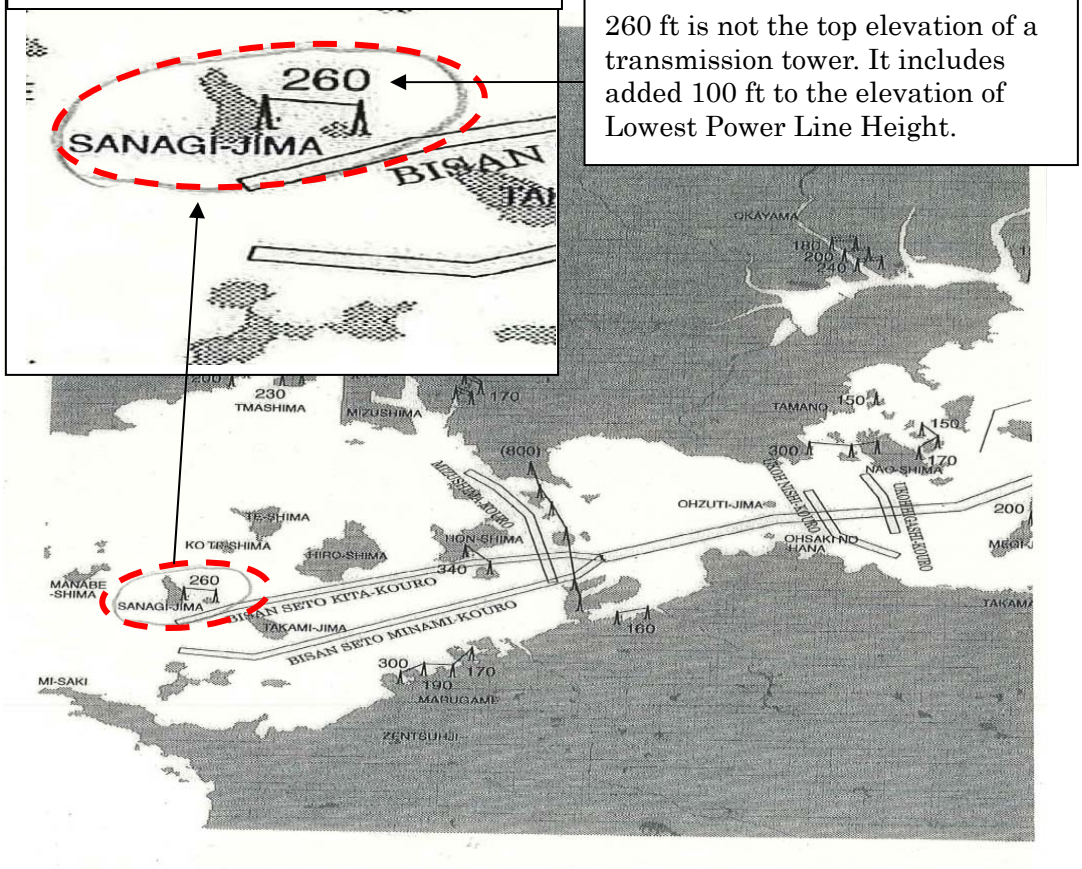


Photo 1　Distant View of Oshima and Sanagijima

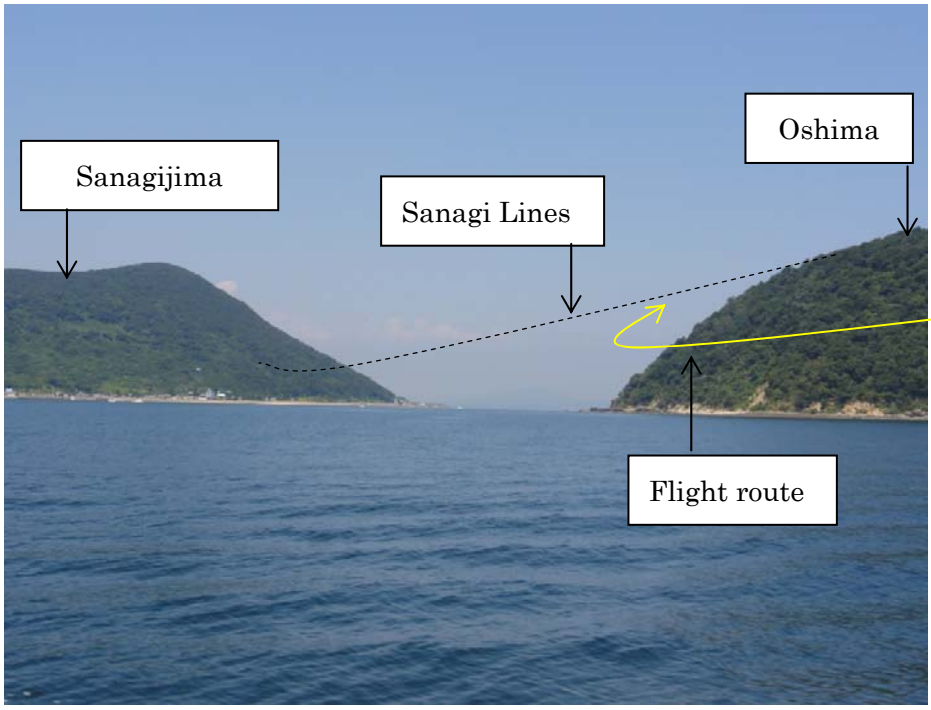


Photo 2　Accident Aircraft

Photo 3　Detached Tailboom

Photo 4　Traces of Abrasion on Cross Tube

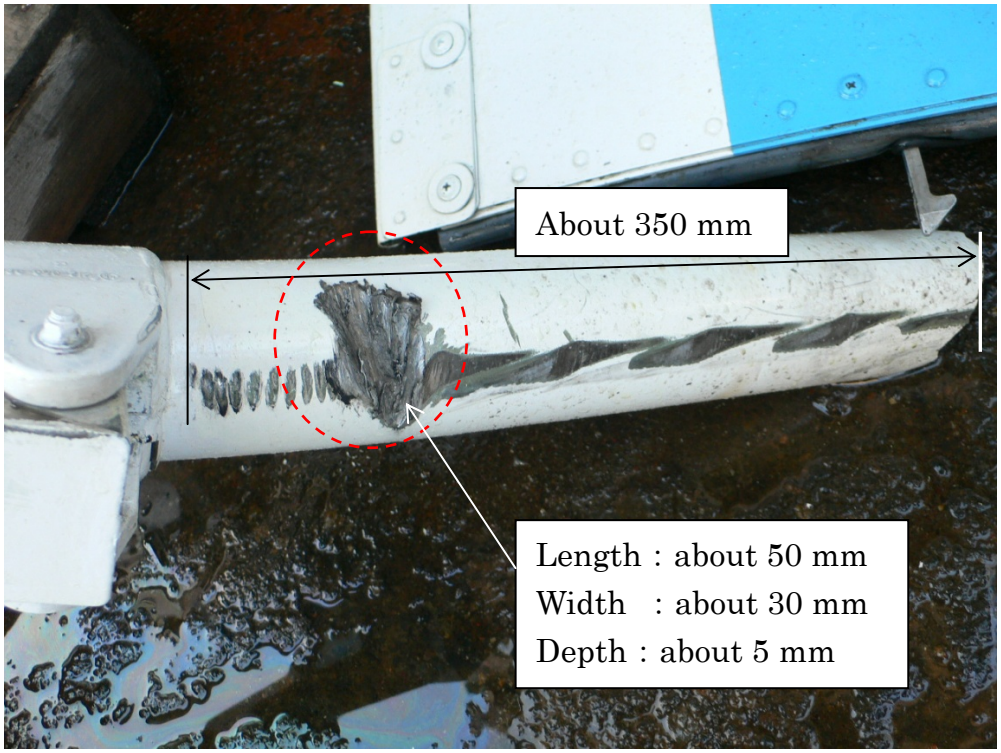


Photo 5　Wrinkles on Main Rotor Blade

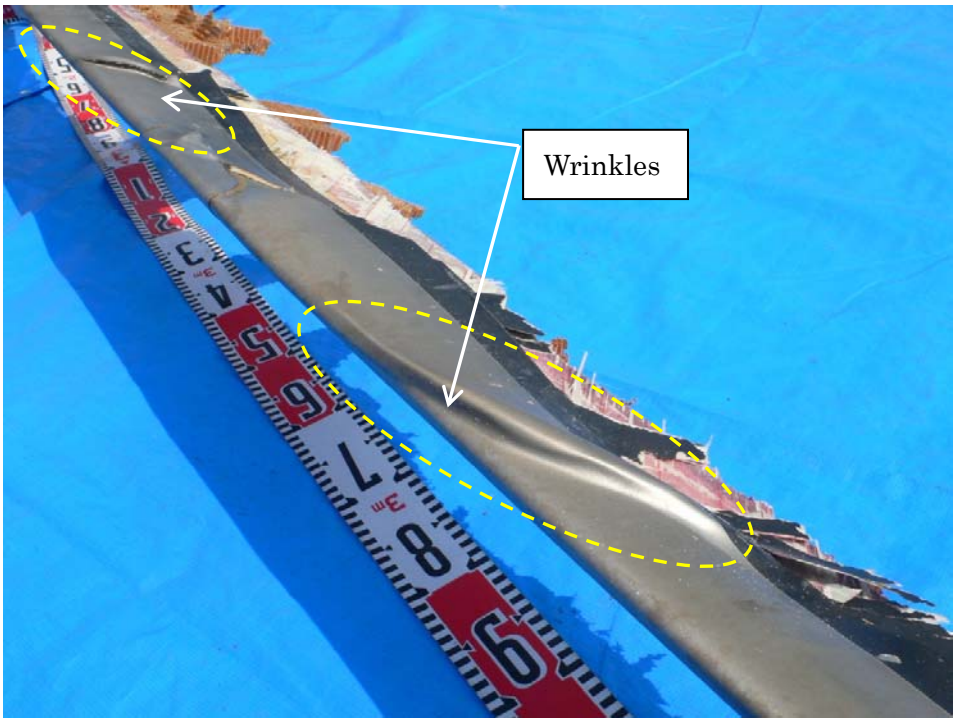


Photo 6　Severed and Deformed Sanagi Lines

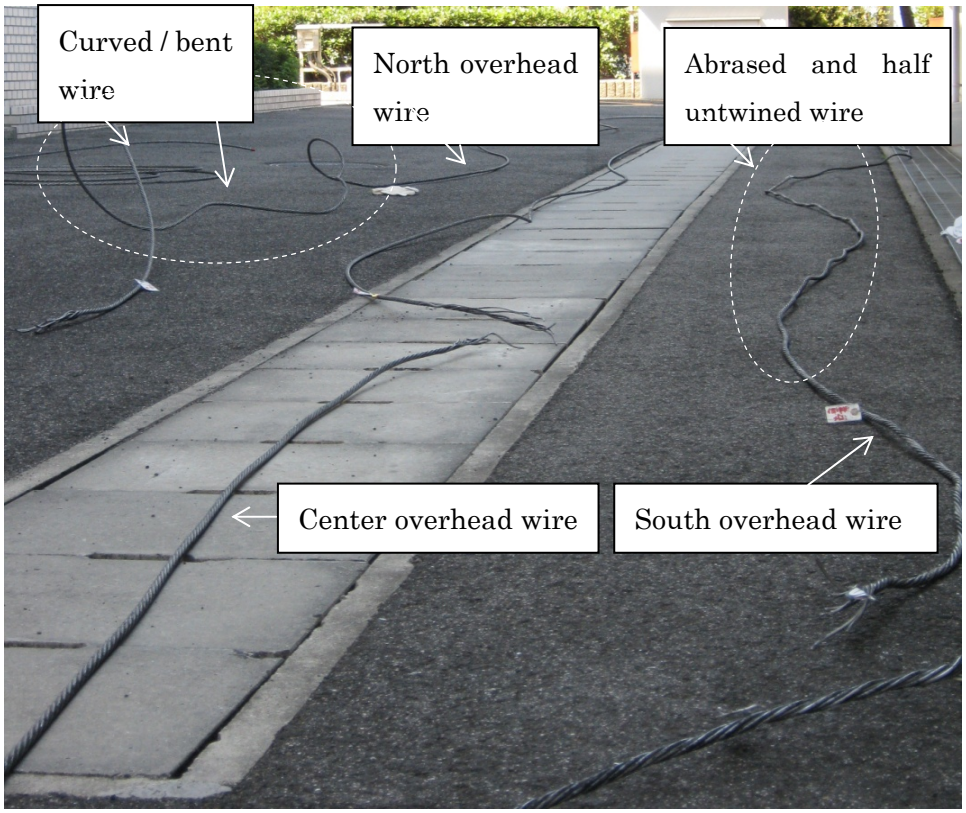
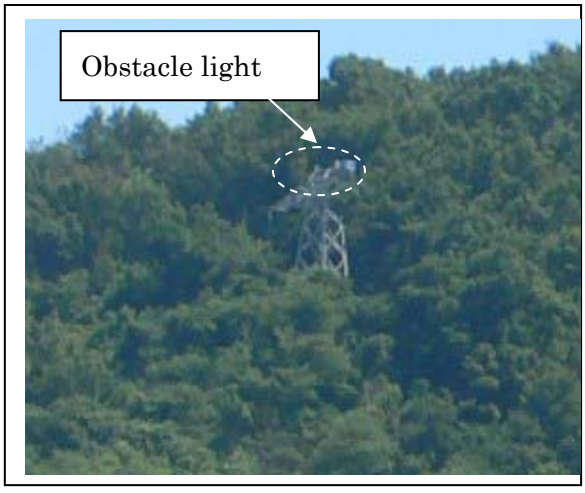
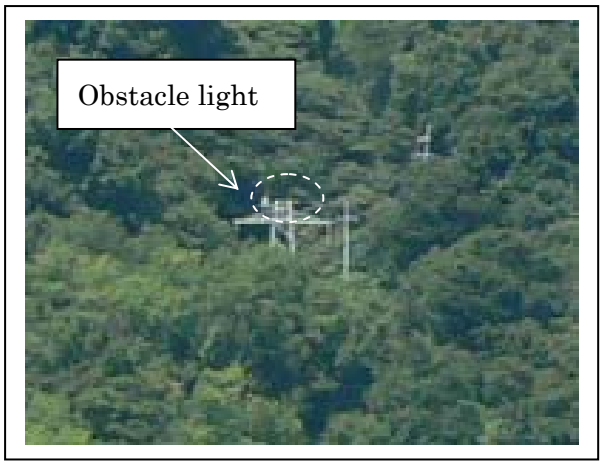


Photo 7　Severed Section of Sanagi Lines

Photo 8　Towers and Obstacle Lights on Oshima and Sanagijima

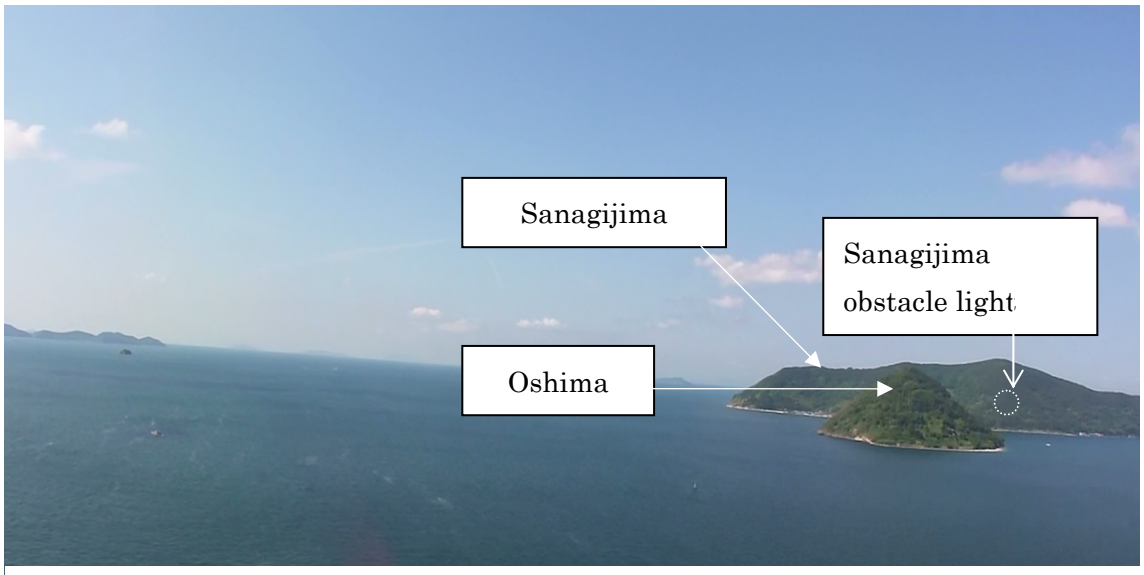


Oshima Tower

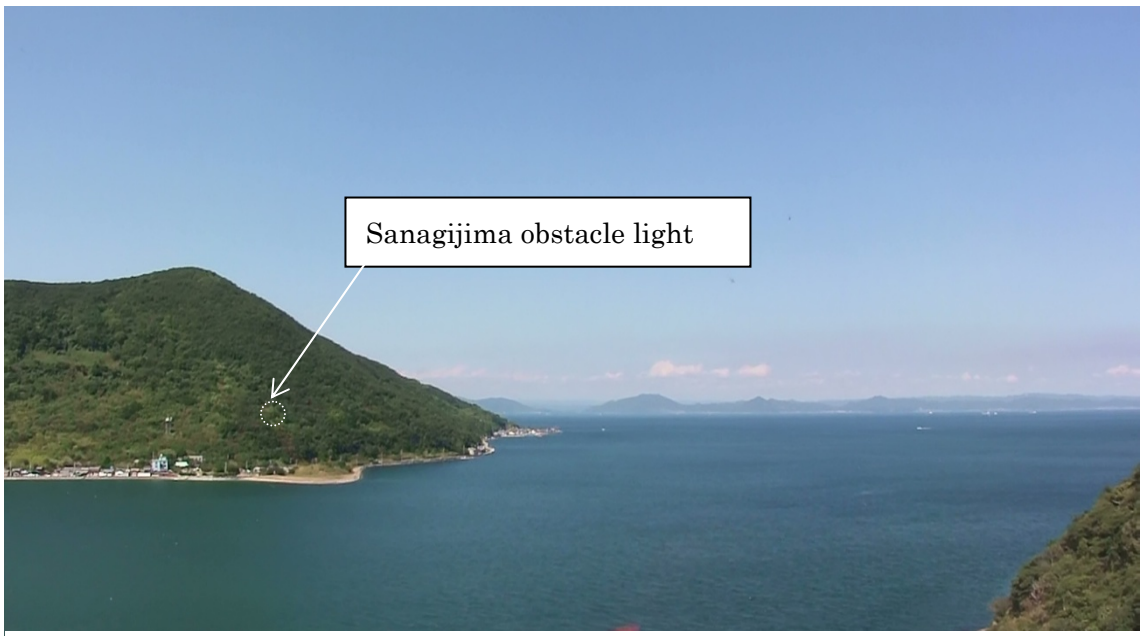


Sanagijima Tower

Photo 9　Discerning Sanagijima Obstacle Light

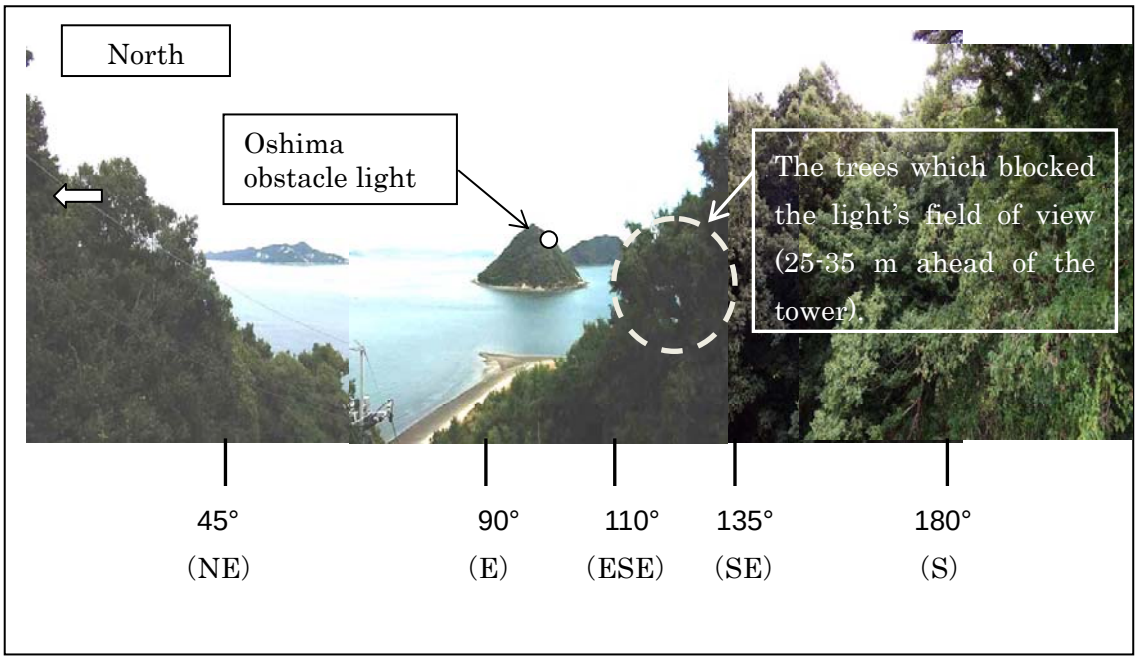


Sanagijima obstacle light viewed from Zone 1 of Figure 6

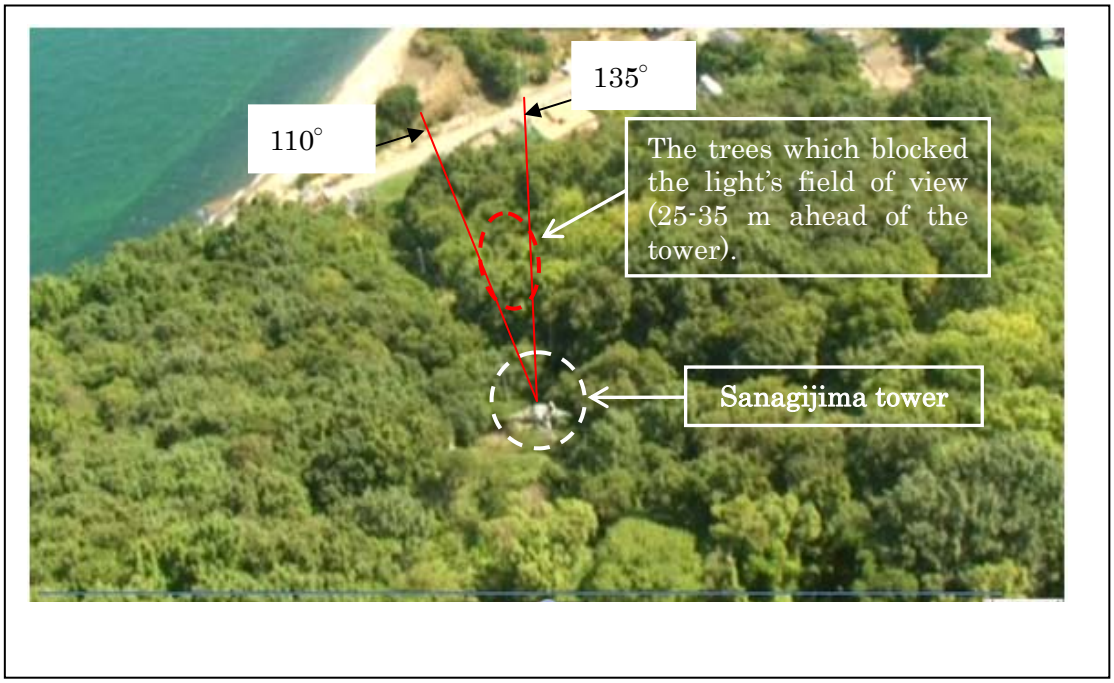


Sanagijima Obstacle Light viewed from Zone 5 of Figure 6

Photo 10　Blocked Field of View at Sanagijima Tower



View from the Top of Sanagijima Tower



Sanagijima Transmission Tower and Trees seen from Above