

2002-9

# SUMMARY OF AIRCRAFT ACCIDENT INVESTIGATION REPORT

ACE HELICOPTER

AEROSPACIAL SA330J, JA6706

WHICH CRASHED DURING APPROACH TO A TEMPORARY  
HELIPAD IN MOUNTAINS, TOYAMA, JAPAN

November 29, 2002

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

The investigation for this report was conducted by aircraft and Railway Accidents Investigation Commission about the aircraft accident of Ace Helicopter Aerospace SA330J in accordance with Aircraft and Railway Accidents Investigation Commission Establishment Law and Annex 13 to the Convention of International Civil Aviation for the purpose of determining cause of the aircraft accident and contributing to the prevention of accidents and not for the purpose of blaming responsibility of the accident.

This English version report has been summarized and translated by Aircraft and Railway Accident Investigation Commission to make easier for those who are not familiar with Japanese as well as English speaking people. Although efforts are made to translate as accurate as possible, only the Japanese full text version is authentic. If there is difference in meaning of the texts between the Japanese version and this English version, texts in the Japanese full text version are correct.

Junzo Sato,

Chairman,

Aircraft and Railway Accidents Investigation Commission

**SUMMARY OF AIRCRAFT ACCIDENT INVESTIGATION REPORT**  
**ACE HELICOPTER AEROSPATIALE SA330J**  
**WHICH CRASHED DURING APPROACH TO A TEMPORARY**  
**HELIPAD IN MOUNTAINS, TOYAMA, JAPAN,**  
**AT ABOUT 0848 JST, SEPTEMBER 16, 2000**

November 6, 2002

**Decision by the Aircraft and Railway Accidents Investigation  
Commission(Air Sub-committee Meeting)**

<b>Chairman</b>	<b>Junzo Sato</b>
<b>Member</b>	<b>Ryouhei Katsuno</b>
<b>Member</b>	<b>Susumu Kato</b>
<b>Member</b>	<b>Sumio Matsuura</b>
<b>Member</b>	<b>Yukiko Kakimoto</b>
<b>Member</b>	<b>Kozaburo Yamane</b>

<b>Date &amp; Time(UTC):</b>	September 15, 2000, around 2348
<b>Location:</b>	36345N137350E about 2345m MSL near Mt.Tateyama in Toyama Prefecture Japan
<b>Aircraft-Model and Registration:</b>	Aerospacial SA330J, JA6706(S/N 1361)
<b>-Year of Manufacture:</b>	1976
<b>-Total Time in Service:</b>	7429hours 44 minutes
<b>No &amp; Type of Engines:</b>	2 Turbomeca TURMO IVC turboshaft Engines(S/N 1611 & 1399)
<b>Operator:</b>	Ace Helicopter Co. Ltd.
<b>Type of Operation:</b>	External Load Operation
<b>Person on Board:</b>	Crew-3 Passengers-None

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

### **1.1 Summary of the Accident**

On Saturday September 16, 2000, an Aerospatiale SA330J of Ace Helicopter Company, Limited, registration JA6706, was engaged in external cargo sling operations and was making an approach to a temporary helipad situated in mountains at Tengudaira-Kunimi, Tateyama-Town, Nakashinkawa-County, Toyama Prefecture at an elevation of 2456m, when it suddenly lost altitude and crashed at around 0848 JST(Japan Standard Time).

Two of the three persons aboard the helicopter, including the Captain, were killed, and the remaining occupant was seriously injured.

The helicopter caught fire and was destroyed.

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

#### **1.2.1 The Implementation of the Investigation**

The investigation proceeded as follows.

September 16–18, 2000	Crash site and aircraft investigations Witness interviews
October 3–27, 2000	Aircraft wreckage investigation and

	witness interviews
November 1, 2000	Witness interviews
November 16, 2000	Aircraft wreckage investigation
October 3, 2000–June 27, 2001	Analysis of weather information and analysis of engine investigation
January 25, 2001–February 7, 2001	Study of similar accident cases
April 13, 2001–June 27, 2001	Detailed engine investigation
July, 2001–June, 2002	Analysis of accident causal factors

## 2. FACTUAL INFORMATION

### 2.1 Flight History

#### 2.1.1 Outline of the Flight History

On September 16, 2000, the accident helicopter, an Aerospatiale S330J, registration JA6706, was based at Gokurakuzaka Temporary Heliport at Tateyama-Town, Nakashinkawa-County, Toyama Prefecture to provide transportation of road repair materials.

The cargo transport flights involved the repeated lifting of road construction and repair materials from Tengudaira Kunimi Helipad (approximate elevation 2345m, referred to hereinafter as the “Loading Helipad”) to the road repair site located 700m to the northeast of the Loading Helipad at an elevation of approximately 2310m (referred to hereinafter as the “Cargo Release Point”).

The helicopter’s pilot was also accumulating flight experience under the supervision of the Captain. According to the operator’s procedures, a pilot shall not fly a revenue flight as Captain unless he has logged over five hours of flight experience within the previous 60 days on the same type of helicopter or an equivalent type. Accordingly, the pilot was flying the helicopter from the right seat under the supervision of the Captain, who occupied the left seat.

From around 0740, the Captain and the assigned maintenance engineer carried out pre-flight checks and a run-up, and found no abnormalities in the helicopter systems or engines. The helicopter departed Gokurakuzaka Temporary Heliport at around 0820 and landed at the Loading Helipad at around 0830. After letting off ground support personnel, the helicopter commenced cargo transport operations at around 0833.

The helicopter was returning from its sixth transport run and was approaching the Loading Helipad for the seventh load of materials to be attached when, while transitioning to hover, it abruptly sank and impacted the ground hard. The helicopter subsequently became airborne again, rotating to the left and scattering parts, before crashing at a point around 26m forward of the first impact point and catching fire.

The assigned maintenance engineer, who squatted beside the cabin left slide door, escaped through a crack which opened next to the escape hatch in the aft fuselage, and was

rescued by cargo-handling ground support personnel, but the pilots in the pilot seats were unable to escape.

The accident occurred at around 0848 at the gradual slope ahead of approximately 20m north of Tengudaira Kunimi Parking of Kita Alps-Tateyama, Tateyama-Town, Nakashinkawa-County, Toyama Prefecture.

## **2.1.2 Statements of the Assigned maintenance Engineer and Eyewitnesses**

The statements of the assigned maintenance engineer and cargo-handling ground support personnel who witnessed the crash concerning the flight history and conditions at the time of the accident are summarized below.

### **2.1.2.1 Statement of the Assigned maintenance Engineer**

“I was responsible for the maintenance of the helicopter, and on the day of the accident I was on board to assist in operating the sling.

“The helicopter had no malfunctions or signs of malfunction. All of the time-regulated parts were already replaced and had around 40 to 50 hours remaining.

“I think there was around 640 liters of fuel remaining when we took off from Gokurakuzaka Temporary Heliport.

“During the flight from Gokurakuzaka Temporary Heliport to the Loading Helipad, I heard the pilot and Captain speaking that there’s a downwards airflow today and it’s difficult to climb.

“I occupied the seat for person to guide at sling operation, which is attached beside the left slide door. However, since guiding work cannot be done with the seat belt fastened, I was wearing a monkey belt and squatting beside the cabin left slide door.

“Because of this, when we first hit the ground I was thrown right and forward, hit the back of the two-person seat installed in the right forward part of the cabin hard, and then fell to the floor hitting my back and shoulders hard. The feeling at the time we dropped was similar to hovering autorotation I have experienced on board pilot training flights. The sound of the engines at that time was no different from usual, so there was no sign of sudden power loss from either engine, and I didn’t think that there were any engine problems. Also, engine bleed air was not being used for heating.

“A vertical crack had opened between the rear window and the left sponson, and I escaped through it.

“On that day, the pilot was undergoing five hour refresher training with the Captain as instructor, and was flying without any problems. The pilot cried “Aaah” when we dropped, and I felt from the scream that it was not possible to recover.”

### **2.1.2.2 Statement of maintenance Engineer “A” who witnessed the Accident while performing Ground Support duties**

“The accident happened when the helicopter was returning after dropping off the sixth load and was in the final stages of approach to the Loading Helipad in order to attach the seventh load.

“At that time, I was at the Loading Helipad providing landing guidance. I didn’t think there were any abnormal sounds or anything particularly unusual in the flight. However, at the time the helicopter was making its final approach I thought its flare was a little larger than normal.

“Just at the moment, I thought the helicopter had leveled after the flare out, the helicopter dropped in an instant, then seemed to recover and climbed to a height of around 10–15 meters while making at least two rotations to the left. At that time, the tail cone flew off in our direction. After that, the helicopter hit the ground hard and tilted

over as if it would roll over to the right, and fire came out of the lower side No. 2 engine.”  
(See Figures 1, 2 and Photographs 1, 2.)

## **2.2 Meteorological Information**

### **2.2.1 Weather Synoptic**

The weather synoptic for the Toyama prefecture region issued by Toyama Local Weather Service Center at 0500 JST on the day of the accident was as follows:

A Pacific high-pressure system covers the Hokuriku region with a front stationary above the Sea of Japan. Typhoon No. 14 is located over the southern part of the Korean Peninsula and is moving north.

Typhoon No. 14 will move north of the Korea Peninsula and it is expected to be downgraded to an extra tropical cyclone tonight.

Warm moist air will move into the Hokuriku region from the south, and the temperature will rise and the weather will be fine, but from the evening it will become cloudy and rain is expected in some areas.

(See Figures 3, 4.)

### **2.2.2 The Weather in the vicinity of the Accident Site**

The following meteorological observations for Murodou on the day of the accident were made by the Murodou Operation Center of the Tateyama-Kurobe Sightseeing Company located in Murodou Terminal, which is near the accident site. Further, as shown in Figure 5 (Murodou wind speed and direction data), there were large variations in wind velocity, with the wind direction varying from north-north-east to south to west-south-west over a range of around 225°, and wind speed varying between 0–18m/s.

Observations for Murodou (situated 1km east of the accident site at an elevation 2400m on the west slope of the Tateyama ridgeline)

0700 Weather: cloudy, Visibility: 15km, Temperature: 13.8°C, Wind direction: south-east, Wind speed: 10m/s

0900 Weather: cloudy, Visibility: 10km, Temperature: 13.8°C, Wind direction: south-east, Wind speed: 10m/s, Humidity: 57%, Cloud cover: 8/8, Precipitation: none.

### **2.2.3 Witness statements relating to the weather**

The following are summaries of the statements of the assigned maintenance engineer who was on board and witnesses who were in the vicinity of the accident site regarding the weather at the time of the accident.

#### **(1) The Assigned maintenance engineer**

“The accident occurred in a mountainous region, where there is wind due to the shape of the terrain. On the day of the accident the wind was mostly northeast on the way from Gokurakuzaka Temporary Heliport to the Loading Helipad from the Shomyo Falls to the vicinity of Midagahara. There were strong up-down motions during the flight due to turbulence, and I heard the pilot and the Captain speaking that the wind is strong today, too.

“Unlike the previous day, clouds were flowing over the ridgeline of the vicinity of Mt. Jodo slightly south of the peak of Mt. Tateyama, and were appearing to swirl as they descended, and I remarked to the pilot ‘the clouds are strange’.”

- (2) maintenance engineer “A” , who witnessed the accident from the Loading Helipad

“Since the wind direction at the time of the accident was east-north-east from the direction of Mikuri Pond, it was a head wind when flying toward the Cargo Release Point, a tailwind when returning, and a crosswind during the approach. The wind speed was constantly averaging around 5–7m/s, and I thought there were occasional gusts which felt like 12–13m/s. It felt like I would be buffeted by the wind unless I stood my guard.

“There was no haze or fog around mountain’s surface in the vicinity of the Loading Helipad, and the weather was slightly cloudy with clouds at high altitudes. Mt. Oyama and Mt. Tsurugidake were sometimes obscured by cloud and sometimes visible, and there were patches of blue sky in places. It was warm on that day.”

- (3) Maintenance Engineer “B” , who witnessed the accident from the Loading Helipad

“The wind was constantly blowing from the northeast, but haze was rising up from the southeast.”

- (4) The Captain of a News Gathering Helicopter

“At around 0945 on the day of the accident, I was flying over the vicinity of the accident site at above 8000ft for news gathering. I estimated the upper air wind over the site was blowing from the southwest at around 20kt, but the lower air seemed to be swirling at around 12–15kt, and there was turbulence. I was unable to approach the accident site at a lower altitude because of these conditions.

- 2.2.4 A descending mountain climber, sheltering at a lodge around 400m northwest of the accident site to escape strong winds from around 0840 before the accident, happened to witness the accident and took a series of photographs. The photographs of the scene showed the air was flowing turbulently as the shapes of the smoke and the direction of smoke emanating from the post-crash fire were changing from moment to moment. (See Photograph 6.)

## 2.3 Accident Site and Wreckage Information

### 2.3.1 Information in the Accident Site (See Figs. 1, 2 and Photographs 1–4)

- (1) Main Rotor Assembly:

Damaged by fire.

- (2) Fuselage:

Destroyed by fire

- (3) Tail Section:

Damaged (torn away from fuselage)

- (4) Engine Section:

- ① Although both engines were damaged by fire, they retained their original shapes. The engine accessories were severely damaged by fire.
- ② An opening was found in the left side of the exhaust diffuser surrounding the free turbine wheel of the No. 1 engine. (See Photograph 4.)

- (5) Landing Gear

- ① The right main gear was damaged by fire, and the tires were destroyed by fire. Also, a deep depression in the shape of a tire was found in the soft ground surface beneath the wheel axle. This is recognized as having been created, when the helicopter first contacted the ground.
- ② The leg attachment bearing of the left main gear and its lower housing were torn



away from the landing gear leg axle and fell to the ground around 40m short of the crash point. No skid marks were found on the tires.

- ③ The nose gear was damaged, and the area around its fuselage attachment point was damaged by fire.

## **2.4 Post-Crash Fire and Fire Fighting**

Tateyama Fire Station received information on the crash at 0852, and fire appliances arrived at the site at around 1000, but by that time, the post-crash fire had already almost burnt out, and the helicopter had been almost totally destroyed by fire except for the tail cone which had been torn away from the fuselage. The fire was confirmed extinguished at approximately 1040.

## **2.5 Tests and Research to Find Facts**

### **2.5.1 Detailed Investigation of the Engines**

As the result of the investigation of the wreckage, an opening was found in the left side of the exhaust diffuser surrounding the No. 1 engine's free turbine wheel . A detailed examination of the engines was carried out to identify the cause of this damage.

As a result of this investigation, it is estimated that the free turbine disc of the No. 1 engine ruptured and fragments were projected through the left side of the surrounding exhaust diffuser. Further, it is estimated that both engines had been operating normally until the helicopter first impacted the ground.

The facts ascertained from the detailed investigation are as follows:

- ① Based on the fracture state of screws on engine-side fittings of the forward attachments of both engines, it is estimated the helicopter was subjected to forward and downward loads at the time of the first impact.  
At that time, the FCU drive shaft dropped out from the No. 1 engine's free turbine accessory gearbox, and as a result the No. 1 engine's Ng (gas generator rotation speed) accelerated to the pre-adjusted maximum rotation speed and Nf (free turbine rotation speed) also increased.
- ② It is estimated that as the result of the shock of the helicopter's second impact with the ground and the shock caused by the still-rotating main rotor blades (MRB) striking the ground, a excessive misalignment occurred in the transmission shaft linking the No. 1 engine to the main gearbox (MGB) between the free turbine shaft and the MGB input section that could not be absorbed by the transmission shaft's MGB input flector, and this severed the flector. The loss of connection with the MGB resulted in the loss of load on the free turbine, which led to an immediate overspeed, and as a result the free turbine disc burst and fragments were projected through the surrounding exhaust diffuser. It is considered that the No. 1 engine's supplementary aft mounting was destroyed and the opening in the exhaust diffuser was created at this time.
- ③ Based on the fact that no damage was found to the No. 2 engine, it is considered that this engine was operating normally until the time of the accident.  
(See Figure 6 and Photographs 4, 5)

## 2.6 Other Necessary Information

### 2.6.1 Extracts from the Rotorcraft Flight Manual (RFM)

The following are summaries of descriptions found in the RFM.

- (1) The limit load factor is +2.67G. The crosswind and tail wind limits are both 30kt.
- (2) During normal operation, when making a final approach at an altitude of above 2000m, it is necessary to keep enough pitch to maintain engine speed at 76% (amber light out) minimum. To this end, avoid too sharp a descent angle or high speed in final approach. Should engine speed drop below 76% the pilot will first bring the speed up to 76%, by light action on the collective pitch control; he may then increase the pitch up to the authorized maximum value for the particular altitude. It is recommended, however, to extend this operation over more than 3 seconds.

### 2.6.2 Extracts from the Operating Standards Manual and Task Operating Manual

The following are extracts specified in the operator's Operating Standards Manual pertaining to operate a helicopter for commercial business and the chapter of cargo transportation of the operator's Task Operating Manual.

#### (1) Operating Standards Manual

- ① The helipad selected for takeoff or landing must be marked clearly with an (H), and a windsock or other means of indicating wind direction must be established.
- ② Takeoffs or landings must not be attempted if wind speeds (including instantaneous speeds) exceed the operating wind limitations specified in the RFM.

#### (2) Task Operating Manual

- ① In establishing the working helipad, an (H) should be marked on the working helipad and a windsock for indicating wind direction and speed, or alternative such as a flag, must be set up at a place which is easy to see and will allow judgment of general wind conditions.
- ② Approaches should not be attempted in tailwind conditions as a rule, and approaches in strong tailwind conditions must not be attempted under any circumstances.
- ③ In mountainous regions, particular attention should be paid to the formation and motions of clouds, and care should be taken not to misjudge whether to carry out or discontinue aerial work. Further, the wind speed and direction should always be kept in mind and appropriate actions taken in all circumstances in flight.
- ④ If circumstances that present a hazard to flight safety occur during transportation operations, the Captain should discontinue operations at once. As a rule, the wind speed should be below 10m/s.

### 2.6.3 Cautionary Factors for Cargo Transportation at Tateyama

The following is a summary of statements regarding cautionary factors relating to cargo lift operations at Tateyama made by the pilot who was the Captain of the helicopter on the day before the accident and who was training the fellow pilot on cargo sling operations.

“On the day before the accident, I was flying in the accident helicopter along with the assigned maintenance engineer and engaged in the same cargo transport operations at the same location. In order to allow the other pilot to accumulate flight time, I occupied the left

co-pilot's seat as the Captain, while the other pilot, who was the same pilot that was involved in the accident, was flying the helicopter from the right seat.

"The day before the accident was fine and the wind was comparatively light. There were no particular problems with the weather, the helicopter, or the pilot, and the cargo transportation proceeded smoothly.

"The flight time accumulated by the pilot was only from the work on the day prior to the accident and was not sufficient (5 hours) to allow him to fly cargo lift operations as Captain according to company rules. I informed the Captain at the time of the accident to this effect on the day before the accident. I also confirmed with that Captain the cautionary factors for operating at high elevation heliports.

"I have been engaged in cargo transportation work with the same type of helicopter at Kunimi Heliport for nearly ten years. Between June and October each year, we transport of food and refurbishing materials for mountain lodges and also the type of materials transported on this occasion.

"Including other types of helicopter, I have been flying annually at Tateyama for nearly 25 years, and on many occasions in the past I have had to discontinue work at that location due to strong winds.

The reason is that when transporting cargo to the mountain lodge located on the east side beyond the Tateyama ridgeline, strong turbulence occurs to the extent that the ridgeline cannot even be approached when a strong easterly wind blows. Particularly in the case of the SA330J, there is considerable deterioration of performance at high altitude, and the point to be aware of above all else is to maintain Ng above 76% and to maintain engine response, when operating at elevations such as at Tateyama.

"If a downstream is encountered at such elevations, even if collective pitch is applied very rapidly there may not be sufficient engine response to prevent Ng falling below 76%. This can easily invite a drop in main rotor speed and lead to a condition in which it is extremely difficult to maintain altitude. In some circumstances, there can even be a danger of hitting the ground."

### **3. ANALYSIS**

#### **3.1 Analysis**

**3.1.1** The Captain and the pilot had valid aircrew proficiency certificates and valid aircrew medical certificates.

**3.1.2** The helicopter had valid certificates of airworthiness, and had been maintained and inspected as specified by the applicable regulations.

#### **3.1.3 Condition of the Helicopter and Engines**

According to the statements of the assigned mechanic and witnesses and from the results of the detailed investigation of the engines, it is considered that there were no abnormalities in the systems and engines of the helicopter.

#### **3.1.4 The Weather at the Time of the Accident**

According to the 850hPa chart, the general pressure pattern at the time of the accident was that there was a typhoon located over the south part of the Korean Peninsula, and in the 850hPa upper air a southerly wind at around 25kt was blowing onto the central districts of the Japanese archipelago. It is thought that strong southerly winds blowing over the Japan Alps would have resulted in mountain waves being

generated, and it is also thought that in mountainous areas in the Tateyama region located downwind there would have been severe turbulence near the ground surface.

Considering in addition the weather observations at Murodou, the series of photographs taken immediately after the accident, the statements of witnesses of the accident and the report of the Captain of the helicopter that later flew over the accident site, it is considered that the weather at Tengudaira at the time of the accident was as follows.

Although the prevailing visibility was over 10km, the weather was changing rapidly, becoming cloudy, and the ridgelines of the mountains east and south of the accident site were covered in a layer of cloud (cap cloud), and the sides of the mountain were partially obscured from view.

The prevailing wind direction was approximately southeast, but there were large variations over short periods.

The general wind speed was 10m/s, but there were frequent stronger gusts sometimes exceeding 15m/s, with large speed variations over short intervals.

The temperature of around 14°C was unseasonably warm.

### **3.1.5 Reasons for not Suspending Cargo Transport Operations**

It is considered that the following are factors related to the reason that the Captain did not suspend cargo transport operations:

#### **(1) Insufficient Awareness of the need to Adhere to Rules**

As described in subsection 2.6.2(1), the company's Operating Standards Manual states that "takeoffs or landings must not be attempted if wind speeds (including instantaneous speeds) exceed the operating wind limitations specified in the RFM". The crosswind and a tail wind limitations specified in the RFM are 30kt (approximately 15m/s).

Further, as described in subsection 2.6.2(2), the company's Task Operating Manual states "if circumstances that present a hazard to flight safety occur during transportation operations, the Captain should discontinue operations at once. As a rule, the wind speed should be below 10m/s."

Regarding weather conditions around the time of the accident, as described in section 3.1.4 the wind speed was around 10m/s but with frequent stronger gusts, and it is reckoned that there were occasional gusts that exceeded 15m/s. It is therefore considered that cargo transport operations should have been suspended.

Concerning the reason that operations were not suspended, it is considered that the Captain was concerned about the progress of the cargo transportation and also had insufficient awareness of the need to adhere to the Operating Standards and other rules and of the need to ensure flight safety.

#### **(2) Inappropriate Assessment of Changes of Wind Speed and Direction**

Since there was no windsock or alternative means of indicated wind speed and direction set up in the vicinity of either the Loading Helipad or the Cargo Release Point, at the time of the accident, and there was no means for obtaining continuous weather information, it is considered that the Captain was judging weather conditions such as the degree of turbulence by bodily sensations etc. Further, given that ground support personnel working at the Loading Helipad were occasionally experiencing gusts to the extent of feeling buffeted, it is considered that the Captain continued operations without due concern for the extreme variations of wind direction and speed.

#### **(3) Priority for Accumulation with Experienced Flight Time for the Fellow Pilot**

In the 30 days prior to the accident, the pilot had logged 22 hours 53 minutes of flight experience as Captain of aircraft other than the SA330J and 4 hours 9 minutes on the SA330J as a non-commanding pilot, and he had accumulated the bulk of the required 5 hours of flight experience specified in the company manuals. It is considered possible that the Captain gave priority to the intention of having the pilot complete these flight experience requirements by the day's flying.

### **3.1.6 Events during the Inadvertent Entry into Abrupt Descent during the Transition to Hover**

**3.1.6.1** It is considered that the extreme variations in wind direction and speed in the vicinity of the accident site due to the turbulence described in section 3.1.4 would have made fine control of the helicopter during its final approach to the Loading Helipad difficult.

When the helicopter transitioned to hover just in front of the Loading Helipad, there was a large shift in the wind direction to a crosswind or a tail wind. It is considered that as a result of this, the helicopter being higher above the ground than intended, and the pilot being unable to reduce groundspeed below his intended speed even though speed should already have been reduced sufficiently by this time, the pilot made a slightly large flare.

From witness statements and the timing of the flare out, it is considered that the helicopter was approximately 30m above the ground when it made the flare out.

**3.1.6.2** While the pilot was transitioning to hover 30m above the ground, there was an abrupt unintended drop which caused the helicopter to impact the ground hard. The following possible reasons for this were considered, but it could not be established which was the actual reason.

#### **(1) Settling with Power**

During the flare out, while the pilot was transitioning to hover by gradually reducing altitude while operating the collective pitch, the helicopter would have been most prone to entering a settling with power condition either when encountering a strong updraft at the time the wind direction shifted to a tail wind or crosswind, or when the helicopter was in a slightly steep flare attitude.

In the case of this accident, it is considered that it would have been impossible to recover from a settling with power state normally by increasing forward airspeed due to insufficient height.

#### **(2) In the case that while in an updraft, the helicopter unexpectedly encounters a sudden downdraft or crosswind or tailwind:**

- ① If the helicopter encountered a sudden updraft while transitioning to hover, in order to counter this it would have been necessary to lower the collective pitch lever while commanding a slightly nose-up attitude. If immediately after this the helicopter had encountered a sudden downdraft, it is considered possible that in order to avoid a sink the momentarily-lowered collective pitch lever might have been abruptly pulled up, deviating from the time specified in the RFM.
- ② The RFM recommends that in the event of Ng dropping below 76% the collective pitch operation should be sustained for a period of greater than three seconds. It is thought that if a large collective pitch input were made before this interval had elapsed, a delay in engine response might have occurred and as a result, it would not have been possible to maintain sufficient main rotor speed and arrest a sink.

### **3.1.7 The Events at First Contact with the Ground**

The following are estimated to have occurred based on:

- the findings that there were traces of wheel contact that correspond to the helicopter nose pointing approximately 40° left of the presumed direction of approach at the point where the helicopter first contacted the ground, the helicopter still had forward speed remaining when it contacted the ground, and the left main gear was torn away from its attachment;
- the assumption that the helicopter encountered a sudden gust accompanied by turbulence; and
- the statements of the assigned maintenance engineer and other witnesses concerning the situation, when the helicopter contacted the ground.

(1) It is estimated that the while the helicopter was reducing speed approaching the Loading Helipad it was experiencing a wind from the left or rear left and turbulent conditions with large changes in updrafts and downdrafts. During transiting to hover, it is estimated that the helicopter abruptly sank and impacted the ground hard with a slight roll to the right.

(2) The helicopter dropped abruptly from a height of approximately 30m and impacted the ground hard. Reacted forward and downward loads resulted such that the left main gear fell away from the airframe and the FCU drive shaft disconnected from the No. 1 engine's free turbine accessory gearbox. Further, the shock of the impact with the ground resulted in large downwards loads on the tail cone and which led to it sustaining damage at fuselage stations (FS) 10120–10492.

It is considered that neither the MRB nor the double hooks struck the tail cone, since there were not traces that were recognized as having resulted from such a strike on either of these parts.

### **3.1.8 Events during the Helicopter becoming Airborne Again**

Due to the FCU drive shaft of the No. 1 engine becoming disconnected when the helicopter first impacted the ground, the No. 1 engine's Ng increased to the set maximum rotation speed, and there was a tendency for Nf to increase also. Meanwhile, the No. 2 engine came to idle.

Because of this, the power output of the No.1 engine increased to maximum and there was sufficient power to increase the MRB speed, and the helicopter became airborne again as the result of this and the influence of ground effect.

### **3.1.9 Events from the Helicopter becoming airborne again until the crash and fire**

The following is a summary of the events that are considered to have occurred from the time the helicopter became airborne again until it crashed and burned based on the statements of the assigned maintenance engineer and other witnesses, the crash site investigation and the detailed investigation of the engines.

(1) It is considered that the fuselage started to rotate to the left (two or more complete turns according witness statements) due to the loss of tail rotor function which opposed the reaction torque of the right-turning main rotor. It is considered that the tail cone was damaged due to subject to bending forces, multiple up/down and torsional forces when the helicopter became airborne again, and then separated and flew off due to the centrifugal force imparted by the spinning fuselage.

(2) The fuselage section of the helicopter came to rest leaning to the right and was destroyed by fire. However, traces were found at two locations before the crash point that were recognized as being the result of the MRB's striking the ground, and the

length of one of those traces was almost the same as the total length of the MRB.

It is thought that immediately after the crash, the helicopter was momentarily at an attitude in which it was completely rolled over to the left, and since both engines were operating, when the out-of-balance helicopter first struck the ground, the main rotors were still rotating. As a result the MRB's struck the ground, and the MRB's and their surrounding parts were damaged.

It is also thought that the left side of the No. 1 engine installed on the left side of the helicopter impacted the ground.

- (3) Immediately after the crash, it is considered that the fuselage righted and came to rest in a stable position rolled slightly to the right, due to the reaction from the MRB's striking the ground at the large left-inclining, that thereafter, the wreckage finally ended up sideways with the right side down due to the weight of the engines installed on top of the fuselage and the MGB and as a result of the destruction of the fuselage by fire.

It is thought that the shock of crash and of the MRB striking the ground caused an excessive misalignment between the No. 1 engine free turbine shaft and the MGB input shaft that the MGB input flexor was unable to absorb, which led to the flexor being severed.

The loss of load from the MGB led to an instantaneous over speed of the free turbine and as a result the free turbine disc burst and fragments were projected through the exhaust diffuser which surrounded the free turbine wheel.

- (4) It is thought that as a result of shocks sustained in the crash, the flexible fuel hose which transferred fuel from the fuel tank to the FCU was damaged, and leaking fuel came in contact with hot engine parts or exhaust gas and ignited.

(See Figure 6 and Photograph 5)

## **3.2 Summary of the Analysis**

**3.2.1** It is considered that there were no anomalies associated with either the crew or the helicopter.

**3.2.2** It is estimated that there was turbulence accompanied by extreme variations in wind direction and speed at the ground surface at Tengudaira at the time of the accident.

**3.2.2** Since no windsock or alternate means for indicating wind speed and direction had been set up at the working helipads for cargo transportation, and as there was no means of obtaining continuous weather information, it is thought that the Captain was judging weather conditions such as the degree of turbulence by bodily sensations etc.

It is therefore considered that the Captain continued cargo transport operations without due concern for the extreme variations of wind direction and speed.

**3.2.4** The helicopter was approaching the Loading helipad in order to sling the seventh load of road construction and repair materials, and just as it about to transition to hover while reducing speed, there was a sudden shift in air currents which caused an abrupt sink.

The inadvertent abrupt sink while the helicopter was transitioning to hover was caused either by the helicopter entered a settling with power condition as the result of a sudden updraft which could not be recovered from due to insufficient height, or the helicopter encountering a sudden downdraft and tail wind or crosswind and recovery actions not taking effect in time due to the low height above ground and the poor power response of the installed engine characteristics.

**3.2.5** Regarding the reasons for the Captain not suspending operations, it is considered as the reason that the Captain had insufficient awareness of the need to adhere to operating rules etc. and because of this, he did not have due concern for variations of wind direction and speed and made a mistake in the decision as to whether or not

carrying out operations was possible.

Further, it is considered possible that the Captain gave priority to the accumulation of flight experience for the pilot.

#### **4. PROBABLE CAUSE**

It is considered that in this accident, the helicopter was carrying out cargo lift operations in severe turbulence and was transitioning to hover on final approach to the Loading Helipad, when it encountered a sudden change in air currents that caused it fell into an abrupt sink, as a result of which it impacted the ground hard.

The inadvertent abrupt sink while the helicopter was transitioning to hover were caused either by the helicopter entering a settling with power condition as the result of a sudden updraft which could not be recovered from due to insufficient height, or by the helicopter encountering a sudden downdraft and tail wind or crosswind and recovery actions not taking effect in time due to the low height above ground and the poor power response of the installed engine characteristics.

A factor regarding the continuation of operations in severe turbulence is considered to be insufficient awareness on the part of the Captain of the need to adhere to operating rules etc. and consequent inadequate due concern for variations of wind direction and speed and which led to a mistake in the decision as to whether or not carrying out operations was possible.

#### **5. FINDINGS**

- 5.1** It was considered that the continuation of cargo transport operations despite the presence of severely turbulent air currents and large variations in wind direction and speed was a contributory factor in this accident.

In order to ensure the safety of cargo transport operations by rotorcraft, persons involved in operations and workers must adhere strictly to standards and procedures while being thoroughly aware of the need to ensure safety.

If there is a concern of coming up against flight rules and limits specified in RFM and operating standards etc., operations should be suspended. Adherence to operating rules and standards and awareness of safety in the decision as to whether cargo operations are possible should be practiced and maintained completely.

- 5.2** When carrying out rotorcraft cargo transport operations in greatly turbulent conditions in mountainous regions, it is important to evaluate correctly the degree of danger presented by the turbulence in air current and to judge whether or not to carry out operations.

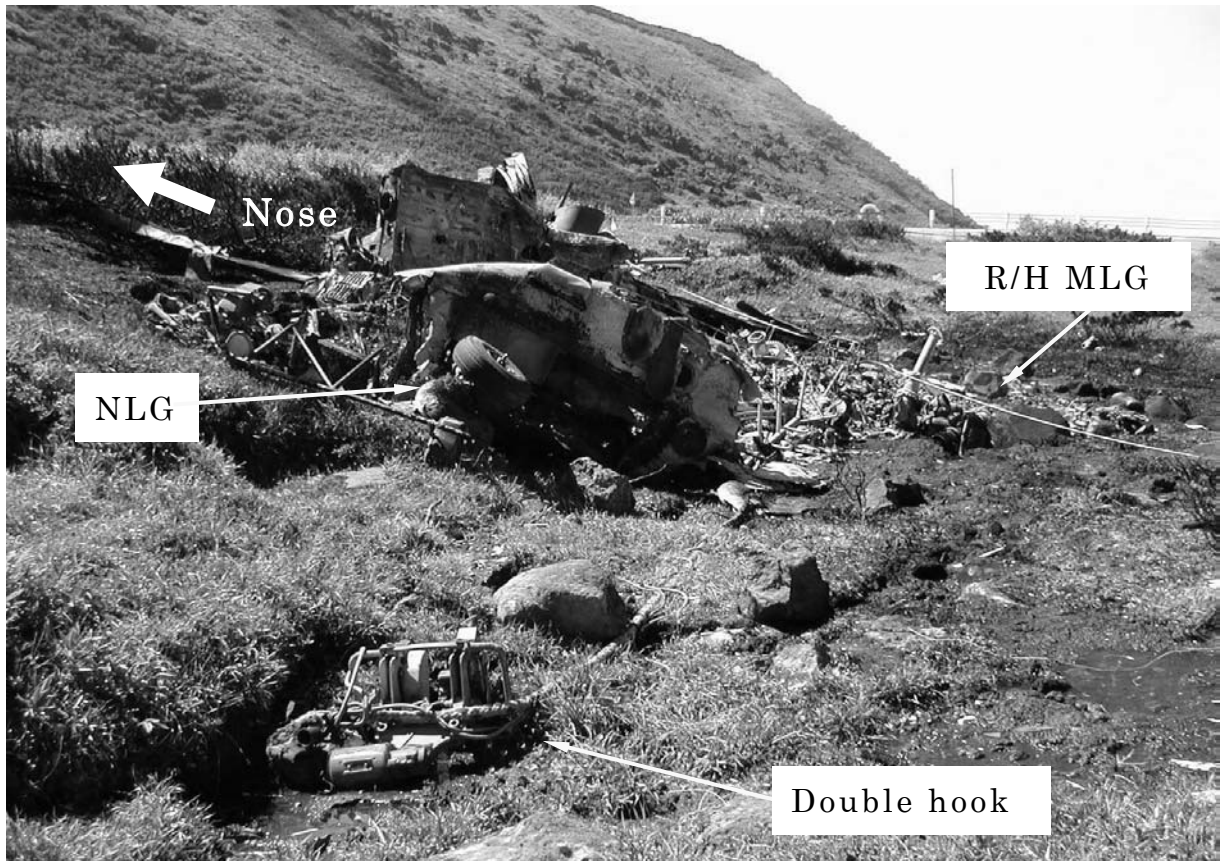
For this reason, it is necessary to certainly effect safety measures specified in Task Standards Manuals etc., such as the establishment of a windsock and the acquisition of recent weather information, to evaluate appropriately weather conditions such as wind speed and direction, and to make correct judgments as to whether or not to continue operations.



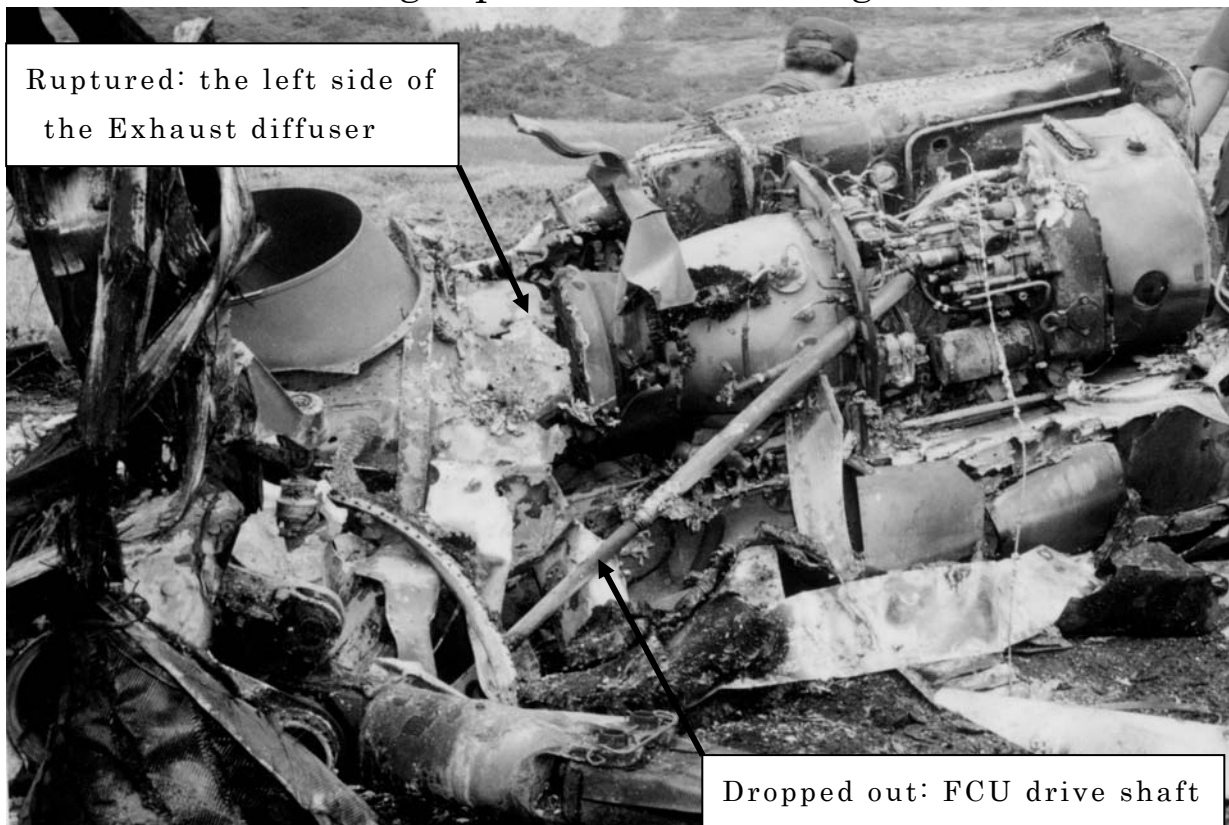
Photograph 5 No.1 Engine  
MGB Power Input (MGB Input Flector)



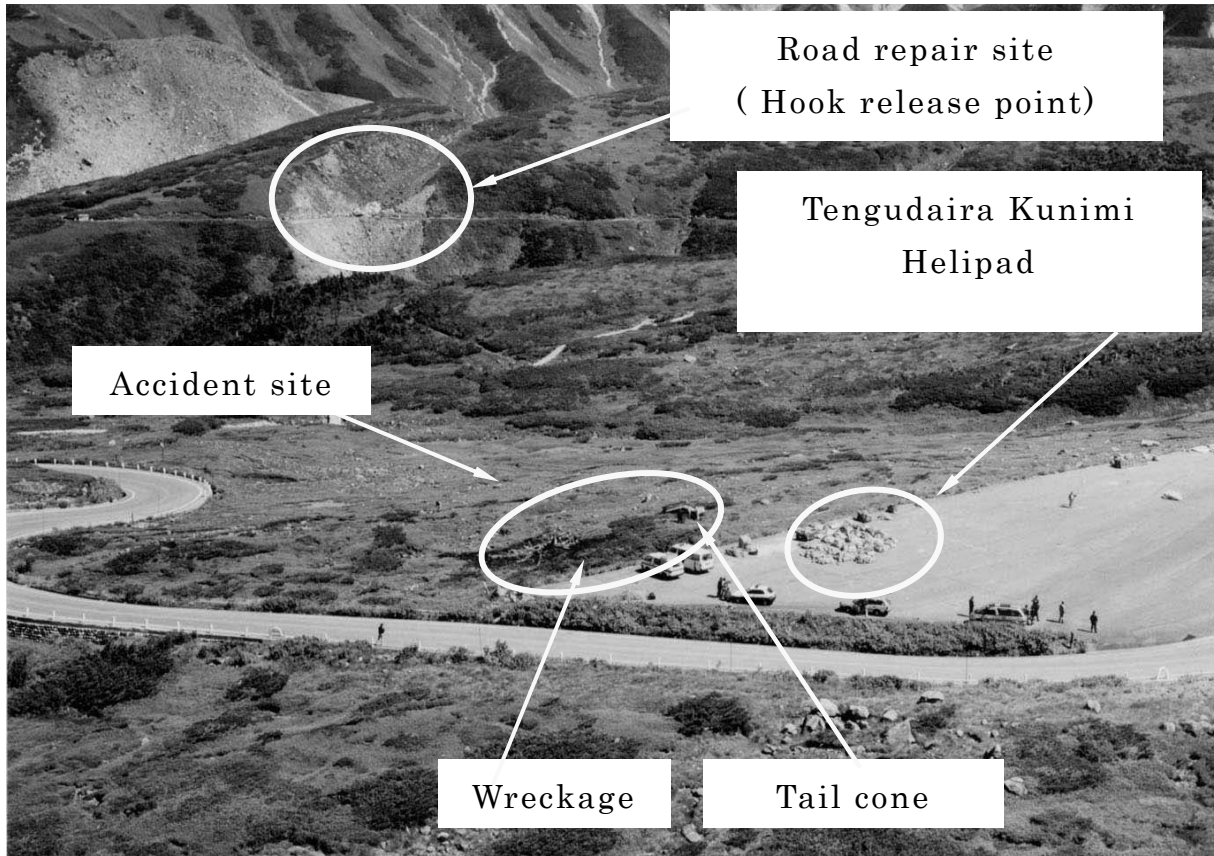
Photograph 3 Wreckage(bottom)



Photograph 4 N o . 1 Engine



Photograph 1 Accident Site



Photograph 2 Wreckage(upper side)

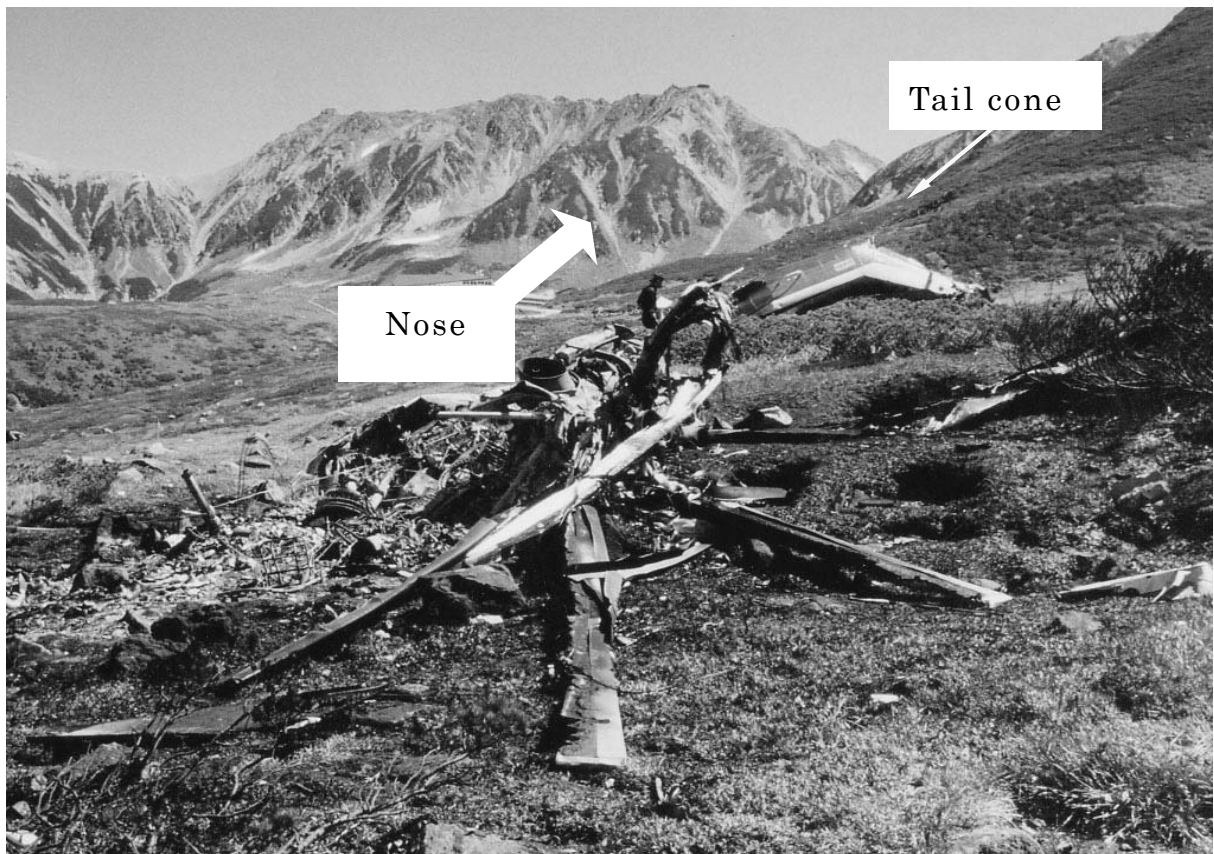


Figure 5 Wind velocity and direction at Murodou  
(Accident occurred around 0848JST.)

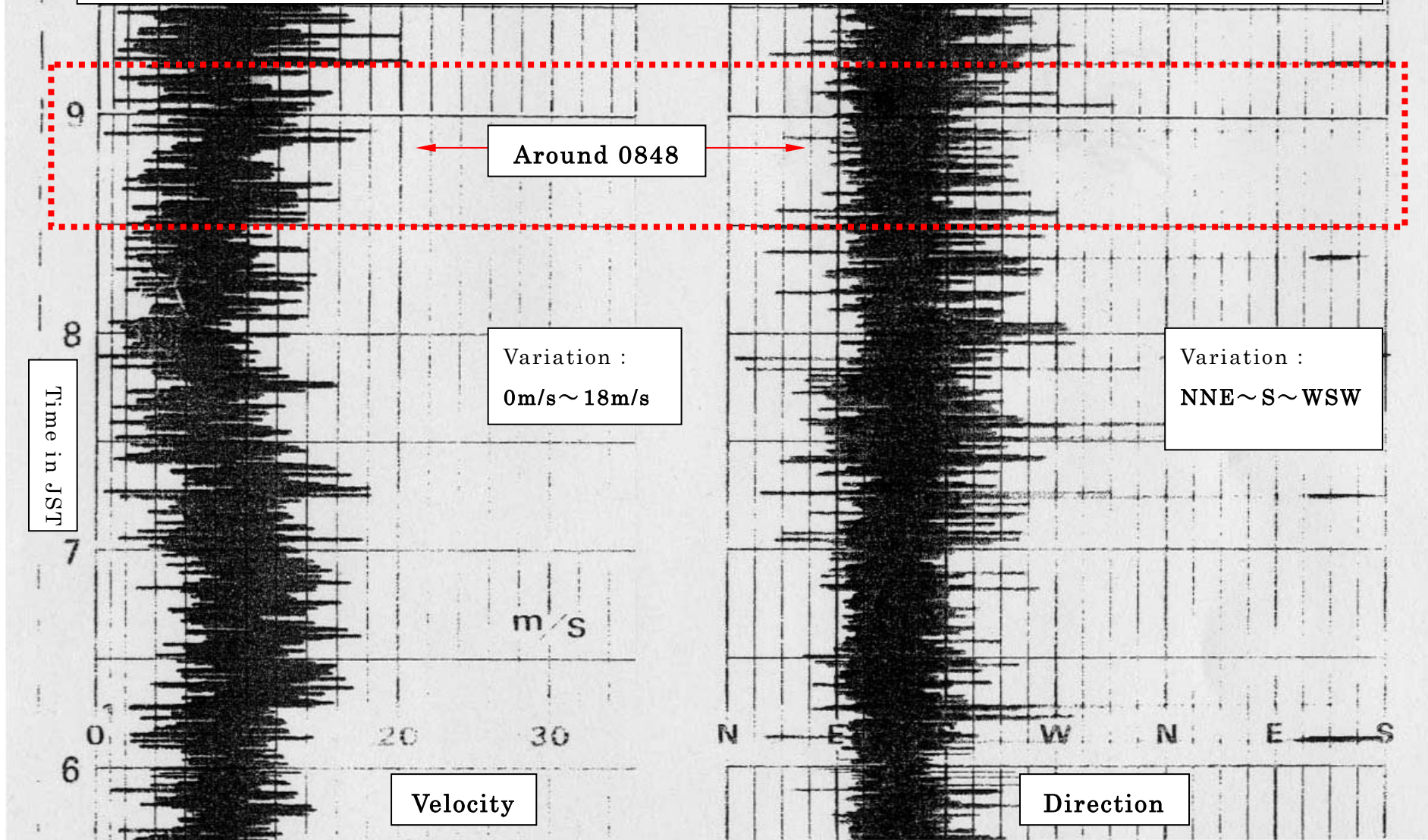
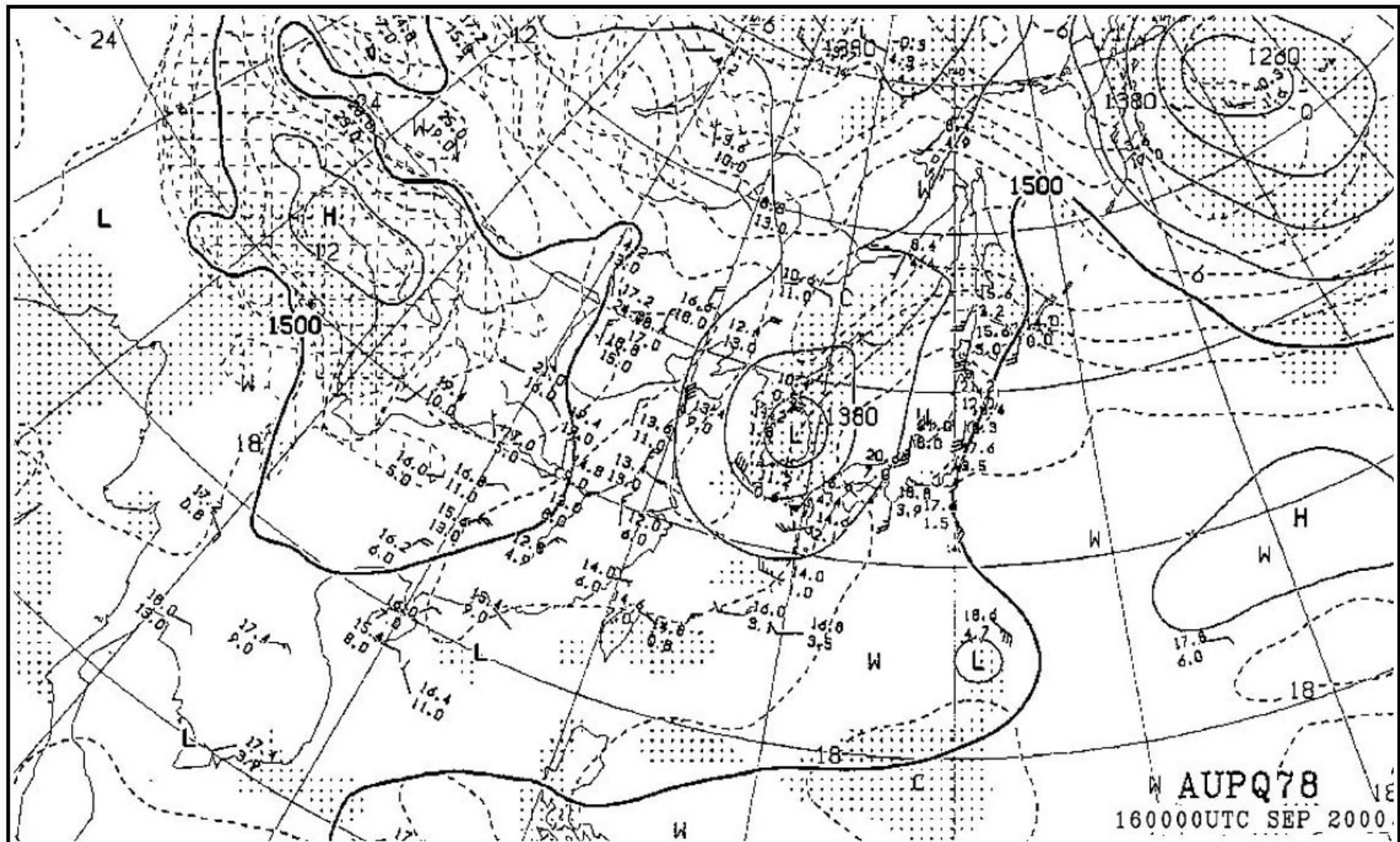


Figure 4 850 hPa Chart (September 16, 2000 0000UTC)



ANALYSIS 850hPa: HEIGHT(M), TEMP(°C), WET AREA::(T-TD<3°C)

Figure 3 Surface Chart (September 16, 2000 0000UTC)

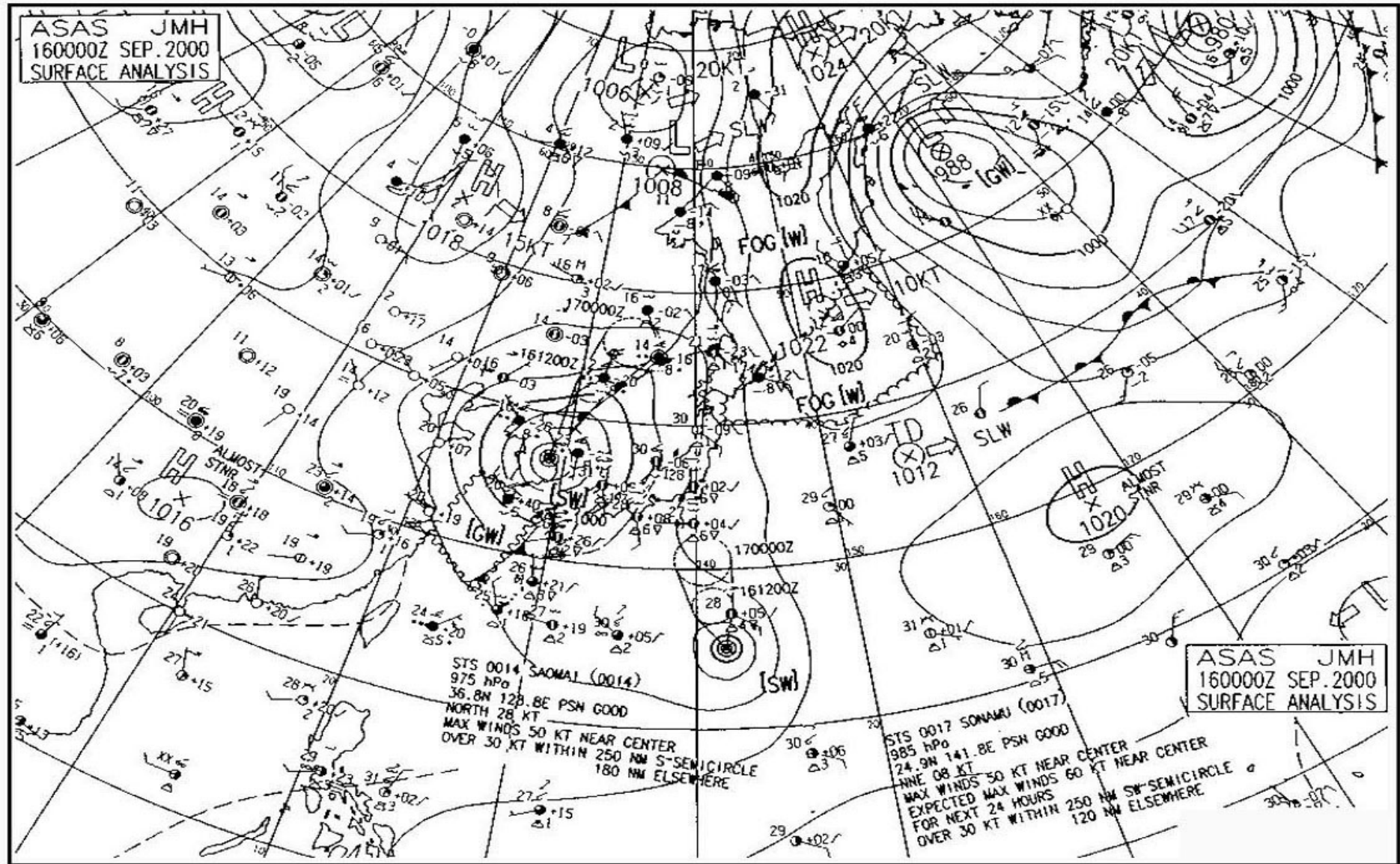


Figure 1 Accident Site and its vicinity & Estimated Flight Path

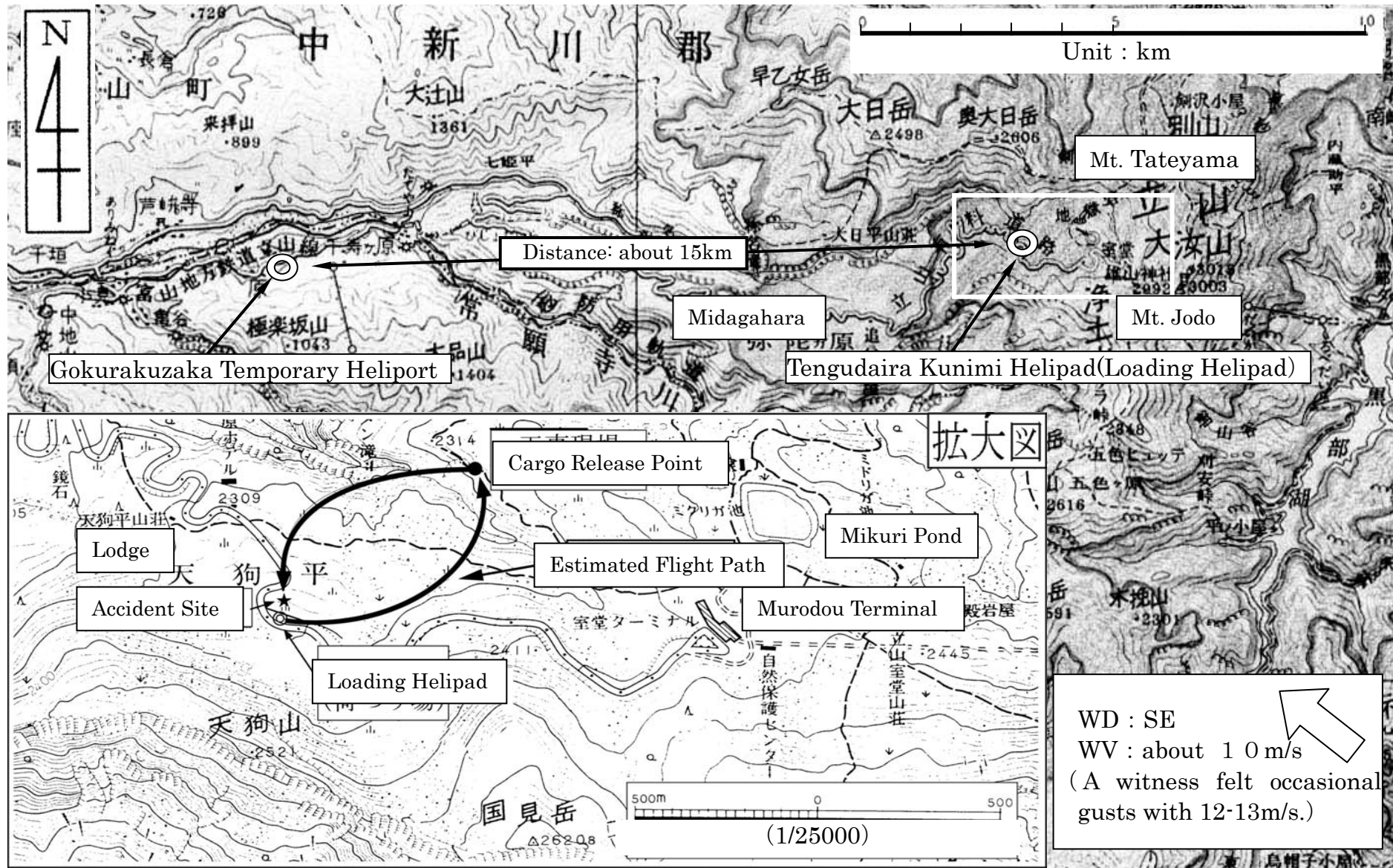


Figure 6 Cut Away View of TURMO IV C Engine

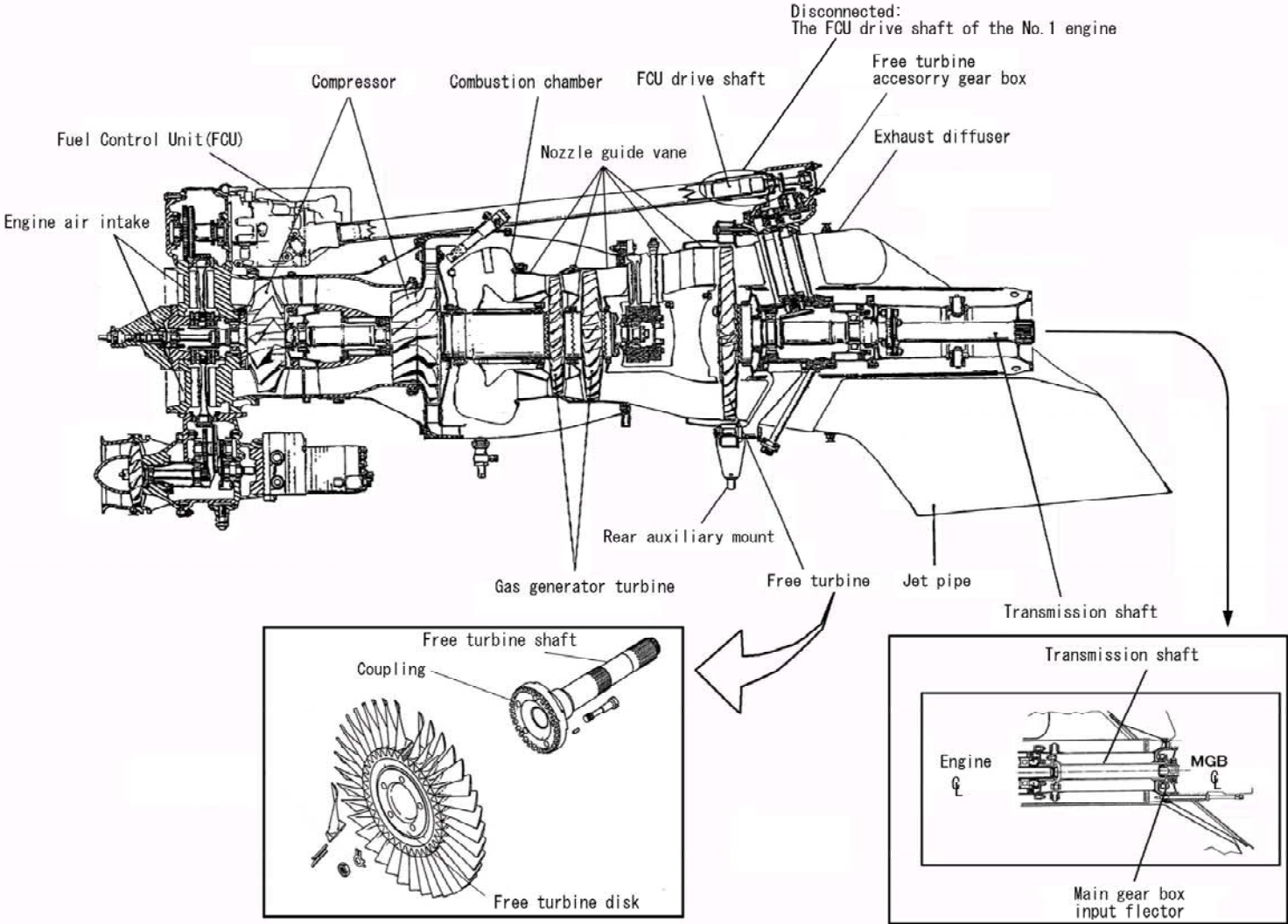
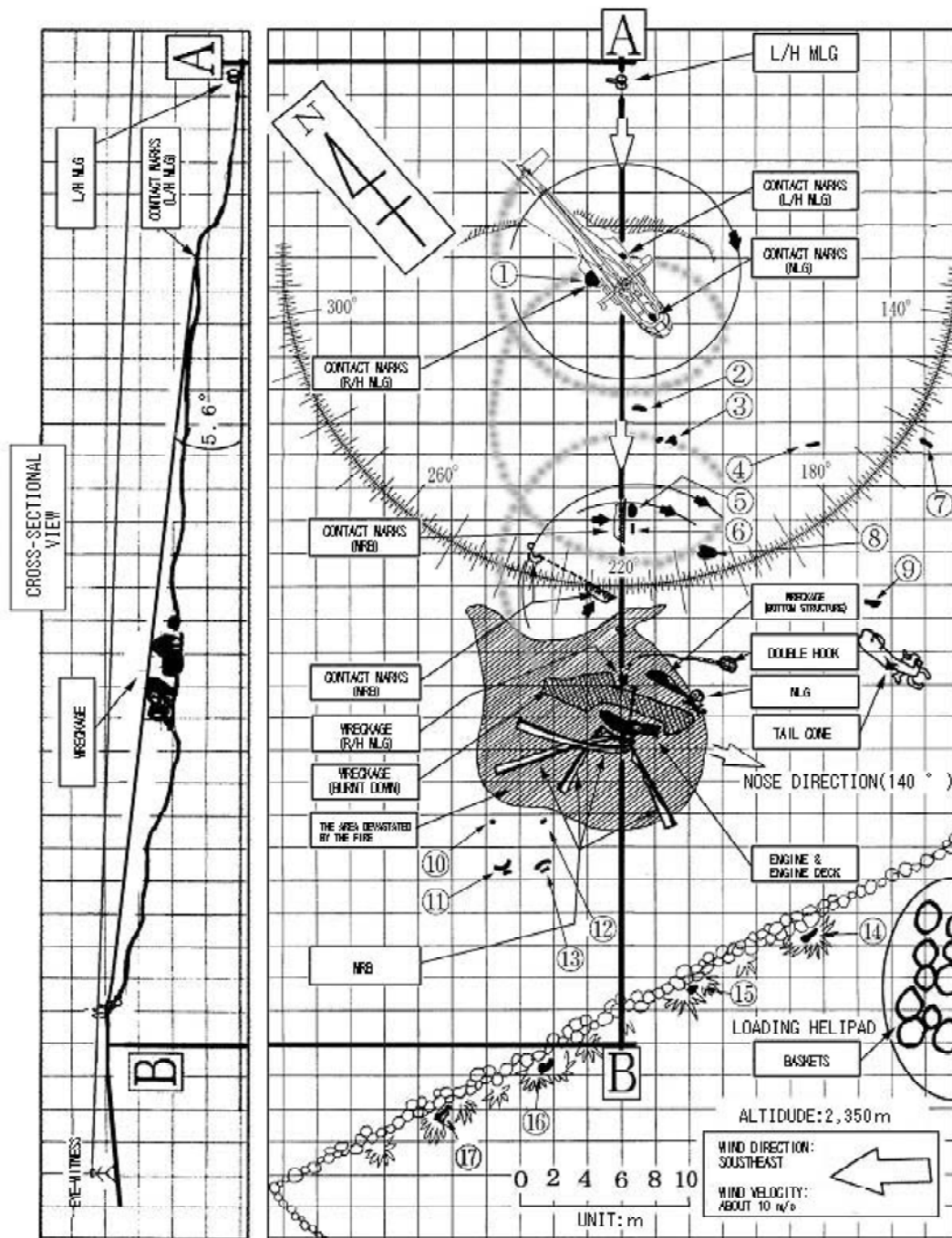




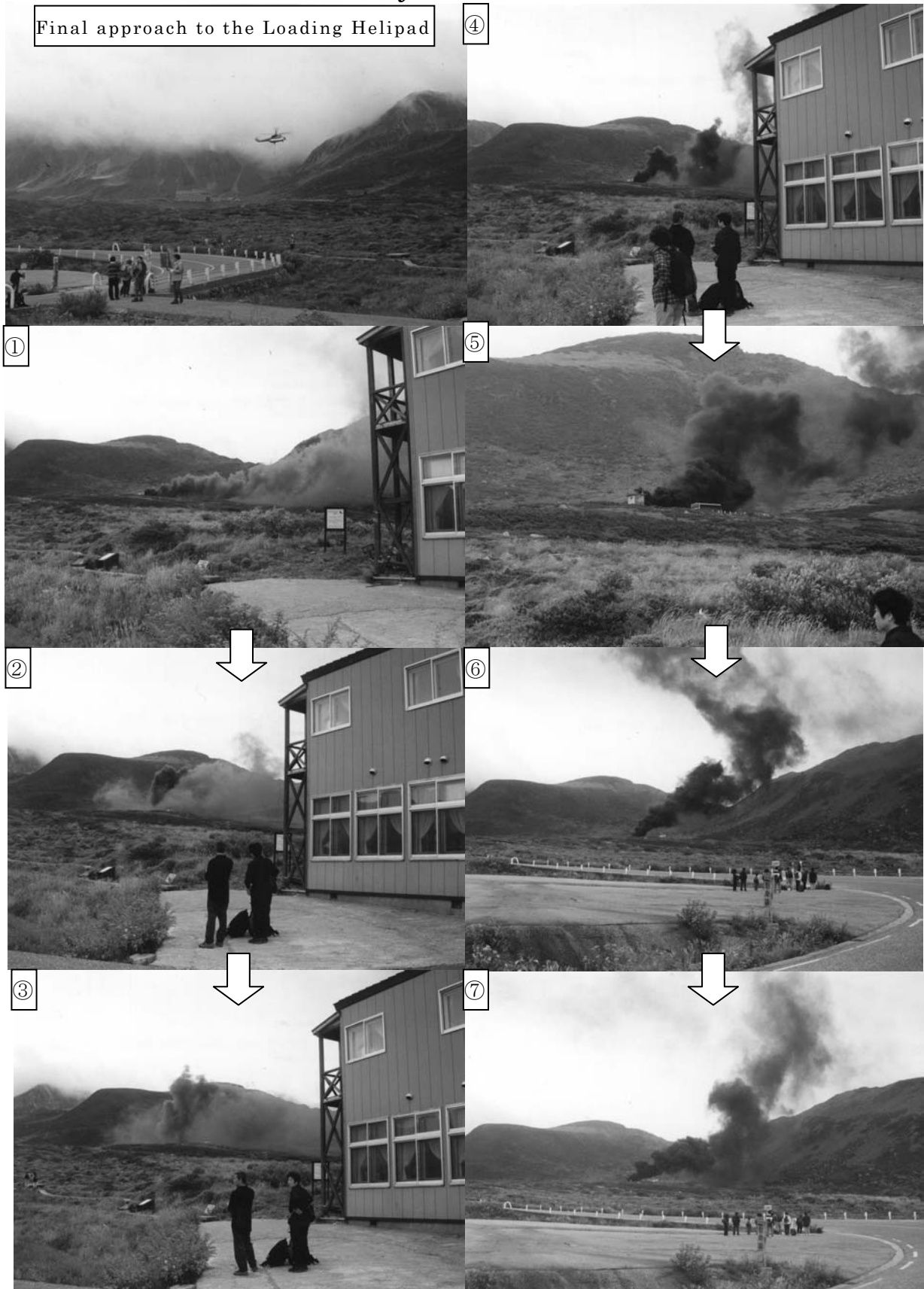
Figure 2 Skttch of Accident Site



- ① Debris of rear window, MRB automatic droop restrainers ② Debris of MRB  
 ③ Debris of main structure ④ Debris of MRB ⑤ Cover: Sound proofing material (Tail cone section)  
 ⑥ On ground retraction safety microswitch ⑦ Debris of MRB leadingedge protective strip  
 ⑧ Debris of T/R drive-shaft, Debris of MRB ⑨ A lump of grass, Debris of MRB  
 ⑩ Debris of T/R drive-shaft ⑪ Debris of MRB leadingedge protective strip ⑫ Debris of MRB  
 ⑬ Debris of R/H Engine cowling ⑭~⑰ Debris of MRB

M/R: Main Rotor T/R: Tail Rotor

# Photograph 6 The series of Photographs taken immediately after the accident



A witness, sheltering at a lodge around 400m northwest of the accident site, took a series of photographs.