

AA2013-1

**AIRCRAFT ACCIDENT
INVESTIGATION REPORT**

Aero Asahi Corporation

J A 9 6 3 5

January 25, 2013

 **JTTSB** *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

**CRASH DURING CARGO TRANSPORT
WITH UNDERSLUNG EXTERNAL CARGO
INTO THE MOUNTAIN SLOPE
AERO ASAHI CORPORATION
AEROSPATIALE AS332L (ROTORCRAFT), JA9635
NEAR KIGENSUGI CEDAR TREE
YAKUSHIMA-TOWN, KUMAGE-GUN
KAGOSHIMA PREFECTURE
AT ABOUT 07:50 LOCAL TIME, SEPTEMBER 26, 2010**

December 21, 2012

Adopted by the Japan Transport Safety Board

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

SYNOPSIS

Summary of the Accident

On Sunday, September 26, 2010, an Aerospatiale AS332L, registered JA9635, operated by Aero Asahi Corporation, took off for sling load cargo transport from Yakusugi Land temporary helipad located in Yakushima-Town, Kumage-Gun, Kagoshima Prefecture, and crashed into the mountain slope near Kigensugi cedar tree in Yakushima-Town at about 07:50 local time*¹.

Onboard the helicopter were a pilot and a loadmaster, and both of them suffered fatal injuries.

The helicopter was destroyed and consumed by fire.

Probable Causes

In this accident, it is probable that the helicopter, while flying in the mountain valley with underslung external cargo, made a left turn to turn back, crashed after nearing the slope with its underslung cargo caught in ground objects during the maneuver. The post-crash fire consumed the helicopter and the pilot and loadmaster suffered fatal injuries.

The following are possible reasons why the helicopter came close to the slope during the left turn, and the underslung cargo came to be caught in ground objects: capable OGE hovering for turn-around was not carried out; en route altitude was well below minimum safe altitude; the climbing was restrained during the left turn as the opening under the cloud base was small; and the failure of judging cargo clearance from the ground objects.

Recommendations

In view of this accident investigation, the Japan Transport Safety Board, pursuant to the provision of paragraph (1) of the Article 27 of the Act for Establishment of the Japan Transport Safety Board makes the following recommendation:

To Aero Asahi Corporation:

Review flight operations whether there were non-compliance activities against laws and regulations.

Remind all employees engaged in safety-related works including pilots and mechanics of the importance of observing fundamental safety standards such as minimum safe altitudes.

Review internal emergency communication procedure.

The following abbreviations and unit conversions are used in this report.

*¹ Japan Standard Time (JST): UTC+9 hr, unless otherwise stated all times are indicated in JST on a 24-hour clock.

Abbreviations

AGL: Above Ground Level
CG: Center of Gravity
DA: Density Altitude
MGB: Main Gearbox
MR: Main Rotor
MSA: Minimum Safe Altitude
OGE: Out of Ground Effect
TAS : True Airspeed
TGB: Tail Gearbox
TR: Tail Rotor
VHF: Very High Frequency
VMC: Visual Meteorological Condition
Vy: Best rate-of-climb speed

Unit Conversion

1 foot (ft) : 0.3048 meters
1 knot (kt): 0.5144 meters per second (1.852 kilometers per hour)
1 pound (lb): 0.4536 kilograms

1. PROCESS AND PROGRESS OF THE ACCIDENT INVESTIGATION

1.1 Summary of the Accident

On Sunday, September 26, 2010, an Aerospatiale AS332L, registered JA9635, operated by Aero Asahi Corporation, took off for sling load cargo transport from Yakusugi Land temporary helipad located in Yakushima-Town, Kumage-Gun, Kagoshima Prefecture, and crashed into the mountain slope near Kigensugi cedar tree in Yakushima-Town at about 07:50.

Onboard the helicopter were a pilot and a loadmaster, and both of them suffered fatal injuries.

The helicopter was destroyed and consumed by fire.

1.2 Outline of the Accident Investigation

1.2.1 Investigation Organization

On September 26, 2010, the Japan Transport Safety Board designated an investigator-in-charge and two other investigators to investigate this accident.

1.2.2 Representatives from Relevant State

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

1.2.3 Implementation of the Investigation

September 27 and 28, 2010:	On-site investigation, helicopter examination and interviews
October 7, 2010:	Interviews
October 26, 2010:	On-site investigation and helicopter examination
November 2 to 4, 2010:	Helicopter examination
November 17, 2010:	Interviews
November 29, 2010:	Examination of the type of helicopter
February 10, 2012:	Interviews

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

Comments were invited from the parties relevant to the cause of the accident except the deceased pilot and the loadmaster.

1.2.5 Comments from the Relevant State

Comments on the draft final report were invited from the relevant State.

2. FACTUAL INFORMATION

2.1 History of the Flight

An AS332L, JA9635, operated by Aero Asahi Corporation (hereinafter referred to as the “Company”) was scheduled to shuttle between Yakusugi Land temporary helipad (hereinafter referred to “Land Helipad” and unloading sites scattered in the vicinity of Yodogawa Mountain Hut (hereinafter referred to “the Hut”) located about 5.4 kilometers west of Land Helipad, in order to transport construction material (stones) for mountain trail maintenance using external sling device. On board the helicopter were a pilot in the right cockpit seat and a loadmaster in the loadmaster seat in the left aft cabin.

The history of the flight up to the accident is summarized as follows, according to the statements of two mechanics on the ground (hereinafter referred to as “Mechanic A” and “Mechanic B”, respectively), a construction worker (hereinafter referred to as “Construction Worker A”) and a person who reported the occurrence of the accident (hereinafter referred to as “the Reporter”):

a. Mechanics A and B

Mechanics A’s and B’s jobs at Land Helipad were refueling the helicopter and hooking external cargo onto the cargo hook. There were five to six construction workers there.

According to Mechanic A, he had worked with the pilot and the loadmaster before. They looked as usual at a hotel or while working on the day before the accident. The loadmaster was well experienced in working on Yakushima Island.

On the morning of the accident, five persons (the pilot, the loadmaster, Mechanics A and B, and the field manager) left the hotel in a car driven by the field manager for Nabeyama temporary helipad (hereinafter referred to as “Nabeyama Helipad”) where the helicopter was moored overnight. The pilot, the loadmaster and Mechanics A and B got off the car there. Then the field manager drove toward the cargo unloading sites. Mechanics A and B conducted a preflight inspection and found no anomalies. At about 07:00, the helicopter took off with four persons on board (the pilot, the loadmaster, Mechanics A and B) for Land Helipad via the unloading sites for aerial inspection. During this flight neither Mechanic A nor B was able to recognize specifically where they were flying because their seating provided partial outside view. The above ground level (AGL) altitude was not too high or too low.

The helicopter landed at Land Helipad and Mechanics A and B started their work. The helicopter did five airlifts. During the 5th airlift Mechanics A and B received a radio call from the helicopter saying that it might land (at Land Helipad) and stand by because the weather was getting worse. Soon afterward, they received another radio call advising that it would need refueling after the next lift.

The helicopter picked up the 6th cargo and took off in the usual manner. Mechanics A and B were expecting the helicopter preparing for the refueling. Although a usual shuttle flight took 7 to 8 minutes, it did not

return even at 08:00, lapsing more than 15 minutes.

There was a possibility that the helicopter had landed at Nabeyama Helipad if the weather had gone worse. Nabeyama Helipad was beyond the radio reception range from Land Helipad and there was no other means of communication. Also it was uncertain whether radio communications from Land Helipad could reach beyond the Hut. Mechanic A called the loadmaster over the mobile phone from the location where his mobile phone could not get reception. After a while, the Reporter came to Land Helipad and said "It seems a helicopter has crashed."

b. Construction Worker A

At the time of the accident, Construction Worker A was at an unloading site in the vicinity of the Hut with other workers. He heard faint sound of the helicopter coming toward them when the accident flight was done. The sound became faint as if it were turning away on the way and became inaudible. He thought that the helicopter might have turned back due to the worsened weather. As Construction Worker A was in the woods and did not see the helicopter then, he was unable to acoustically figure out the distance.

c. Reporter

He was near Kigensugi cedar tree since 07:00 and he heard the helicopter flying back and forth. When he saw the helicopter through the trees, it was flying in the valley to the north of the cedar tree toward the Hut. It was flying several hundred meters away from him, at the altitude of his eye level, a little higher than trees with cargo underslung.

At the time of the accident, the helicopter came closer shaking the trees with strong winds accompanied by tremendous sounds. Although the trees around him blocked his view of the helicopter, he sensed that it was coming toward him from the direction of the Hut. At that moment, he heard loud distinctive rustling sounds like something was hitting trees and branches. He felt certain that something had fallen down. Then he heard dry high-pitched whirring sounds continue for a few seconds and it became distant and faded away. Then he heard big peeling sounds five or six times followed by seemingly rustling sounds made by branches. He hid himself behind the thick trunk of the cedar tree.

One or two minutes later, he saw smoke rise from the mountain ridge.

The accident occurred 3.3 kilometers west of the Land Helipad, at an elevation of about 1,290 meters (30°18.6' N, 130°32.44' E), at about 07:50.

(See Figure 1: Estimated Flight Route and Accident Site, Figure 2: Accident Site Layout, Figure 3: Aerial Photo of Accident Site and Terrain Features (3D Image), , Figure 5: External Cargo Sling Device, Photo 1: Type Helicopter, Photo 2: Accident Helicopter (Main Wreckage), Photo 3: Accident Site Taken From Afar During Rescue Operation, Photo 4: Accident Site Blow-up)

2.2 Injuries to Persons

Both the pilot and the loadmaster on board the helicopter suffered fatal injuries.

2.3 Damage to the Helicopter

2.3.1 Extent of Damage

The helicopter was destroyed

2.3.2 Damage to the Helicopter Components

Fuselage:	Broken and burnt
Main Rotor (MR) System:	Broken and burnt
Tail Rotor (TR) System:	Broken

2.4 Other Damage

Trees in the national forest area were damaged including fire damage.

2.5 Personnel Information

Pilot:	Male, Age 47
Commercial pilot certificate (Rotorcraft):	August 26, 1991
Type rating for Multi-Engine Turbine Land (Aerospatiale SA330):	May 17, 2007
Class 1 aviation medical certificate	
Validity:	Until October 8, 2010
Total flight time:	7,026 hr and 7 min
Flight time in the last 30 days:	53 hr and 17 min
Total flight time on type:	751 hr and 30 min
Flight time on type in the last 30 days:	31 hr and 57 min

2.6 Helicopter Information

2.6.1 Helicopter

Type:	Aerospatiale AS332L
Serial number:	2097
Date of manufacture:	February 5, 1986
Certificate of airworthiness:	No. Toh – 22 – 277
Validity:	Until September 2, 2011
Category of airworthiness:	Rotorcraft, Transport Category TA/TB or Special helicopter X
Total flight time:	10,800 hr and 39 min
Flight time since last periodical check (Annual and 500 hr inspections, August 19, 2010):	118 hr and 5 min

(See Figure 4: Three Angle View of Aerospatiale AS332L)

2.6.2 Engines

	No.1 Engine	No. 2 Engine
Type	Turbomeca-Makila 1A	
Serial number	624	394
Date of manufacture	September 18, 1986	November 29, 1983
Total time in service	8,127 hr and 50 min	7,547 hr and 53 min

2.6.3 Weight and Balance

When the accident occurred, the weight of the helicopter was 5,303 kilograms, while its operating weight combined with the estimated underslung cargo weight of 2,700 kilograms, was 8,003 kilograms.

The position of the center of gravity (CG) for the operating weight of the helicopter was estimated to have been 4,610 millimeters aft of the reference point and 10.2 millimeters right of the centerline, both of which were estimated to have been within the allowable range (the maximum weight of 9,350 kilograms when combined with the external jettisonable weight, and the CG range of 4,475 to 4,868 millimeters aft of the reference point and 80.0 millimeters left to 90.0 millimeters right of the centerline corresponding to the operating weight at the time of the accident).

2.6.4 Fuel and Lubricating Oil

The fuel and the lubricating oil were Jet A-1 and Mobil Jet Oil II, respectively.

2.6.5 Method of External Cargo Slings

a. Rigging of External Cargo Sling

One end of a cargo slings connected by means of shackles was hooked to the helicopter main hook by means of a shackle, while the other end was connected to the twin pendant hook by means of connecting device.

The wire ropes attached to the four corners of the cargo net are hooked to twin pendants while the net enfolds the cargo load. The length from the main hook to the bottom of the cargo net was about 30 meters.

At the time of the accident the wire ropes were still new and the breaking strength of the wire rope was 9.83 tons. Bagged large pebbles constituted the cargo weighing about 2.7 tons.

b. Roles of loadmaster

The loadmaster was on board the helicopter with the left cargo door open to perform his assignments—cargo monitor, precise helicopter guidance, cargo release and outside obstacle watch. There was a seat for him in the left aft cabin. From there he operated the twin pendant hook with the permission of the pilot.

(See Figure 5: External Cargo Sling Device)

2.6.6 Altimeter

The helicopter was equipped with a barometric altimeter and a radio altimeter.

2.7 Meteorological Information

a. Weather conditions stated by the persons in the vicinity of the accident site

(1) Mechanics A and B

On the day of the accident, the helicopter called us during the 5th cargo lift, saying that it might land (at the Land Helipad) and stand by due to the worsening weather. The weather conditions at the Land Helipad when the helicopter left for the 6th cargo lift and when they were expecting the return were overcast (no sunshine) with no fog.

(2) Construction Worker A

The weather conditions in the vicinity of the Hut at the time of the accident were overcast with calm wind. Fog was not observed near the Hut. When the helicopter came overhead, it was clearly visible.

(3) Reporter

The weather conditions in the vicinity of Kigensugi cedar tree at the time of the accident were cloudy, and the upper part of the trees was not veiled in the mist and the mountains on the other side of the valley were dimly visible. It was a little misty in the direction of the Hut.

When he was walking along the mountain trails in the vicinity of the cargo unloading sites (08:40-09:20, after the accident), he was in quickly drifting patchy fog shrouding him for a short time— for about 10 seconds.

The weather in the vicinity of the accident site when rescue workers rappelled from the disaster prevention helicopter about 10:00 was the same as the moment when the accident occurred.

b. According to a pilot aboard the disaster prevention helicopter, the Disaster Prevention Aviation Center, Kagoshima Prefecture (hereinafter referred to as “Disaster Prevention Aviation Center”) which came above the accident site for the rescue operation, weather conditions over the accident site were as follows:

At about 10:00 when they arrived at the accident site, it was overcast with the cloud base 4,500-4,600 feet (1,370-1,400 meters) hanging over the ridges in the vicinity of the accident site. The horizontal visibility was good. The wind was blowing from the south at 5-6 knot.

c. The aeronautical weather observations at Yakushima Airport located about 14 kilometers north-northeast of the accident site around the time of the accident were as follows:

08:30

Wind direction 170°; Wind velocity 2 kt

Prevailing visibility 20 km

Cloud: Amount 2/8, Type Unknown, Cloud base 4,000 ft
Amount 6/8, Type Unknown, Cloud base Unknown
Temperature 25°C, Dew point 19°C
Altimeter setting (QNH) 30.01 inHg
(See Photo 3: Accident Site Taken Afar During Rescue Operation, Photo
4: Accident Site Blow-up)

2.8 Communication

The communication between the helicopter and the workers on the ground was established with VHF radios. It was unable to establish air-to-ground radio communication unless the helicopter and the workers were on the line of sight.

Ground-to-ground radio communication between the Land Helipad and the cargo unloading sites was impossible, while mobile phone connections were intermittent. If situated out of the line of site, there was no means of communication available.

Although the helicopter had an onboard mobile satellite phone, the ground sites did not.

2.9 Helipad Information

The cargo unloading sites were scattered in the vicinity of the Hut which was located 5.4 kilometers west of Land Helipad. The elevation of Land Helipad was 1,080 meters, while those of the scattered cargo unloading sites were about 1,400 meters. The highest point was 1,420 meters.

Nabeyama Helipad where the helicopter was moored overnight was located 6.6 kilometers east-northeast of the Land Helipad, at an elevation of 210 meters.

Permission to use Land Helipad and Nabeyama Helipad was obtained, pursuant to the proviso of Article 79 of the Civil Aeronautics Act (CAA).

Permission to fly lower than the minimum safety altitude (MSA) above the cargo unloading sites was obtained, pursuant to the proviso of the CAA Article 81.

(See Figure 1: Estimated Flight Route and Accident Site)

2.10 Accident Site and Wreckage Information

2.10.1 Geographical Features of the Vicinity of the Accident Site

The accident site, which is located in the southern part of Yakushima Island, is on a mountain slope covered with densely growing tall trees.

The slope faces north and the Arakawa River runs east at the foot of the slope. The slope is milder than the opposite slope far side of the river. The accident site lies on the protruding bump-like terrain feature along the river.

(See Figure 1: Estimated Flight Route and Accident Site)

2.10.2 Accident Site Description

Large mass of the helicopter wreckage (hereinafter referred to as “the Main Wreckage”) rested 3.3 kilometers west of the Land Helipad, at an elevation of about 1,290 meters.

To the north about 280 meters from the accident site runs the Arakawa River

with its elevation of 1,150 meters, about 140 meters lower than the Main Wreckage.

The Main Wreckage rested close to the base of a big tree (hereinafter referred to as “Tree A”) standing on the slope with an average degree of incline of approximately 30°, and its trunk and branches were charred black by fire while big branches at about 10 meter high were broken and lay on the ground.

The wreckage other than the Main Wreckage and the underslung cargo scattered in the area west-northwest of the Main Wreckage, which measured 160 meter long by 45 meter wide.

A tall tree of about 15-meter high (at an elevation of 1,260 meters) located 180 meters west-northwest of the Main Wreckage (hereinafter referred to as “Tree B”), was found to have had its top branches broken. From this tree toward the east-southeast on uphill slope scattered the fragments of main rotor (MR) blades, tail rotor (TR) blades, cargo nets, cargo pebble stones, cargo sling, twin pendent hook, tail gear box (TGB), TR assembly and the right main landing gear.

The cargo stones scattered all around the ground, and there was a big round rock with a diameter of about 1 meter (hereinafter referred to as “Rock A”) nearby. The entire surface of Rock A was smeared with dirt, and there were traces of having been moved uphill by about 1 meter in the direction of the east-southeast.

Trees with broken branches or impact marks were found along the line from Tree B to the Main Wreckage. A tree about 20-meter high, (at an elevation of 1,280 meters) standing east-southeast of the underslung cargo (hereinafter referred to as “Tree C”) was found to have had its top branches broken.

One of the four MR blades was found at a place 135 meters north-northwest of the Main Wreckage (elevation 1,240 meters).

The occupants were found near their seats in the vicinity of the Main Wreckage.

Kigensugi cedar tree (elevation 1,230 meters) is located at about 160 meters south of the river, about 80 meters higher than the river and 60 meters lower than the Main Wreckage.

(See Figure 1: Estimated Flight Route and Accident Site, Figure 2: Accident Site Layout, Photo 1: Type Helicopter)

2.10.3 Detailed Information on Damages

- a. The fire consumed the most part of the fuselage except the area aft of the main landing gears.

The entire tail boom was damaged with crush marks on its right side.

- b. All the four MR blades were broken. One of them was separated from the MR hub, and was found away from the Main Wreckage.
- c. The TGB and the TR assembly were damaged and separated from the tailboom. The TR drive shaft was ruptured, separated, and found away from the tail boom. All of five TR blades were damaged: one was separated from the hub and the others were fractured near the hubs.
- d. The main hook was properly locked and its exterior was damaged by fire. Interior inspection revealed no deformation, crack or rupture.

The twin pendant hook was broken, and was found alone away from the Main Wreckage, the underslung cargo and the sling. The shackle was

ruptured. Both hooks were open. Due to the deformation of the housing and hooks, hooks did not lock.

The wire ropes attached to the four corners of the cargo net were released from the twin pendant hooks, and were away from the Main Wreckage and the twin pendent hook. They were kinked across the length.

All of the cargo stones scattered all over the ground.

The cargo slings hung from branches of the nearby trees. Neither the cargo slings nor the shackles were broken.

Each of the three cargo nets was torn near the center with a hole of about 1 meter diameter.

(See Figure 4: Three Angle View of Aerospatiale AS332L, Figure 5: External Cargo Sling Device, Photo 1: Type Helicopter, Photo 2: Accident Helicopter (Main Wreckage))

2.11 Medical Information

According to the Kagoshima Prefectural Police Department, the cause of death for the pilot and the loadmaster was traumatic shock due to bruising all over the body.

Their blood samples tested negative for alcohol, drug and toxic substances.

2.12 Search and Rescue Operations

- a. Search by the persons who were near the accident site

The Reporter placed an emergency call to the police by dialing 110 at 07:52 near Kigensugi cedar tree which stands near the accident site; however, it did not get through. As he was alone, he drove in the direction of the Land Helipad, and informed one of the construction workers at Land Helipad of the helicopter crash. The construction worker reported the occurrence of the accident by calling 119 for ambulance dispatch at 08:30.

The Reporter drove Mechanic A to the trailhead to inform the field manager of the accident, who was at a cargo unloading site. As Mechanic A did not know at which unloading site the field manager was, they took separate trails. As Mechanic A reached the field manager by radio on the way, Mechanic A asked him to come down to the trailhead and walked backed to the trailhead ahead of the Reporter. Later Mechanic A joined the Reporter, the field manager, and Mechanic B and the construction workers who hurriedly drove there later from Land Helipad. They all drove for the cedar tree using two cars.

Upon arriving at the cedar tree sometime after 09:30, four people (Mechanics A and B and two construction workers) climbed the slope to search for the helicopter and the crew. The field manager who stayed at the road side recognized the smoke rising and informed it to the four. At last they found the burning helicopter a little before 10:00, immediately followed by the pilot and loadmaster.

- b. According to the Kagoshima Prefectural Firefighting Association and Disaster Prevention Aviation Center, information on their rescue operations

after the occurrence of the accident was as follows:

08:30 Reception of the accident occurrence
08:42 Request of a dispatch of a disaster prevention helicopter
09:20 The helicopter took off from Makurazaki Airport.
09:25 Dispatch of an ambulance
10:00 The arrival of the helicopter over the accident site
10:10 Rescuers started rappelling from the helicopter to the road near Kigensugi cedar tree.
10:17 The helicopter left the site temporarily for refueling.
10:18 The ambulance arrived at a parking lot near the cedar tree.
10:24 Emergency treatment started for the occupants.
10:50 The pilot was taken to the ambulance and it departed for hospital.
11:40 The helicopter arrived over the accident site.
11:45 He was hospitalized.
11:55 The loadmaster was taken to the helicopter and it took off.
12:01 He was moved from the helicopter to an ambulance at a park, and was taken to hospital.
12:06 He was hospitalized.

2.13 Helicopter Performances

a. Allowable maximum weight of the helicopter

We calculated the allowable maximum weight of the helicopter at an altitude of 1,300 meters in the vicinity of the accident site as follows, based on the additional provisions to the flight manual as described in the subsection 2.17 b.

As there are no observed values available for the pressure altitude and the temperature at 1,300 meters in the vicinity of the accident site at the time of the accident, they are calculated as follows.

- (1) Let the pressure altitude be 1,300 meters (4,265 feet).
- (2) We used the temperature value of 25°C observed at Yakushima Airport at 08:30 the same day for the base of calculation, applying the temperature lapse rate of the standard atmosphere (0.65°C per 100 meters). We got the temperature of 16.8°C.

Based on these figures, we got 8,600 kilograms as allowable maximum weight.

As the operating weight of the helicopter at the time of the accident was 8,003 kilograms as described in the subsection 2.6.3, the operating weight had a margin of 597 kilograms before reaching the allowable maximum weight.

Deceleration from a forward flight to an OGE hovering*² needs a large

*² “OGE hovering” stands for Out of Ground Effect hovering (hovering at an altitude larger than half the length of a MR diameter where the ground reaction force created by the downwash is unavailable). OGE hovering requires a larger amount of engine power than IGE (In Ground Effect) hovering which is normally carried out below OGE hovering altitude.

amount of well coordinated control input and significant power change. According to the Company, the helicopter travels about 300 meters before the deceleration from 55 knots to an OGE hovering completes.

(See Figure 6: Allowable Maximum Weight)

b. Estimated speed of the turn

At the time of the 6th cargo transport, the helicopter was flying to the west toward a cargo unloading site over the Arakawa River in the vicinity of the accident site. Let us assume the following: the helicopter made a steady 180-degree left level turn from the point due north of the accident site at the maximum bank angle (ϕ) of 25 degrees as described in the section 2.17 b; and a wind identical to that of 10:00 was blowing at 6 knots (3.1 meters per second) from the south above the accident site.

- (1) A turning diameter (D) is expressed by the following formula, where “R”, “V” and “g” stand for a turning radius, the velocity, and the gravitational acceleration (9.087 meters per second squared), respectively.

$$D = 2R$$

$$= 2V^2 / (g \cdot \tan \phi) \text{ (unit: meter)}$$

- (2) Time (t) required for making a 180-degree turn is expressed by the following formula:

$$t = \pi V / (g \cdot \tan \phi) \text{ (unit: second)}$$

- (3) The distance (ℓ) to be carried away by a wind blowing from the south at a speed of 6 knots (3.1 meters per second) while making a 180-degree turn, is expressed by the following formula:

$$\ell = 3.087 t \text{ (unit: meter)}$$

- (4) The distance (d) from the Arakawa River to the helicopter when making a 180-degree left turn from the point above the Arakawa River, is expressed by the following formula:

$$d = D - \ell \text{ (unit: meter)}$$

The distance from the Arakawa River to the helicopter (d) was calculated as shown in the table below, with bank angle (ϕ) of 25 degrees and speeds between 75 knots and 50 knots with an interval of 5 knots. It is concluded that the speed which produces a turning diameter close to 280 meters (from the Arakawa River to the accident site as described in the subsection 2.10.2) is 55 knots minus some knots.

Velocity	Velocity	Turning Diameter	Time Required for Turn	Distance Carried Away	Distance From the River
V (kt)	V (m/s)	D (m)	t (sec)	ℓ (m)	d (m)
75	38.6	651	26.5	82	569
70	36.0	567	24.7	76	491
65	33.4	489	23.0	71	418
60	30.9	417	21.2	66	351
55	28.3	350	19.4	60	290
50	25.7	289	17.7	54	235

c. Rate of climb

The time required for a 55-knot 180-degree turn with 25-degree bank is approximately 19.4 seconds as described in the subsection 2.13 b. With the assumption that the helicopter made a steady climbing 180-degree left turn from 1,230 meters (Kigensugi cedar tree elevation) to 1,305 meters (1,260+15+30) where the underslung cargo collided with Tree B, the average rate of climb is calculated to be 760 feet per minute (231 meters per minute).

According to the manufacturer, with a true air speed (TAS) of 55 knots, a pressure altitude of 1,300 meters, a temperature of 17°C, and an operating weight of 8,000 kilograms (the lift which is required at 25-degree bank is 8,800 kilograms, about 1.1 times bigger than the operating weight), the type helicopter can make a climbing turn at a rate of approximately 1,400 feet per minute with the take-off power, well above 760 feet per minute.

d. Recommended climb speed V_y

The flight manual describes that the recommended climb speed V_y , is 70 knots at 0 feet density altitude (DA) with a linear decrease of 1 knot per 1,000 feet DA. The DA at 1,300 meters (about 4,265 feet) with 16.8°C is calculated to be 1,650 meters (5,413 feet), we get 65 knot as V_y (5 knots lesser than 70 knots).

2.14 Information on Company's Cargo Transport

2.14.1 Schedule and Results of the Cargo Transport

The cargo transport was planned to be carried out in two days, covering September 25 and 26, 2010. They started work on September 25 as scheduled, the day before the accident.

On 25th the helicopter transported almost half amount of the total cargo after 22 shuttle flights between 09:20 (first takeoff time) and 11:49 (last landing).

On 26th the day of the accident, as the helicopter was supposed to transport the remaining cargo, it started the flight sometime after 07:00, did five flights, and the accident occurred during its 6th flight.

The remaining cargo was transported on November 8 with 24 shuttle flights.

2.14.2 Flight Operations Procedures

The flight operations procedures provided by the Company contains the following description (excerpt):

1. *Purpose*

Cargo transport for river bank protection works on Yakushima Island.

2. *Flight Standards*

The Regulations for Flight Operations and the Operating Regulations for the type aircraft apply.

3. *Survey Flight*

Prior to the cargo transport, conduct a survey flight to grasp the working conditions (deforestation, geographical features, hazardous materials, wind direction and velocity). Determine the directions of approach and takeoff identifying obstacles on the route.

4. Operational Conditions

(2) Altitude

- a. Cruising Altitude: at or higher than minimum safety altitude
- b. During Unloading Cargo: 30 meters

5. Weather Conditions

(1) Daytime VMC only

11. Operating Weight

See the attached table.

(The gross weight shown in the attached table is calculated using 95 percent of the maximum power. If long sling*³ is used, use 90 percent of the maximum power.)

12. Emergency Measures

In case of emergency, take prompt and appropriate measures pursuant to “Supplementary Provisions for Emergency Procedures” to Regulations for the Implementation of Flight Operations in the Operations Manual

<i>Applicable Weight</i>		
<i>Type of helicopter</i>		<i>332L</i>
<i>Maximum gross weight (cabin)</i>		<i>9,350 kg</i>
<i>90%</i>		<i>8,415 kg</i>
<i>Operating weight</i>	<i>(omitted)</i>	<i>(omitted)</i>
	<i>Total</i>	<i>5,544 kg</i>
<i>Conditions</i>	<i>Gross weight (allowable cargo sling weight)</i>	<i>2,871 kg</i>

* The gross weight in the above table is calculated with 90 percent of the maximum power.

(omitted)

<i>Maximum elevation</i>	<i>1,420 m</i>
<i>Outside air temperature</i>	<i>5 ~25°C</i>

The whole sections of “Supplementary Provisions for Emergency Procedures” to Regulations for the Implementation of Flight Operations in the Operations Manual referred above were deleted due to the revision done before the accident. This

*³ The Company explains that a long sling cargo operation denotes a cargo transport with slings longer than 6 meters in the case of the type helicopter. The total length from the main hook to the bottom of the cargo does not exceed 36 meters.

revision made the Company to take emergency measures based on “Aircraft Accident Procedures” established as internal regulations.

2.14.3 Regulations for the Implementation of Flight Operations (Helicopter)

The Company’s Regulations for the Implementation of Flight Operations contains the following description: (excerpt)

Chapter 2 Implementation Procedures for Flight Operation Control

2-4 Standards for Flight Operation Control

2-4-1 Flight Plan and Go-No-Go decision

(3) Characteristics of the Aerodromes

(a) Standards in special areas (omitted)

(omitted)

- *Maximum operation weight should be less than 95 percent of allowable OGE hovering weight.*

(omitted)

Chapter 8 Minimum Weather Conditions

8-2 VFR (Visual Flight Rules)

(omitted) Should operate under visual meteorological conditions as prescribed in Article 5 of the Regulations (omitted), provided pilots observe the following minimum weather conditions.

(1) Ground visibility of 1,500 meters

(2) Cloud base should be 300 meters from either the ground surface or the water surface (not applicable to emergency medical operations and aerial work services)

Chapter 9 Minimum Safety Altitude

9-1 General

The minimum safety altitude should be higher than the minimum safety altitude prescribed in Article 81 of the Civil Aeronautics Act (CAA) (except when permitted as specified in the proviso and CAA Article 81- 2 is applicable). Select altitudes to satisfy the following conditions taking into account navigational errors, geographic features on the flight route and turbulence.

(1) Select altitudes where communication with air traffic control authorities is available at all times (as much as possible during VFR).

(2) Multi-engine aircraft select altitude which allows safe landing at a destination or alternative airfield using the available engine in case of the critical engine failure.

2.15 Laws on MSA

The MSA is stipulated in the Ordinance for Enforcement of the CAA as follows: (excerpt)

Article 174 The minimum safety altitude pursuant to CAA Article 81 shall be

as follows:

- (i) *In the case of aircraft navigating on a visual flight rules shall take any of the highest of the altitude at which landing is feasible, when power system only has stopped during a flight, without causing danger of human beings or objects on the ground or on water and the following altitudes:*
 - (a) *(omitted)*
 - (b) *In the case of above an area without human beings or houses, an altitude at which an aircraft can continue flight while maintaining a distance of 150 meters or more from human beings or objects on the ground or water.*
 - (c) *In the case of a space over an area other than that prescribed under (a) and (b), an altitude of 150 meters or more from the ground or water surface.*

2.16 Additional Information

2.16.1 Pilot's Cargo Transport Experience Near the Accident Site

The Company stated that the pilot had done a cargo transport from the Land Helipad to the cargo unloading sites using the helicopter on October 1, 2009, almost a year before. The flight route at that time was along the Arakawa River.

2.16.2 Days-off, Duty Schedules for the Pilot Before and After the Accident

- a. The duty schedule after his days off before the accident, and the duty plan before his next days off was as follows. All of the duties he took during the period were done with the helicopter.

September 19:	Day-off
20:	Day-off
21:	He traveled from his house to Hiroshima Prefecture.
22:	He flies the helicopter from Hiroshima-Nishi Airport for power line construction material. He flew to Fukuoka Prefecture to do similar duties.
23:	Rest at a hotel
24:	After the cargo flight of power line construction material, he traveled to Yakushima Airport
25:	Cargo transport of stones
26:	After finishing the cargo flight, he was supposed to travel to Ehime Prefecture.
27:	Power line replacement flight
28:	After the work, he was supposed to travel to Okayama Prefecture for air lift of transmission tower construction material, then to Hiroshima-Nishi Airport
29:	Air lift of transmission tower construction materials. Then he was supposed to travel to Fukuoka Prefecture.

- 30: Transport of transmission tower construction material
- October 1: After the transport of transmission tower construction material, he was supposed to travel to Hiroshima Prefecture for the similar duties, then to Kochi Airport.
- 2: He was supposed to return to his house
- 3: Day-off
- 4: Day-off

b. The Company policy for work schedule

Most of the work at the Company including cargo transport is not required to be finished within the planned period. In case of unfinished work due to adverse weather, for instance, the Company reschedules the work.

2.16.3 Turn during the Cargo Transport Operation

The Company stated on turning flight during a cargo transport as follows:

There is no particular method for turning during a sling load operation.

A pilot selects a speed and a bank angle to get appropriate turning radius which fits the situation. Making a turn by decelerating to a hovering is also possible.

As slip may lead to unstable underslung cargo (swinging), a pilot should make a coordinated turn.

2.16.4 Wire Rope Kinking

The Company stated that repeated tension stress kinks a wire rope as it gets worn out by use. Even wires which have not yet got worn out by use may be kinked under large tension load.

2.17 Flight Manual

a. The aircraft flight manual includes the following description (excerpt):

SECTION 4 Normal Procedure

SECTION 4.1 Operation Procedures

7 Take-Off— Transition to Forward Flight — Climb

7.3 Climb

— Recommended speeds: V_y

- *70 knot at zero density altitude with a linear decrease of 1 knot per 1,000 feet density altitude (details omitted)*

b. The Aircraft flight manual supplement includes the following description—*10.6 TRANSPORT OF EXTERNAL LOADS 4,500 kilograms (9,920 pound) (excerpt):*

SECTION 2 Limitations

2.1 Underslung Load

— maximum allowable load: 4,500 kilograms (9,920 pounds) (omitted)

2.2 Maximum Allowable Weight

The maximum allowable weight of the aircraft for takeoff and landing (1), with a jettionable external load, is the weight which allows OGE hovering with two engines.

- Absolute maximum weight: 9,350 kilograms (20,610 pounds)*
- Modifications to the weight determined by altitudes and temperatures are given in SECTION 5.1 and in Figure 2 of the present supplement.*

2.4 Maneuvering Limitations

With underslung load the maximum bank angle is 25 degrees.

(See Figure 6: Allowable Maximum Weight)

3. ANALYSIS

3.1 Airman Competence Certificate

The pilot held both a valid airman competence certificate and a valid aviation medical certificate.

3.2 Airworthiness Certificate

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

3.3 Meteorological Conditions

3.3.1 Weather Conditions over the Vicinity of Cargo Unloading Sites at the Time of the Accident

Mechanics A and B at the Land Helipad received a radio call from the pilot saying that the helicopter might land (at Land Helipad) and stand by because of worsening weather conditions during the 5th cargo transport. Also, construction Worker A near the Hut heard faint sound of the helicopter coming toward him during the 6th cargo transport. The sound became faint as if the helicopter were turning away on the way.

Judging from these statements and what to be described in the next subsection 3.3.2, it is probable that the squeezed opening between the lowered cloud base and the surface made it difficult for the helicopter to continue the flight near the cargo unloading sites at the time of the accident.

3.3.2 Weather Conditions Near the Accident Site at the Time of the Accident

The elevation of the accident site is 1,290 meters (4,230 feet). The pilot of the Disaster Prevention Aviation Center stated that “It was overcast with the cloud base of 4,500-4,600 feet (1,370-1,400 meters) hanging over the ridges in the vicinity of the accident site, and the horizontal visibility in the vicinity was good at about 10:00, about two hours after the accident.” The Reporter stated that “the weather at about 10:00 in the vicinity of the accident site was the same as when the accident occurred.”

Judging from these statements, it is probable that the weather conditions over the accident site were such that the cloud base was 100 meters above the site—small opening between the ground and the cloud base.

3.4 Flight Route at the Time of the Accident

a. Flight route

It is probable that the flight route was along the Arakawa and Yodogawa Rivers due to the following reasons:

- (1) The Reporter stated that he had heard the helicopter flying back and forth when he was near Kigensugi cedar tree, and had seen it flying in the valley to the north of the cedar tree in the direction of the Hut.
- (2) It is probable that due to the following advantages the pilot chose

to fly in the valley rather than over the mountain ridge for the route of helicopter short-distance shuttle flights for cargo transport, as he was aware of the absence of linear obstacles (such as wires and cables) and was fully familiar with the geographical features.

(a) A flight at a low altitude will shorten the length of the route and provides the helicopter with better margin of usable power (cargo sling capability), which lead to less flight time and fuel consumption.

(b) Flying over a river provides bigger AGL altitude.

b. Altitude

Judging from the Reporter's statement that the altitude of the helicopter was almost at his eye level when he saw it at Kigensugi cedar tree, and the fact that the cedar tree's elevation is 1,230 meters and the Arakawa River's elevation to the north of the cedar tree is 1,150 meters, the helicopter was estimated to have been flying about 80 meters above the river.

With the assumption that the trees standing near the Arakawa River are 10-meter high, the distance between the cargo bottom to the treetop is estimated to have been 40 meters, as the total length of the underslung cargo was 30 meters.

On the other hand, permission to fly below the MSA was obtained only for the flight over the cargo unloading sites. In the vicinity of the accident site the pilot should have maintained more than 150 meters of distance between the treetop and the cargo bottom observing the MSA. It is very probable that the helicopter was flying far below the MSA (at least by about 110 meters).

If the helicopter was flying along the river observing the MSA, the estimated cargo elevation should be at least 1,310 meters (the Arakawa River's elevation of 1,150 meters + tree height of 10 meters + 150 meters). In fact the elevation of Tree B's branch which was possibly broken by the cargo slung by the helicopter in a climbing turn was about 1,275 meters (1,260+15), about 35 meters lower than the 1,310 meters. Also, the elevation of the collision should be higher than the starting altitude of the turn by the increased amount gained during the turn. These elements point to the very high probability that the helicopter was flying far lower than the MSA.

If the deceleration to an OGE hovering without changing course and altitude had been started at the point to the north of the accident site to be described in the subsection 3.4 c, the clearance between the cargo bottom and treetops at the OGE hovering point would have been secured.

c. Direction and Position of the Turn

The cedar tree is located about 160 meters south of the Arakawa River, and the Reporter stated that the helicopter which was flying over the valley came toward him just before the accident, and crashed.

The helicopter was probably on its way back to the usual flight route to secure maximum AGL altitude, and it was in the middle of turning around when it crashed because its last trajectory was east-southeast bound to be described in the section 3.5 a.

It is possible that it started the left turn at a point further west, nearer to the Hut than due north of the accident site. If so, it should have taken the course to return to the point above Arakawa River to secure AGL altitude judging from the terrain features. The last trajectory was not river-bound as mentioned above.

With additional consideration of what are described in the above mentioned subsections a and b, it is probable that the helicopter started the left turn in the vicinity above the Arakawa River due north of the accident site, and approached the slope during the turn.

d. Turning Speed and Estimated Rate of Climb

Judging from the estimations in the above subsections b and c as well as subsections 2.13 b, c, and d, the helicopter, which was climbing from the Land Helipad toward the Hut at about 65 knots (V_y), probably reduced its speed to about 55 knots immediately before the left turn, started a climbing turn with increased rate of climb to approximately 760 feet per minute, and collided with ground objects such as Tree C.

What is described in the subsection 2.13 c probably supports the idea that the helicopter had the rate of climb of 1,400 feet per minute at 55 knot at the time of the accident. It is probable that at the time of the accident the helicopter was capable of avoiding the collision at the accident site.

3.5 Developments of the Crash

- a. The Reporter stated that the helicopter came toward him from the direction of the Hut at the time of the accident. Also, the wreckage of the helicopter, the impact marks and the cargo stones on the ground scattered from Tree B to the Main Wreckage in the direction of east-southeast.

Judging from the weather conditions and these facts, the helicopter probably aborted the flight toward the unloading site, changed direction toward Land Helipad and crashed amid its left turn flying east-southeast.

- b. The wire ropes were new, but they were kinked. In light of what is described in the subsection 2.16.4, it is highly probable that the new wire ropes were kinked due to large tension load applied.

These facts indicate that the underslung cargo was caught in ground objects such as branches of Tree B or Rock A while the helicopter was advancing, causing the main hook mounted on the belly of the helicopter to be exposed to a strong tension load.

- c. The cargo slings were found at a location away from the Main Wreckage, while neither the cargo slings nor the shackles were broken. The main hook was locked at its regular position with no major deformation, crack or rupture.

Judging from these facts and what is described in the subsection 3.5 b,

it is probable that, by recognizing that the underslung cargo was caught in ground objects the pilot or the loadmaster released the cargo sling from the main hook before the collision with Tree C.

- d. Judging from what described in the subsections 2.10.2, and 3.5 b, c, the probable sequence of the collision was as follows: as the underslung cargo was caught in ground objects, the helicopter released the cargo in nose-down unsteady attitude; it continued advancing while MR blades colliding with branches of Tree C which was on the slope at a higher elevation than Tree B, until it collided with Tree A and fell on the ground; and this caused a fire to break out.

3.6 Reasons for Unavoidable Collision with the Trees

It is probable that the pilot selected the easier maneuver of the left turn than OGE hovering above the Arakawa River although the latter was possible if he accepted a large control input as described in the subsection 2.13 a. His selection resulted in the proximity to the slope in the valley causing the underslung cargo being caught in the ground objects. Reasons for his selection are as follows:

- a. It is highly probable that the helicopter was flying over the route for the cargo transport far below the MSA.
- b. The pilot possibly reduced the climb rate to avoid in-cloud situation during the turn, as the opening between the flying altitude and the cloud base was small, although it had enough climbing power to avoid the collision with trees.
- c. The pilot possibly failed to judge the cargo clearance from the tree top because it was the left turn—his right seat position hampered his look-out, with the cargo slung with 30-meter long slings.

As the starting point of left turn was on the shuttle flight route, no additional precautions for terrain features were probably necessary. However, the turning in the valley required his additional attention to the vertical margin and terrain features.

3.7 Means of Communication Among the Working Sites for the Cargo Transport

As the sites for the cargo transport were in a mountainous area where the mobile phone reception was limited and VHF radio communication was only available when the helicopter was airborne, and with the absence of effective means of communication available, it was necessary for the persons concerned to get together in order to share information about the helicopter which had lost communication with them. The absence of contingency plan for each site probably created two lapses for reporting and locating the accident site; about 40 minutes for the former, two hours for the latter.

With a satellite phone at each site and contingency plan when to launch surveillance operations in case of emergency such as lost contact with the helicopter, sooner search for the missing helicopter could have been initiated.

3.8 Decision Making to Suspend Flight Under Unfavorable Weather Conditions

The helicopter's probable proximity to the slope occurred because the pilot reduced the rate of climb to avoid in-cloud conditions during the left turn as the opening under the cloud base was small, although the helicopter was capable of producing enough climb rate. Considering this possibility and his awareness of deteriorating weather conditions to the west beyond Kigensugi cedar tree during the 5th cargo transport, he should have aborted the flight before it was too late.

4. CONCLUSIONS

4.1 Probable Causes

In this accident, it is probable that the helicopter, while flying in the mountain valley with underslung external cargo, made a left turn to return back, crashed after nearing the slope with its underslung cargo caught in ground objects during the maneuver. The post-crash fire consumed the helicopter and the pilot and loadmaster suffered fatal injuries.

The following are possible reasons why the helicopter came close to the slope during the left turn, and the underslung cargo came to be caught in ground objects: capable OGE hovering for turn-back was not carried out; en route altitude was well below MSA; the climbing was restrained during the left turn as the opening under the cloud base was small; and the failure of judging cargo clearance from the ground objects.

4.2 Other Safety-related Findings

The sites for the cargo transport were in a mountainous area where the mobile phone and VHF reception were limited, and with the absence of effective means of communication available, it was necessary for the persons concerned to get together in order to share information. The absence of contingency communication procedure created lapse before the post-accident response was initiated.

5. Actions Taken

5.1 Safety Actions Taken

5.1.1 Safety Actions Taken by the Company

- a. On September 26, 2010, the Company issued “Reminder (JA9635 helicopter Accident)” which included the following (excerpt):
 - (1) Thorough pre/post-flight check.
 - (2) Fly under visual meteorological conditions.
 - (3) In case of in-flight malfunction, run the emergency procedures and, if need be, execute a preventive landing.
 - (4) Other related instructions
 - (a) “Stick to fundamentals”: do what should be done and don’t do what shouldn’t be done.
 - (b) Always keep in mind that “Stay calm, don’t push yourself too hard, and stay on the safe side when choosing courses of action.”
- b. On September 29, 2010, the Company issued “Reminder (Cargo Transport Operation)” which included the following (excerpt):
 - (1) Check weather conditions to take appropriate measures
 - (a) The pilot should collect information on general weather outlook and local weather for the area of operation to decide go-no-go.
 - (b) Do not fly when your judgment tells you that the weather will not hold for two shuttle flights. Pay special attention to when high mountains will be shrouded by clouds and its future developments.
 - (c) Reduce airspeed appropriately in case of weather deterioration. Consider cargo clearance from obstacles. In case where such clearance is impossible, jettison the cargo after confirming the ground safety to secure the crew and the helicopter.
 - (2) Flight route
Survey the area of operation to determine flight route considering ground safety. When flying stick to the selected route. When weather element such as fog forces deviation from the route, suspend the flight and wait for the recovery of the weather
 - (3) Selection of an appropriate speed and altitude
Select an appropriate speed considering the nature of the cargo, length of the sling and the weather. Don’t pursue speed oriented efficiency.
 - (4) Cargo weight
 - (a) Check helicopter performance.
 - (b) A heavy cargo flight with very small amount of fuel very likely limits freedom of action against sudden deterioration of the weather. Careful consideration of weather development and onboard fuel is necessary.

(5) Crew communication

When pressed by the decision making, exchange views with your crew for the option which falls on the safe side.

(6) Recurrence preventive measures

All cargo transport pilots are mutually evaluated on a temporary basis in addition to the work authorization checkride.

6. Recommendations

In this accident, en route altitude below minimum safe altitude is the possible contributing factor to the cargo caught in ground objects while the helicopter operated by Aero Asahi Corporation was turning left in the valley. Time lapsed before launching the emergency surveillance activities.

In view of this accident investigation, the Japan Transport Safety Board, pursuant to the provision of paragraph (1) of the Article 27 of the Act for Establishment of the Japan Transport Safety Board makes the following recommendation:

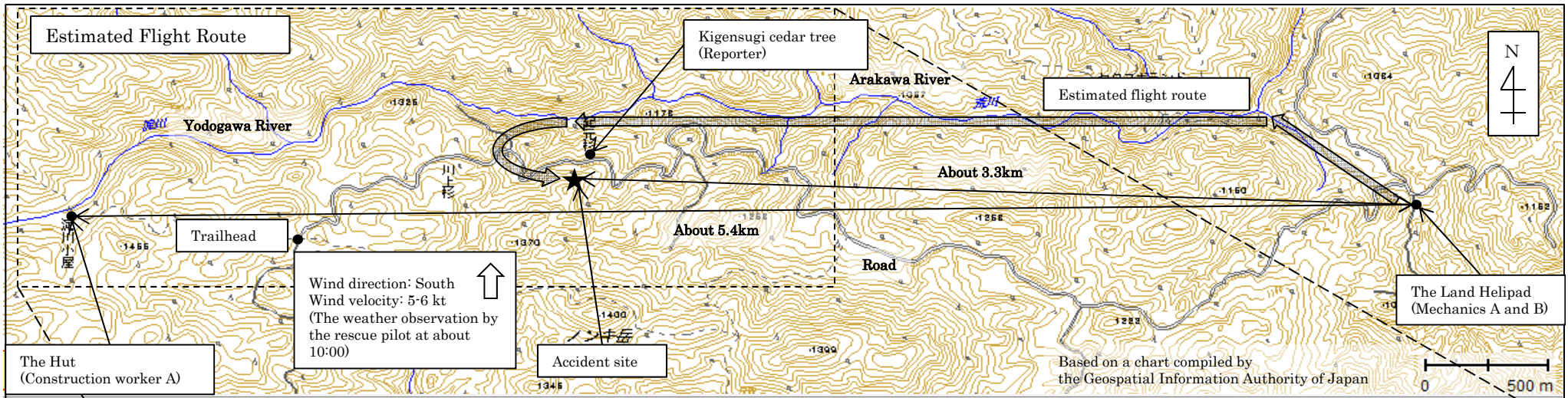
To Aero Asahi Corporation:

Review flight operations whether there were non-compliance activities against laws and regulations.

Remind all employees engaged in safety-related works including pilots and mechanics of the importance of observing fundamental safety standards such as minimum safe altitudes.

Review internal contingency communication procedure.

Figure 1: Estimated Flight Route and Accident Site



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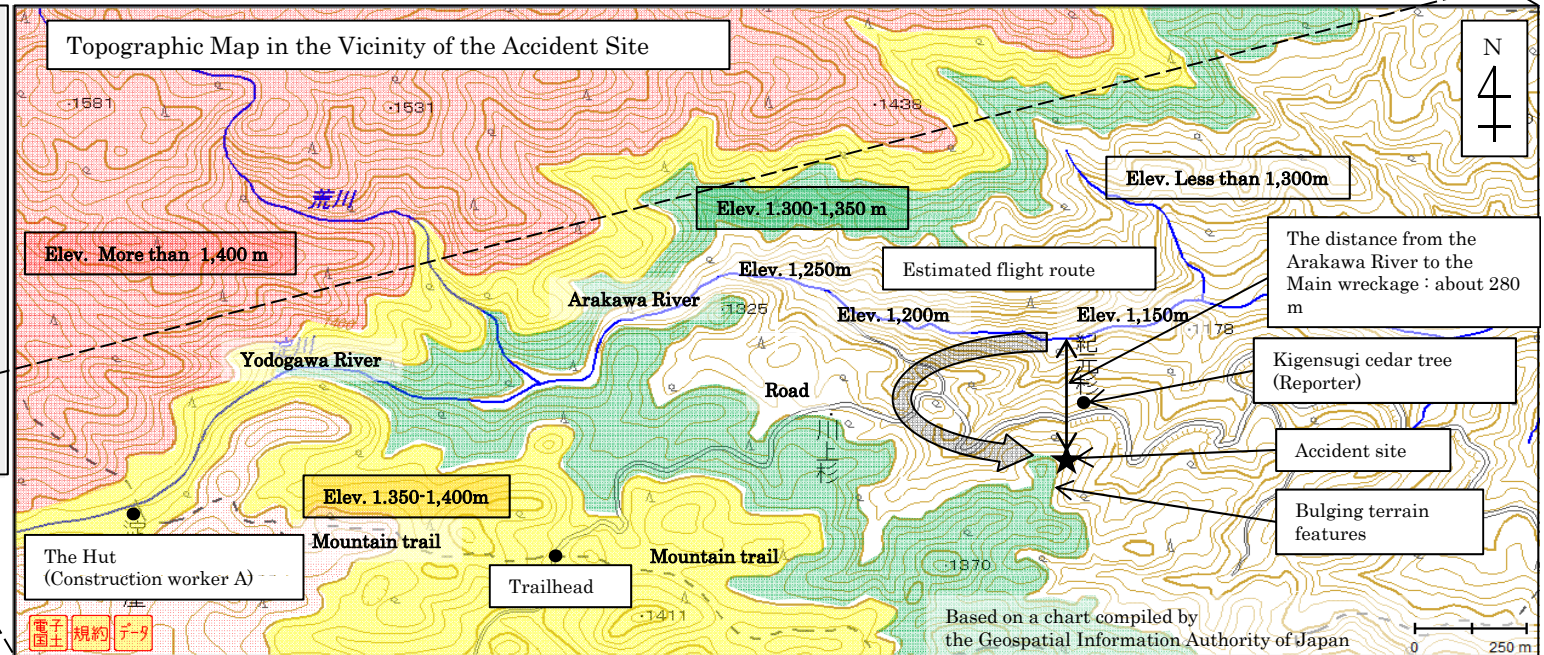
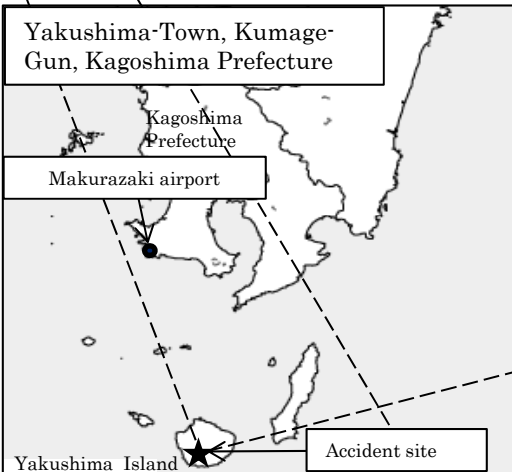
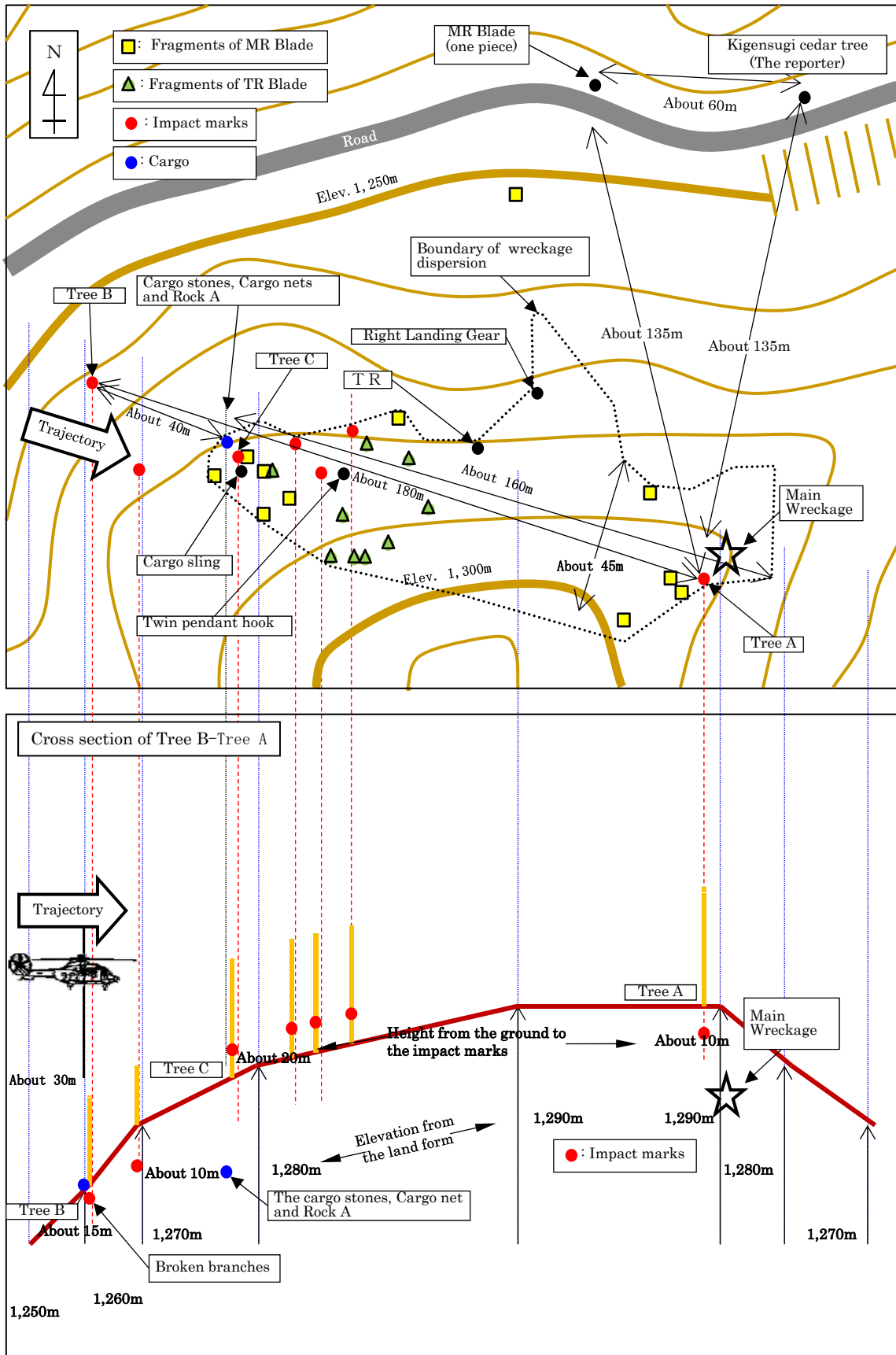


Figure 2: Accident Site Layout



※ Tall trees densely grow on the slope.

Figure 3: Aerial Photo of Accident Site and Terrain Features (3D Image)

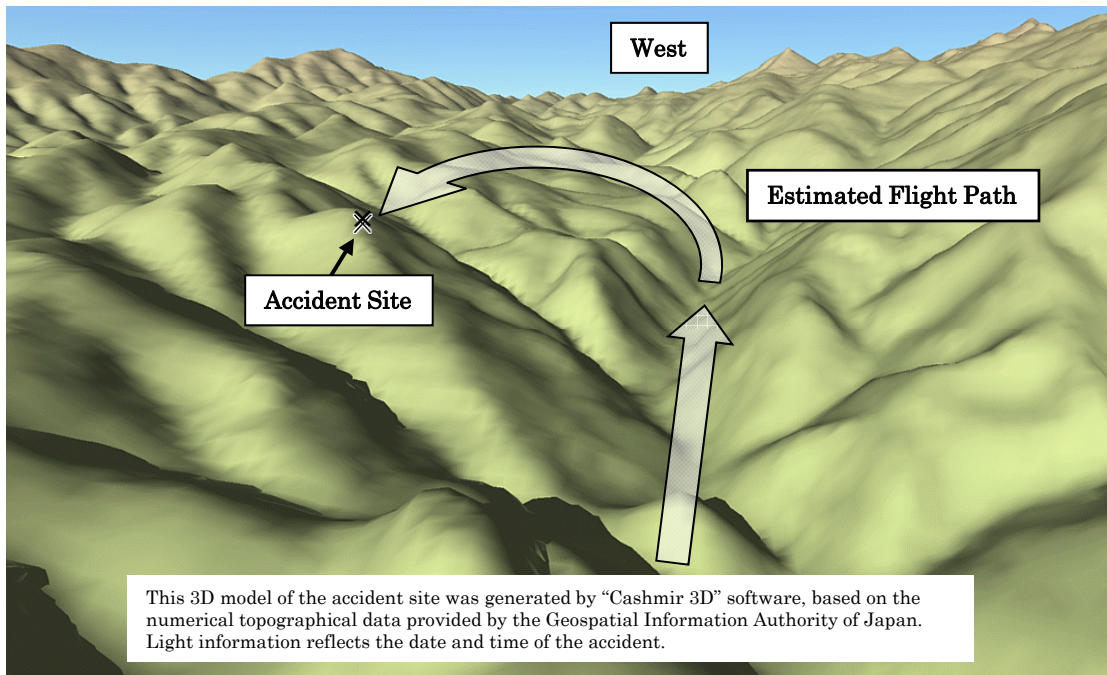
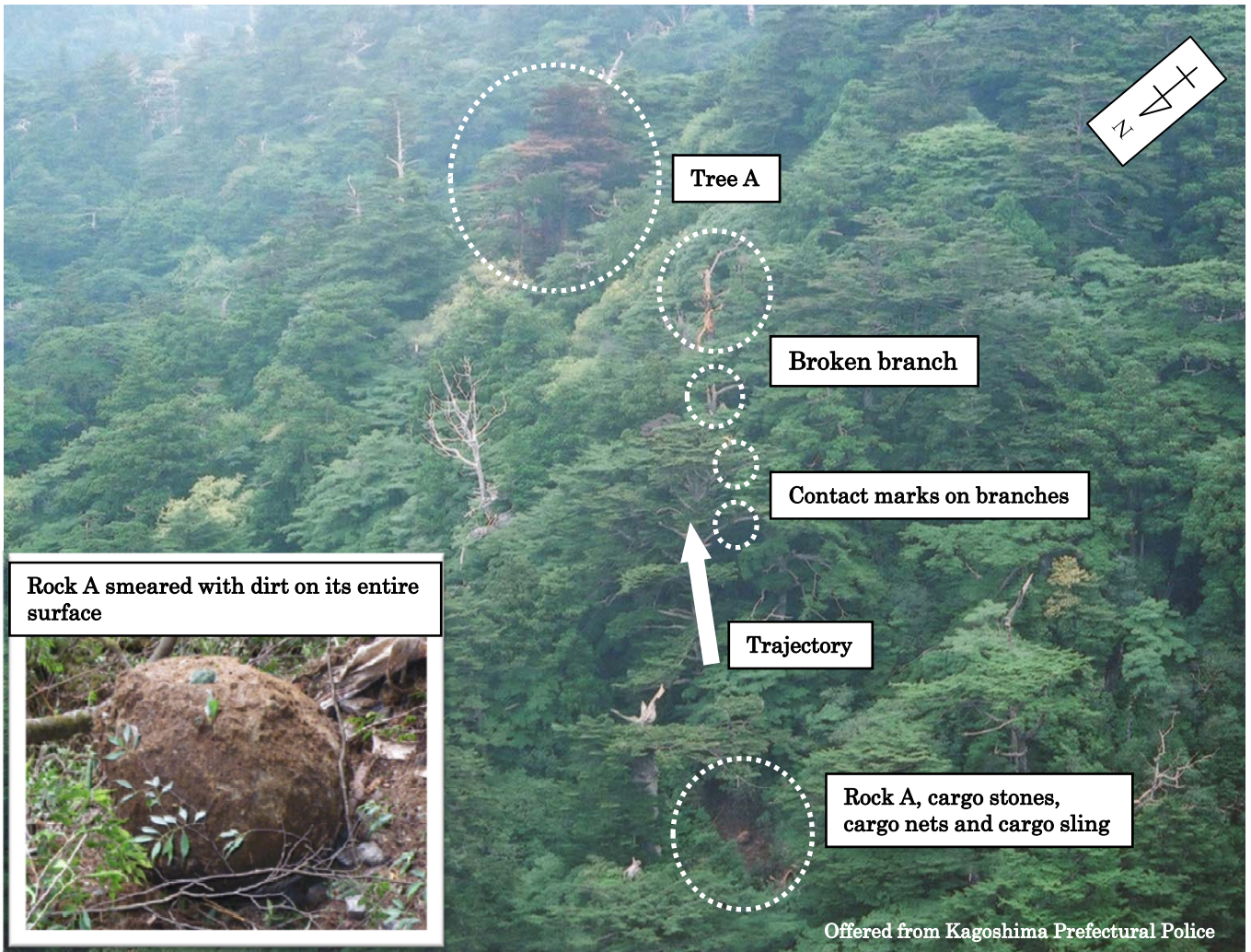


Figure 4: Three Angle View of Aerospatiale AS332L

Unit: m

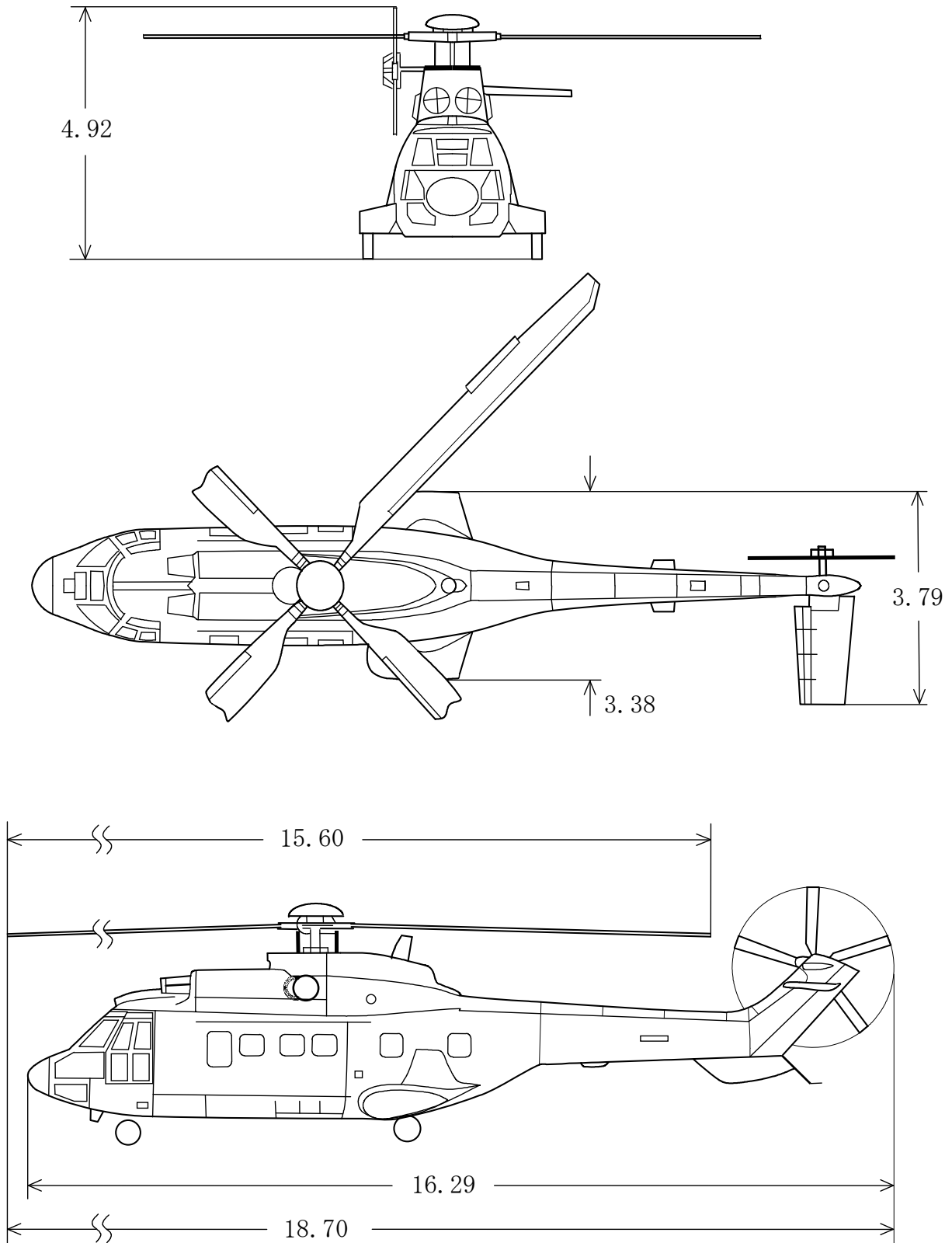


Figure 5: External Cargo Sling Device

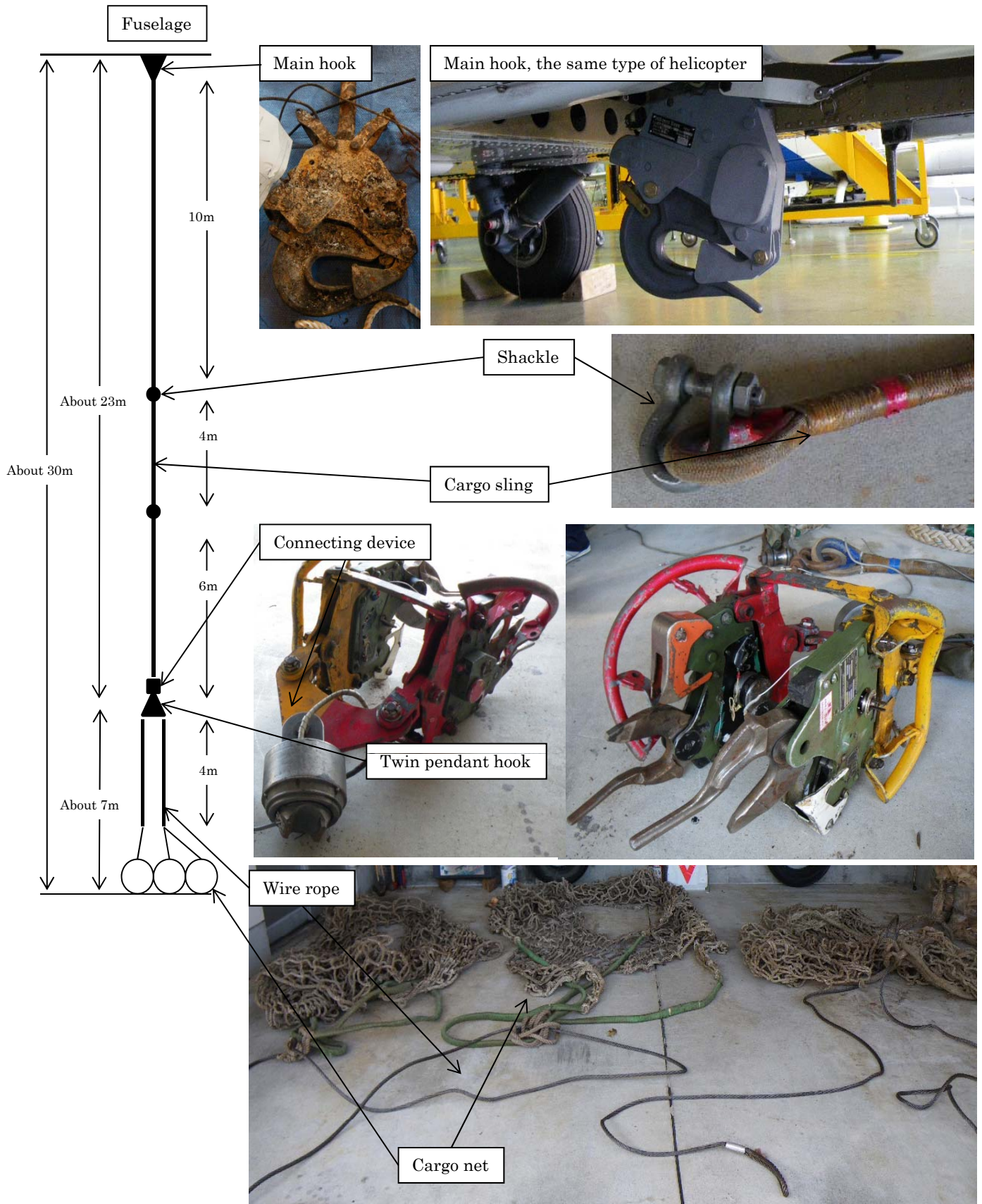
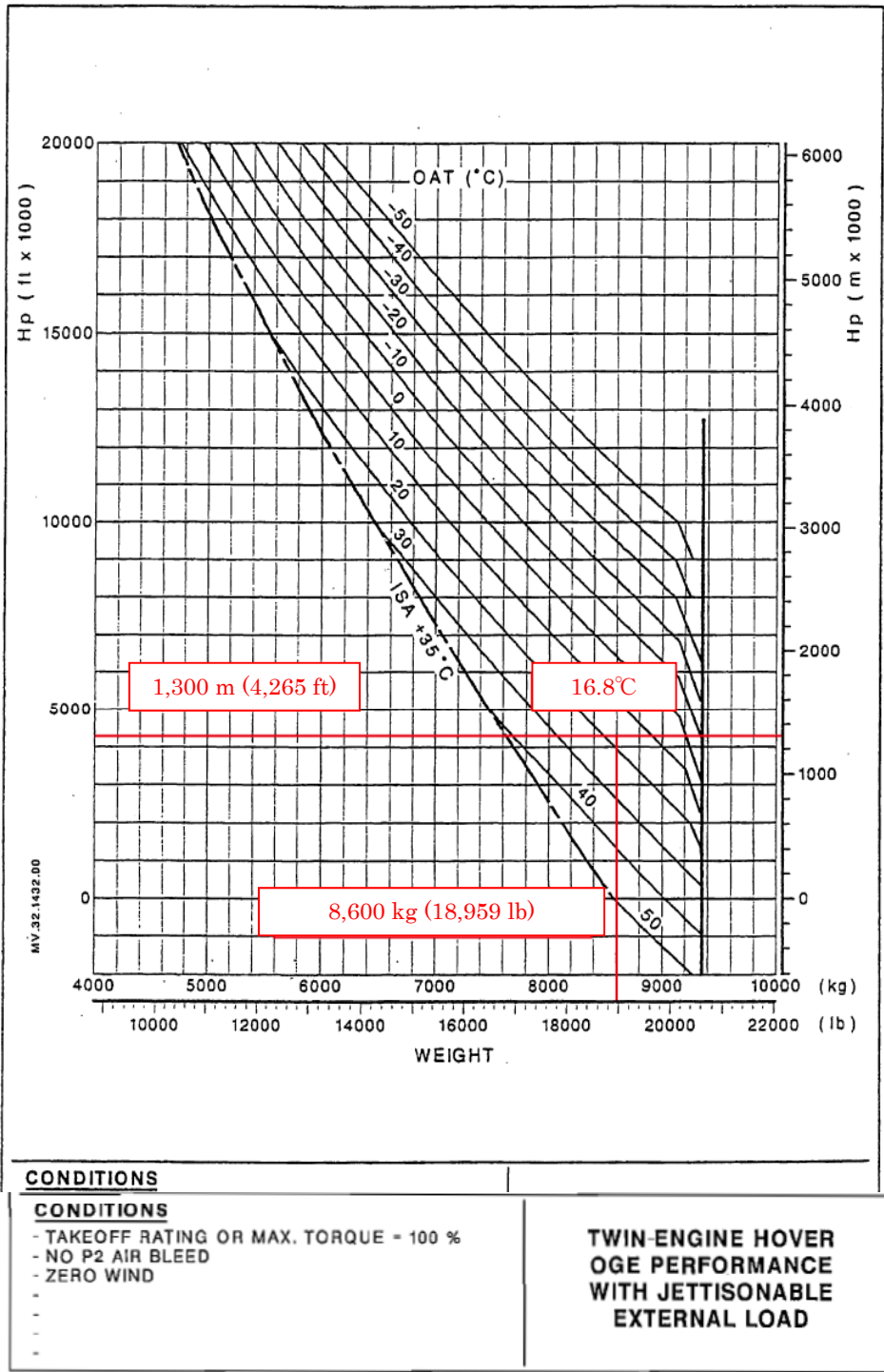


Figure 6: Allowable Maximum Weight

TRANSPORT OF EXTERNAL LOADS
4,500 kg (9,920 lb)

Aerospatiale AS332L
Japan Civil Aviation Bureau
approved Oct. 7, 2005



CONDITIONS

- CONDITIONS**
- TAKEOFF RATING OR MAX. TORQUE - 100 %
 - NO P2 AIR BLEED
 - ZERO WIND
 -
 -
 -

**TWIN-ENGINE HOVER
OGE PERFORMANCE
WITH JETTISONABLE
EXTERNAL LOAD**

Figure 2

EASA Approved:

332 L

SUP.10.6

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Photo 1: Type Helicopter



Photo 2: Accident Helicopter (Main Wreckage)



Photo 3: Accident Site Taken From Afar During Rescue Operation

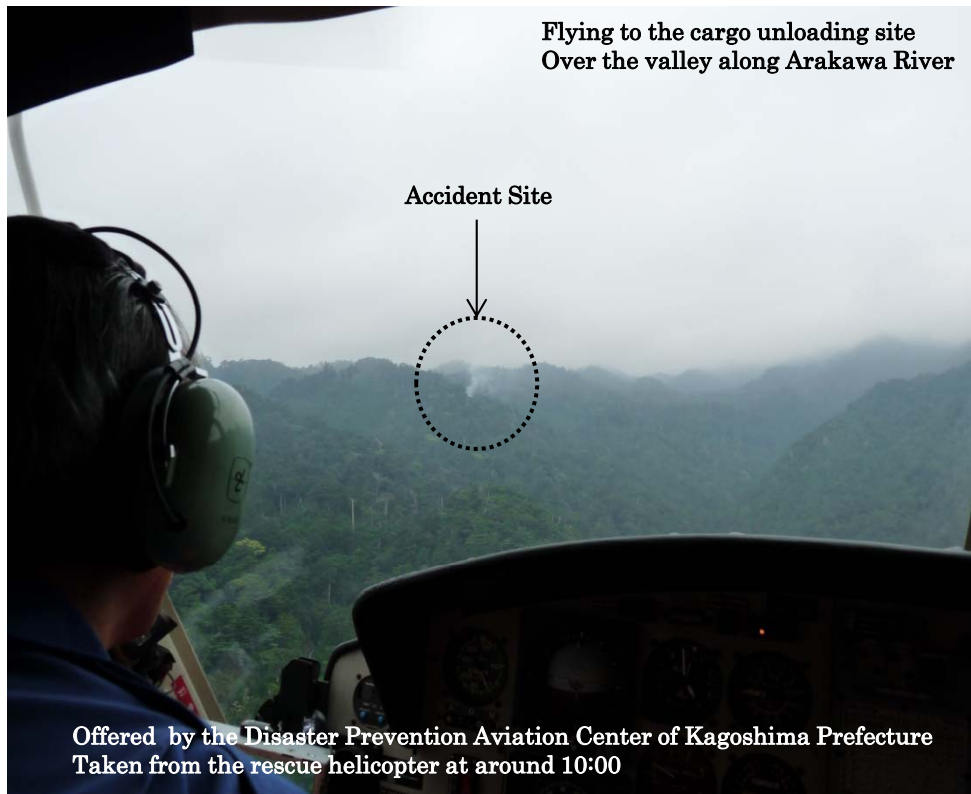


Photo 4: Accident Site Blow-up

