AA2005-2

AIRCRAFT ACCIDENT INVESTIGATION REPORT

YUUHI AVIATION COMPANY LIMITED
AEROSPATIALE AS350B, JA9445
YAMAGATA AIRPORT, JAPAN
JUNE 2, 2004

March 25, 2005

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

The investigation for this report was conducted by Aircraft and Railway Accidents Investigation Commission, ARAIC, about the aircraft accident of Yuuhi Aviation Company LTD., Aerospatiale AS350B in accordance with Aircraft and Railway Accidents Investigation Commission Establishment Law and Annex 13 to the Convention of International Civil Aviation for the purpose of determining cause of the aircraft accident and contributing to the prevention of accidents and not for the purpose of blaming responsibility of the accident.

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

Junzo Sato,
Chairman,
Aircraft and Railway Accidents Investigation Commission

AIRCRAFT ACCIDENT INVESTIGATION REPORT

YUUHI AVIATION COMPANY LIMITED
AEROSPATIALE AS350B, JA9445
CRASH DURING AN AUTOROTATION LANDING
DUE TO FUEL STARVATION
YAMAGATA AIRPORT, YAMAGATA PREFECTURE, JAPAN
AT ABOUT 11:34 JST, JUNE 2, 2004

February 23, 2005

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

Chairman Junzo Sato
Member Yukio Kusuki
Member Susumu Kato
Member Sumio Matsuura
Member Yukiko Kakimoto
Member Akiko Matsuo

1. PROCESS AND PROGRESS OF THE ACCIDENT INVESTIGATION

1.1 Summary of the Accident

On Wednesday June 2, 2004, a Yuuhi Aviation Company Limited Aerospatiale AS350B, registration JA9445, departed Gunma Heliport and after refueling at Kawashima. Temporary Heliport, headed towards Yamagata Airport while conducting aerial photography.

While the aircraft was holding in the traffic pattern at Yamagata Airport to land, it declared an "Emergency Landing" and started an approach to Yamagata Airport. At around 11:34, the aircraft crashed in a grass field approximately 90m east of the approach end of runway 01.

Two persons were on board the aircraft, the captain and a photographer. The captain was seriously injured and the photographer sustained fatal injuries.

The aircraft was destroyed but there was no outbreak of fire.

1.2 Outline of the Accident Investigation

1.2.1 The Organization of the Investigation

On June 2, 2004, the Aircraft and Railway Accidents Investigation Commission (ARAIC) assigned an Investigator-in-Charge and two investigators with responsibility for investigating this accident.

1.2.2 Cooperation by Foreign Authorities

A representative of the France, the state of design and manufacture of the aircraft, participated in the accident investigation.

1.2.3 The Implementation of the Investigation

The investigation proceeded as follows.

June 2–4, 2004	On-site investigation, investigation of the aircraft, and collection of witness statements.
June 7, 2004	Collection of statements
June 11, 2004	Collection of statements
June 28, 2004	Collection of statements
July 28, 2004	Collection of statements

1.2.4 Hearings from Persons relevant to the Cause of the Accident

Hearings were held to hear the opinions of persons connected with the cause of the accident.

1.2.5 Hearing with Participating States

Hearing was held.

2. FACTUAL INFORMATION

2.1 Flight History

On Wednesday June 2, 2004, an Aerospatiale AS350B 'Ecureuil', registration JA9445 ("the aircraft"), of Yuuhi Aviation Company Limited ("the company"), took off at 07:09 from Gunma Heliport in Maebashi City, Gunma Prefecture with the captain and a photographer on board, and after refueling at Kawashima Temporary Heliport at Kawashima-Chou, Hiki-Gun, Saitama Prefecture (Kawashima Heliport), took off at 07:35 for an aerial photography sortie.

The flight plan for the aircraft submitted to the Tokyo Airport Office was as follows:

> FLIGHT RULES: VFR, DEPARTURE AERODROME: Gunma Heliport, START TIME: 07:45, CRUISE SPEED: 100kt, CRUISE ALTITUDE: VFR, ROUTE: Yonezawa–Nanyo–Kaminoyama, DESTINATION AERODROME: Yamagata Airport, TOTAL EET: 4 hours, PURPOSE OF FLIGHT: aerial photography, ENDURANCE: 4 hours 20 minutes, PERSONS ON BOARD: 2.

A summary of the progress of the flight compiled from the statements of the captain, company personnel connected with the flight, the Flight Information Officer at the airport mobile communication station at Yamagata Airport (Yamagata Radio), and eyewitness accounts is as follows.

(1) The Captain

"On the day, after arriving at Gunma Heliport at around 06:30, I began preparations for the flight, and at around 07:05, I received a report from the photographer that preparation of the aerial photography equipment was finished. The fueling service at Gunma Heliport does not start until after 07:45. Since I wanted to proceed to the photography location as soon as possible, I checked with the company mechanic at Kawashima Heliport if I would be able to refuel there and decided to head there quickly.

"At around 07:09, I took off from Gunma Heliport, and after taking on maximum fuel at Kawashima Heliport, I took off from there at around 07:35. At the time, I was not particularly aware that I had landed and taken off from a point not scheduled in flight plan.

"I headed for Yonezawa, the first photography location, but I detoured the mountains because of a strong north wind over them. It took just over an hour to reach Yonezawa at maximum cruise power.

"The aerial photography was done at an altitude of 1,000–1,500ft and a speed of 40–60kt, and I was repeatedly climbing to avoid obstacles over the city.

"The Fuel Caution Light (Note 1) illuminated during aerial photography over the third location, Kaminoyama city. I think that the time was about 11:10, but I don't remember exactly. Although the fuel caution light was illuminated, I continued the sortie because there was still some photography remaining and I thought it would be all right judging by the distance to Yamagata Airport (around 15nm).

"When I headed to Yamagata Airport I think I flew at an altitude of around 2,500ft and a speed of around 110kt. I was gradually descending while flying to conserve fuel. I made contact with Yamagata Radio around 2nm south-southwest of Yamagata city and requested information for landing. I was informed of the arrival of flight JAR3187 (a scheduled J-AIR flight, the 'JAR flight'), but at that time I mistakenly thought that Yamagata Airport had a parallel taxiway, and I was thinking that even if I arrived at the same time as the JAR flight and was unable to land on the runway, I could land on the parallel taxiway if I ran out of fuel. I realized that there was no parallel taxiway as soon as I sighted the airport, and when I was instructed to hold at the base leg I was a bit worried about the fuel.

I was about 3nm short of the airport when I sighted the JAR flight about 2nm away at 5 o'clock. I continued to approach keeping the JAR flight in sight.

"I though to fly as high as possible while holding so I could reach the airport in autorotation if the engine stopped, so I think I flew at an altitude of around 1,500ft (about 1,200ft above ground level) at a speed of about 80–90kt, but I don't remember exactly.

"I circled left two or three times on the base leg while watching the JAR flight landing. I deliberately moved gradually closer to the final approach path so that if the worst happened with the remaining fuel, I would be able to reach the inside of the airport perimeter in autorotation, and I was conscious of being easily able to reach the nearest area in airport even at the farthest point of the turn.

"While turning I felt a change in the engine running and looked at the tachometer and fuel gage. I can't remember the tachometer reading, but the fuel gage was reading almost close to zero. A second change in the engine running was accompanied by vibration of the main rotor, and reckoning I was out of fuel, I lowered the collective pitch lever and pushed the cyclic stick forward. Since the nose was pointing east at the time, I directed the nose toward the airport.

"There was an aircraft taxiing on the runway, so I recall aiming for the southeast corner of the runway, but I don't remember anything after that.

"I checked the engine instruments on the way to Yamagata Airport but found nothing abnormal and there were no engine problems while I was holding."

(Note 1): The Fuel Caution Light illuminates when the fuel remaining drops below approximately 60 liters. The rotorcraft flight manual states that when the fuel caution light is illuminated, "Avoid large attitude changes. Flight is possible for about a further 25 minutes.

(2) The Yamagata Radio Flight Information Officer

"The aircraft flew in from the south-southwest of the airport, and held circling left on the base leg. A JAR flight landed on runway 01 at 11:33, and after turning round at the north end of the runway, was taxiing south along the runway.

"As I was thinking the aircraft was making for the final approach leg, it reported

'Yamagata Radio, JA9445, Emergency Landing', and headed straight in, but I felt it was slightly off to the side of runway. The rotor was turning and it looked like it was in a normal approach attitude, but I felt the speed was high. The aircraft appeared to be in a level attitude, and it dropped to the ground without changing attitude from level and turned over."

(3) The Captain of the JAR Flight

"We had completed our turn at the north end of the runway and were heading south when I heard 'Emergency ・・・・・', and so I looked forward and saw an aircraft on final. It seemed that the aircraft descended from directly above the crash point. I had heard about helicopter autorotation, so I supposed it was doing autorotation training, but the aircraft proceeded to crash."

2.2 The Progress of the Flight based on ATC Communication Recordings

Based on recordings of ATC communications, the progress of the flight from the aircraft's first contact with Yamagata Radio until just before the accident is as follows:

11:25:35 The aircraft reported to Yamagata Radio that it was 2nm southwest of Yamagata city at an altitude of 1,500ft, and requested runway information to land at Yamagata Airport.

11:25:48 Yamagata Radio informed the aircraft using runway 01 , wind direction 210°, wind speed 2kt, QNH 30.13inHg, cautioned it about a VFR JAR flight that was expected to pass over ZAO-YAMADA VOR/DME at 11:28 and make a straight-in approach to runway 01, and report to passing over Yamagata city.

11:26:11 The aircraft acknowledged report to passing over Yamagata city and the JAR flight information.

11:29:11 The aircraft reported to Yamagata Radio that it was 6nm south-southwest of the airport at an altitude of 1,500ft.

11:31:01 The aircraft reported to Yamagata radio that it had sighted the approaching JAR aircraft.

11:31:44 Yamagata Radio instructed the aircraft to hold on left base.

11:31:47 The aircraft read back the instruction to hold on left base.

11:32:13 Yamagata Radio informed the JAR aircraft wind direction 260°, wind speed 5kt.

11:33:25 Yamagata Radio informed the JAR aircraft that it had landed at 11:33, and instructed it to make a 180 degree turn and taxi to spot.

11:34:08 The aircraft reported 'Emergency Landing' to Yamagata radio.
(There was loud high-pitched sound in the background of the emergency report, but the sound stopped during the transmission.)

11:34:15 Yamagata Radio acknowledged reported emergency landing.

The accident site was in a grass field at Yamagata Airport 90m east of runway 01 abeam the

threshold, and occurred at around 11:34.

(See Figures 1, 2 and Photographs.)

2.3 Deaths, Injuries or Persons Missing

The captain sustained serious injuries and the photographer sustained fatal injuries.

2.4 Damage to Aircraft

2.4.1 Extent of Damage

The aircraft was severely damaged.

2.4.2 Damage to Aircraft by Part

(1)	Fuselage:	Front windshield destroyed, fuselage deformed
(2)	Main rotor:	The star-flex of the hub was fractured
(3)	Skids:	Both left and right skids were fractured
(4)	Tail:	The tail boom had separated at the fuselage attachment.
		One of the tail rotor blades had fractured at the mid section.

2.5 Crew Information

2.5.1 Flight Crew

Captain: Male, aged 44

Commercial Pilot License (Rotorcraft)	Issued February 28, 1996
TypeRatings	
Airplane single-piston engine (land)	Issued February 16, 1994
Airplane single-turbine engine (land)	Issued April 5, 1994
Airplane multi-turbine engine (land)	Issued May 26, 2005
Instrument Rating	Issued May 29,1997
Class 1 Airman Medical Certificate	
Term of Validity	until March 24, 2005
Total flight time	2,774 hours 22 minutes
Flight time during the previous 30 days	96 hours 44 minutes
Total flight time on the same model of aircraft	1,582 hours 46 minutes
Flight time during the previous 30 days	54 hours 22 minutes

2.6 Aircraft Information

2.6.1 The Aircraft

Type	Aerospatiale AS350B
Serial Number	1964
Date of manufacture	October 21, 1986
Certificate of Airworthiness	Tou-15-686
Term of validity	March 29, 2005
Category	Rotorcraft Normal (N)
Total flight time	4,761 hours 24 minutes
Flight time since scheduled maintenance (100 Hr Check on May 6, 2004)	75 hours 42 minutes

2.6.2 The Engine

Type	Turbomeca Arrial 1B
Serial Number	4041
Date of manufacture	October 21, 1986
Total flight time	4,576 hours 05 minutes
Flight time since scheduled maintenance (100 Hr Check on May 6, 2004)	75 hours 42 minutes

(See Figure 3)

2.6.3 Weight and Center of Gravity

The weight of the aircraft at the time of the accident is estimated to have been approximately 1,363kg, with the center of gravity at 3.40m. It is estimated that both values were within the allowable limits (maximum take-off weight 1,950kg, with an allowable center of gravity range corresponding to the weight at the time of the accident of 3.17–3.43m).

2.6.4 Fuel and Lubricating Oil

The fuel on board was Aviation Fuel Jet-A-1. The lubricating oil was Mobile Jet Oil II.

2.7 Meteorological Information

The aviation weather observations provided by Yamagata Airport at around the time of the accident are as follows:

Time of Observation	11:40 JST
Wind Direction	Variable
Wind Speed	03kt

Visibility	More than 40km
Cloud Amount	1/8
Cloud form	Cumulus
Height of Cloud Base	5,000ft
Cloud Amount	5/8
Cloud form	Unknown
Height of Cloud Base	Unknown
Temperature	21℃
Dew Point	06℃
Altimeter setting (QNH)	30.12inHg

2.8 The Crash Site and Aircraft Wreckage

2.8.1 The Crash Site

The site of the accident was at Yamagata Airport around 90m east of the threshold of runway 01. There was a sharply excavated groove around 80cm long and around 20cm deep in the grass field 86m southwest of the point the aircraft came to rest. Tail rotor blades fragments were found around 3m left of this groove. Tracks continued 86m from around the groove to the position of the aircraft, and fragments of the fuselage were scattered to the left and right side of the tracks.

The aircraft came to rest rolled onto its left side pointing opposite to the direction of travel, and traces of a small amount of fuel leakage were found.

The tail boom had separated at its fuselage attachment, and traces of hydraulic fluid leakage were found.

(See Figure 2 and Photographs.)

2.8.2 Detail of the Damage to the Aircraft

The nose section was deformed, the windshields had been broken and lost, and both cockpit doors had came off. The right side of the fuselage-strengthening X-frame had been destroyed.

The lower part of the fuel filler port was damaged, and the fuel tank was empty. The star-flex sections of the main rotor hub assembly were broken at three locations, but there was no substantial damage to the main rotor blades.

Both the left and right landing gear skids were damaged, and the cross tubes installed with the left and right skids were greatly deformed.

The tail boom had separated at its attachment to the fuselage, and the tail hydraulic pipe was broken. The lower vertical tail fin had been bent left through around 90°, but otherwise

there was no substantial damage. One of the tail rotor blades was fractured at the mid section.

(See Photographs.)

2.8.3 Positions of the Cockpit Switches

The pedestal panel contains a total of 19 switches, including the master switch which disconnects electrical power source from the battery and fuel pump in an emergency, and a switch to silence the low main rotor speed aural warning.

These panel switches were of the push type, but they were found midway between the on and off positions, so it could not be discovered whether they had been in the on or off positions at the time of the accident.

2.9 Medical Information

According to the Murayama Police Department, Yamagata Prefecture, the captain sustained serious injuries and the photographer died five hours after the accident.

2.10 Information on Search, Rescue and Evacuation relating to Survival, Death or Injury

The Yamagata Airport firefighting team on standby at Yamagata Airport had monitored the emergency call from the aircraft, rushed to the scene and arrived there at 11:36. A Ground Self Defense Force attachment stationed at the airport received a request to dispatch from Yamagata Airport Administrator and arrived at the scene at 11:40. There was no outbreak of fire. The Yamagata Airport firefighting team and Ground Self Defense Force conducted the rescue of the aircraft occupants, and rescued the captain who was hanging from his shoulder harness, and loaded the photographer, who had been thrown from the aircraft, into an ambulance. The photographer was admitted to hospital at 12:13, and the captain at 12:28.

2.11 Tests and Research to Find Facts

2.11.1 Engine and Transmission System Investigation

Inspection of the engine exterior revealed no damage, the turbine section could rotate smoothly, and no metal chips were found on the magnetic chip detectors in the engine itself. No metal chips were found on any of the magnetic chip detectors in the accessory gearbox, the reduction gearbox and the main gearbox of the transmission system.

2.11.2 Hydraulic System

Except for the loss of the tail section system, the aircraft's hydraulic system was undamaged and the hydraulic pump drive system was normal in appearance. No metal chips were found on either the hydraulic fluid tank outlet magnetic plug or the hydraulic pump outlet magnetic plug.

2.11.3 Investigation of the Background Sound on the ATC Communication Recordings

A loud high-pitched sound was recorded in the background on the ATC communication recording when the emergency call was made at 11:34:08, but stopped during the emergency call.

The aircraft had been fitted with a speaker for aural alerts. When the main rotor speed drops to a low speed of 255–335rpm or there is a drop in hydraulic pressure, a warning sound is issued from the speaker. The warning sound stops when the main rotor rpm becomes higher or lower than the range described above, if hydraulic pressure recovers, or if the aural alert is switched off.

The frequency of the aural alert was found to coincide with that of the background sound in the ATC communication recording.

2.12 Other Information

2.12.1 Reference Fuel Consumption Rate

A reference fuel consumption rate is given in an annex to the company's Operations Manual, Aircraft Operating Procedures, chapter 6 Flight Planning, as follows:

Chapter 6 (Extract)

4 Required fuel load

Reference fuel consumption (liter/hour)

On ground	Climb	Cruise ①	Cruise ②	Descent	Usable Fuel
10	170	160	135	130	530 (Note2)

However, Flight conditions (Ambient Pressure and Temperature, Altitude, Operating Weight, Kind of Job) may effect to fuel consumption. Therefore, refer to fuel quantity indicator in flight basically.

Cruise ①: Fuel consumption at around IAS 115kt

Cruise ②: Fuel consumption at around IAS 65kt

（Note2 ）The fuel tank on the aircraft was modified at the time of the manufacture, and fuel capacity is 540 liters and unusable fuel is 1.25 liters.

2.12.2 Autorotation Procedures described in the Rotorcraft Flight Manual

Chapter 3, Rotorcraft flight manual: Emergency Procedures (Extract)

1. Autorotational Landing

C. Autorotational landing procedure following engine failure

・Set low collective pitch

・Monitor and control rotor rpm.

・Establish approximately 65kt (120km/h) airspeed.
・Move the fuel flow control to the shutdown position.
・Otherwise dependent to cause of engine failure：
Omission
・Maneuver to bring the helicopter head on to the wind in final approach.
・at a height of approximately 65ft (20m) above the ground, flare to a nose-up attitude.
・At height 20～25ft (6～8m) and at constant attitude, gradually apply collective pitch to reduce the sink-rate.
・Resume level attitude before touch down, and cancel any-slip tendency.
・Gently reduce collective pitch after touch-down.

2.12.3 Fuel Caution Light

A caution light illuminates when the usable fuel quantity drops to around 60 liters.

During the 500-hour periodic check performed in October 2003, it was confirmed that the aircraft's fuel caution light illuminated at 62 liters. On subsequent flights, the illumination of the caution light had been checked several times by the captain and other pilots.

The company standard operating procedure describes the following actions when the fuel caution light illuminates:

Chapter 8 Corrective actions to be taken at an emergency
8-2-4 Corrective action making an emergency landing
(2) When fuel caution light is illuminated, land to an airport or an airfield as soon as possible.

2.12.4 The Aircraft's Fuel Consumption Rate and Endurance based on Flight Experience

Regarding the aircraft's fuel consumption rate, the president of the company, who had flown the aircraft many times, stated as follows:

"Based on past experience, the fuel consumption rate flying between locations at maximum cruise power is around 150 liters/hr, and during aerial photography with 85–86% power and a speed of 40–50kt, the fuel consumption rate is around 130 liters/hr."

Regarding flight time, the captain stated as follows:

"On previous experience, it is possible to fly for about 4 hours and 15–20 minutes. I judge endurance from both the elapsed flying time and the fuel gage reading. I fly considering 4 hours to be the standard endurance, and in the case of distant photography locations, I allow for around 15 minutes of holding near the airport. Up to now I have twice landed with the fuel gage reading around 3 %." (Note 3.)

Furthermore, during the one year prior to the accident, the captain had made 16 flights by the aircraft that exceeded 3 hours 50 minutes, and on four of those occasions the flight time had

exceeded four 4 hours.

(Note 3): 3% corresponds to around 16 liters, equivalent to around 7 minutes of flight time.

2.12.5 The Captain's Flight Experience

(1) The president of the company, who had been the captain's flight training instructor, stated as follows regarding the captain's flying:

"The captain is eager to study, and after obtaining a commercial pilot license, studied for the instrument rating and got it on the first try. After that, from November 2000, he began training for certification as a flight instructor. Autorotation landing is one of the subjects in the flight instructor certification examination and so he began training for it, but the captain is a fast learner and became able to make autorotation landings without assistance. It was considered that he had attained sufficient proficiency for the flight instructor certificate in May, 2001."

(2) Regarding autorotation training, the captain stated as follows:

"I hadn't made an autorotation landing this year, but when landing at Kawashima Heliport I was practicing simulated autorotation landings by doing an autorotation descent in the air, then doing what is called power recovery training before touching down by engaging the engine clutch and making a powered landing. I have done this several times this year. I practiced starting at speeds higher or lower than the autorotation speed (65kt) because the gliding path angles changes depending on the wind and initial speed.

2.12.6 Flight Plan

The person responsible for dispatch and sales filed the aircraft's flight plan using the SAT service at around 20:00 on the previous night (a data communication service for distribution of aviation weather and operations information and filing flight plans), and the flight plan had been accepted.

The aircraft landed at Kawashima Heliport, which was not included in the filed flight plan. Although the take-off from Gunma Heliport was reported to the AEIS (Aeronautical Enroute Information Service) Center after take-off, there was no report of the change in flight plan.

3. ANALYSIS

3.1 The captain had valid airman proficiency and airman medical certificates in accordance with the applicable regulations.

3.2 The aircraft had a valid certificate of airworthiness and had been maintained in accordance with the applicable regulations. Furthermore, considering the flight condition just before the accident, it is estimated that there was no abnormality of the aircraft or the engine prior to the accident.

3.3 Regarding the weather at the time of the accident, the wind direction and speed notified to the JAR flight just before the accident aircraft started its approach to the airport were 260° and 5kt. It is considered possible that the tailwind on the landing approach made control of the autorotation landing more difficult.

3.4 Based on the fuel consumption rate described in 2.12.1, the aircraft's endurance was around 4 hours in cruise. Further, given that the fuel leakage from the aircraft was very small based on the traces of leakage from the fuel tank found at the accident site, and that the captain stated that the fuel caution light illuminated at around 11:10 and that a further 24 minutes passed from the fuel caution light illuminating until the accident occurred, it is estimated that the time from the warning light illuminating until the accident corresponded almost exactly with the remaining possible flight endurance. It is therefore estimated that the aircraft's fuel was virtually exhausted.

From the captain's statement that the endurance for a photography sortie is around 4 hours 15 minutes, give or take a little depending on conditions, it is thought possible that on the day of the accident he was aiming at a flight time of that order.

It is considered that the captain did not recognize that due to flying at maximum cruise power for more than one hour and frequently climbing and descending during photography, the aircraft's fuel consumption was greater than in his previous experience.

The captain should have positively recognized that the fuel was almost exhausted, made an emergency call to Yamagata Radio, and received landing priority.

However, it is considered that because captain hesitated to request landing priority due to the arrival of a scheduled flight before his aircraft, and he thought that his aircraft could fly for a further 1 to 2 minutes, he did not make an emergency call until the aircraft started behaving abnormally.

3.5 As described in 2.11.3, given that the frequency spectrum of the background sound recorded along with the emergency call coincided with that of the aircraft's aural warning, and that there

were no other such sound sources, the background sound in the ATC communication is considered to have been the sound of the aircraft's aural warning.

Concerning the fact that the warning sound stopped during the emergency call, although it would have been possible to suppress the warning sound by a switch operation, given that the captain was making an emergency call and aiming for a landing point in autorotation flight, it is considered extremely unlikely that he would have removed his hand from the collective pitch lever to operate the switch. It is therefore considered that he did not operate the switch.

Further, since no abnormality was found in the aircraft's hydraulic system or flight control system, and since the warning sound stopped, it is considered that the warning sound was not the result of a drop in hydraulic pressure.

Considering the estimated flight path and airspeed, it is thought unlikely that the main rotor speed would have dropped below the lower RPM threshold of the rotor speed warning.

In consideration of the above, it is estimated that the aural warning was issued due to a drop in main rotor RPM, but that during the captain's emergency call the main rotor speed recovered and the sound stopped.

3.6 The captain stated that as he felt the main rotor vibrate, he pushed the collective pitch lever down and aimed for the airport. However, it is estimated that the main rotor low RPM warning sounding during the emergency call was due to a delay in the captain starting autorotation after feeling the vibration, which caused a drop in main rotor speed.

Since the aircraft was the heading east at the time the captain felt the main rotor vibration, it is thought that he was slow to lower the collective pitch lever because he had to diagnose fuel exhaustion and then transition to autorotation at the same time as turning toward the airport.

The captain stated that he aimed for a grass field on the southeast side of the approach end of runway 01, and the actual touchdown point coincided with this statement. Furthermore, it is estimated that the traces of initial contact at the accident site were made by the tail rotor, and that the aircraft was nose high on ground contact and touched down tail first.

As a result of these, it is estimated that the aircraft was in the condition to be able to maneuver until ground contact.

After a hard impact with the ground, given that the aircraft slid along the ground for 86m before finally rolling onto its side and damaging the nose section, it is estimated that the touchdown speed was high and that the aircraft flew into the ground at a shallow angle.

3.7 Although the captain had the skill to make an autorotation landing and there was no abnormality in the aircraft's flight control system, it is considered possible that the following factors contributed to preventing him from being able to properly control the aircraft:

(1) He lowered the nose and increased speed to recover from the low main rotor speed condition and to try to reach inside the airport perimeter.

(2) He delayed reducing speed in order to extend the touchdown point beyond the airport perimeter.

(3) Flaring was not immediately effective in reducing speed because ground speed had risen due to the slight tail wind.

(4) The captain was over confident he would always be able to make a safe autorotation landing even in the event of fuel starvation.

3.8 From the post-crash situation, it is estimated that the photographer had been seated in the rear seat. Further, based on the fact that he was thrown out of the aircraft and from the condition of the rear seat seatbelt, it is considered that his seatbelt was not fastened.

Given that the rear seat remained intact, it is considered possible that the photographer would have survived if he had fastened his seatbelt securely.

3.9 As described in 2.12.3, given that the company's operating standards specified to "land at an airport or at an emergency location as soon as possible" when the Fuel Caution Light illuminates in flight, it is estimated that the accident might have been avoided if the captain had adhered to procedures.

Furthermore, the captain landed and took off from a place which was not filed in the submitted flight plan, and continued the flight without notifying the change of flight plan. Regarding this matter, it is estimated that the captain had little awareness of the importance of a flight plan.

Since the captain is responsible for the operations and safety at the company, it is desirable he should be more strongly aware of safety and importance of the observance with procedures.

4. PROBABLE CAUSE

It is estimated that in this accident, the aircraft's fuel became exhausted while it was holding for landing, but during an autorotation emergency landing to the side of the runway, it failed to reduce speed sufficiently and contacted the ground hard, destroying the fuselage.

It is estimated that the captain's decision to continued the aerial photography sortie after fuel caution light had illuminated contributed to the fuel starvation in flight while holding.

5. OPINIONS

An aircraft's fuel consumption rate varies with factors such as the flight conditions and ambient temperature, and so aircraft are equipped with a low fuel caution light and have colored marks on the fuel quantity gage. Considering these matters, it is thought necessary that the company be required to make pilots and operations personnel adequately understand the following items, and to periodically refresh their attention of these items.

(1) Pilots themselves should recognize their endurance and flight situation, and operate their aircraft with an adequate fuel margin.

(2) If for some reason the margin is lost and it becomes necessary to land at an airport in a low fuel situation, an emergency call should be made to ATC organizations without hesitation so that landing priority be obtained.

(3) Various rules such as the flight manual and company internal regulations should be observed.

Figure 1　Presumed Flight Rute

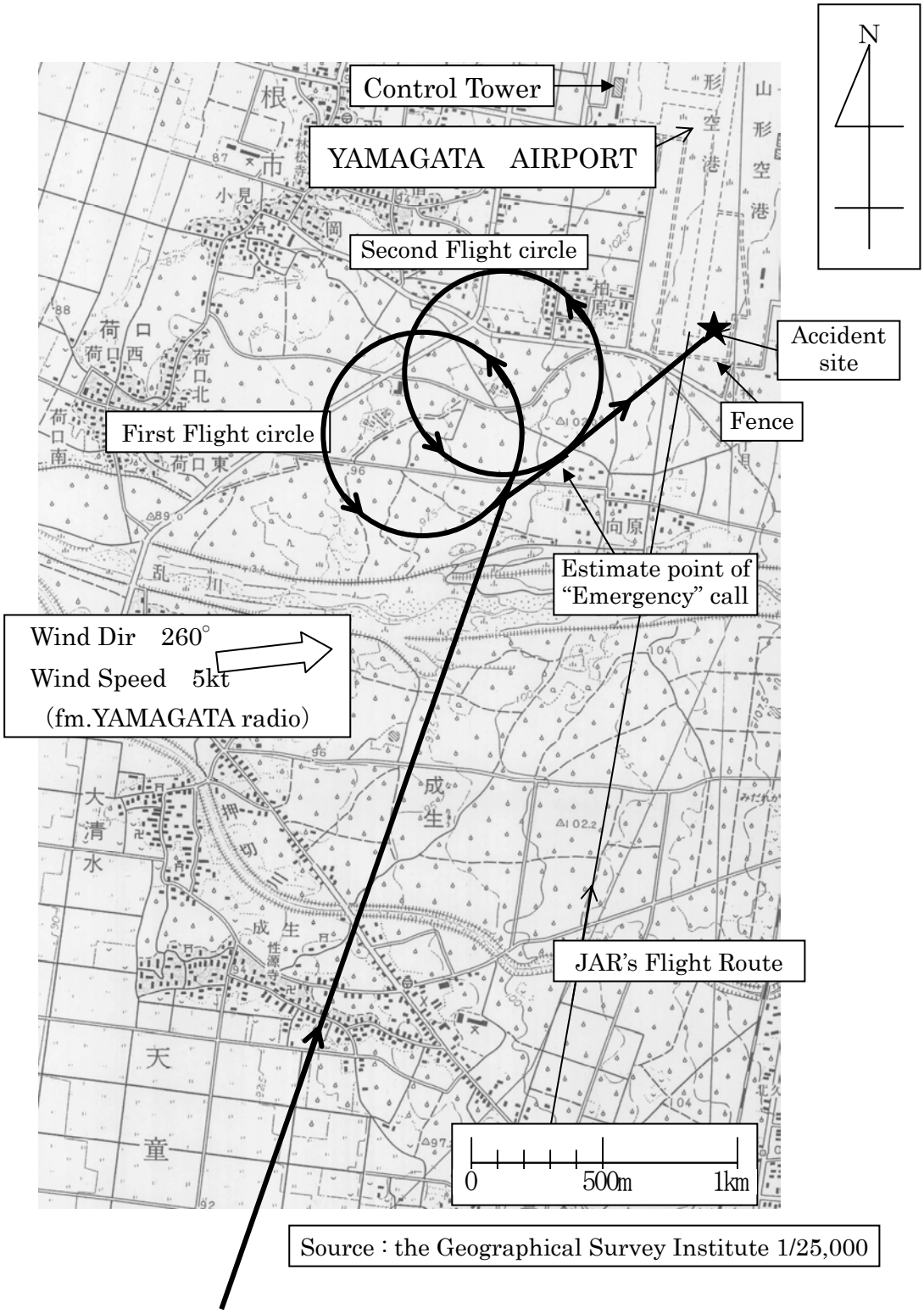


Figure 2　Accident Site Layout

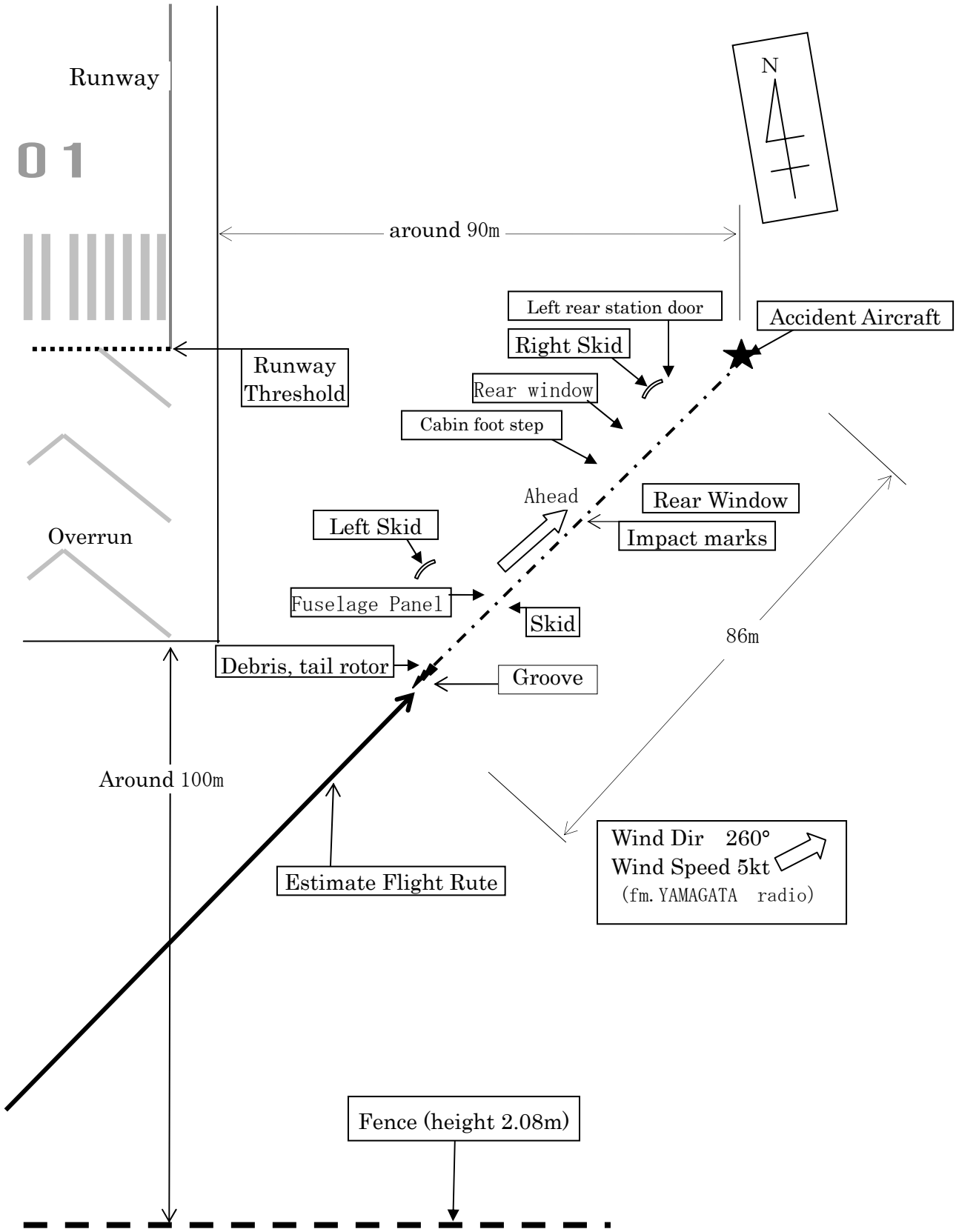
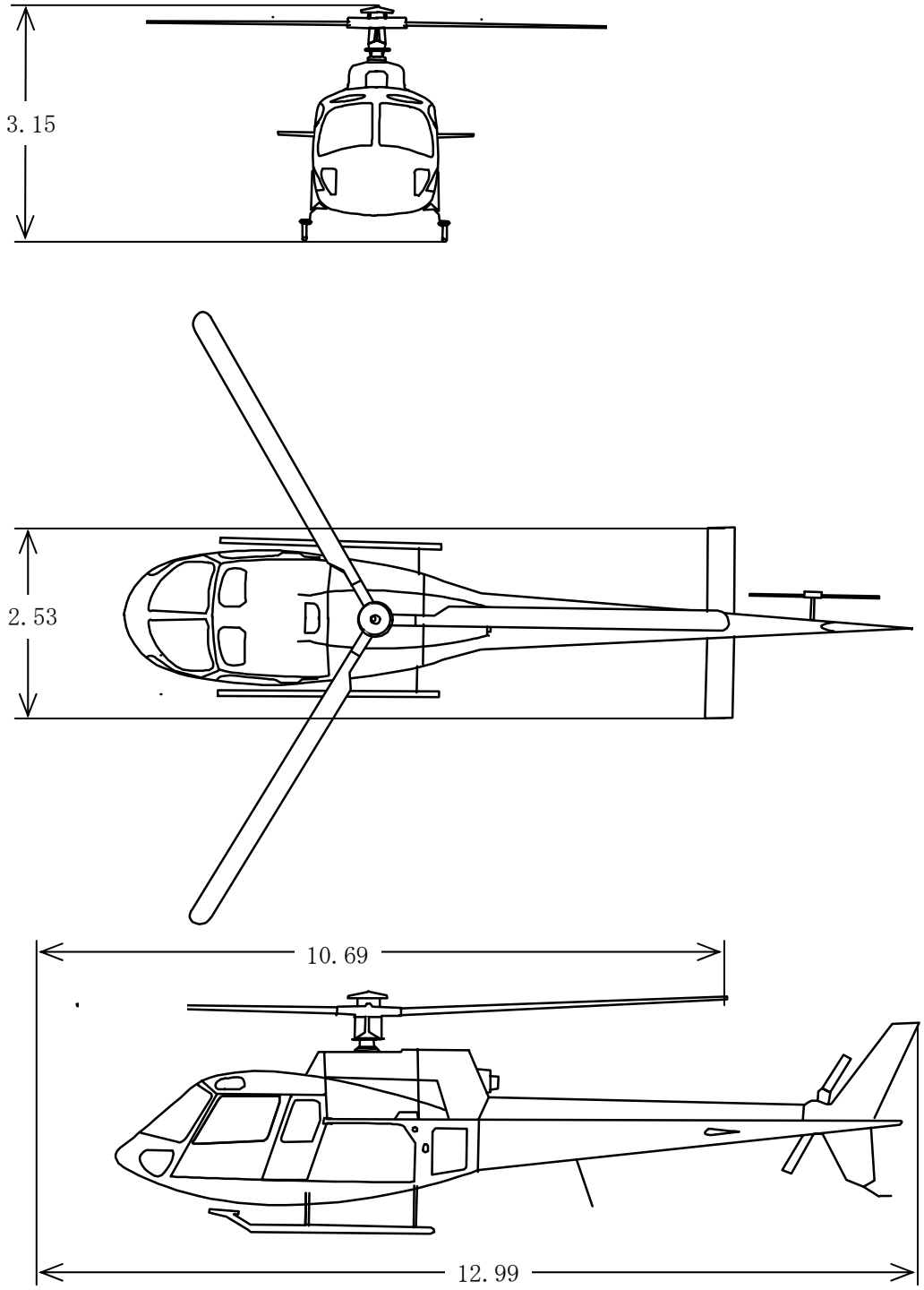


Figure 3 Three angle view of Aerospatiale/

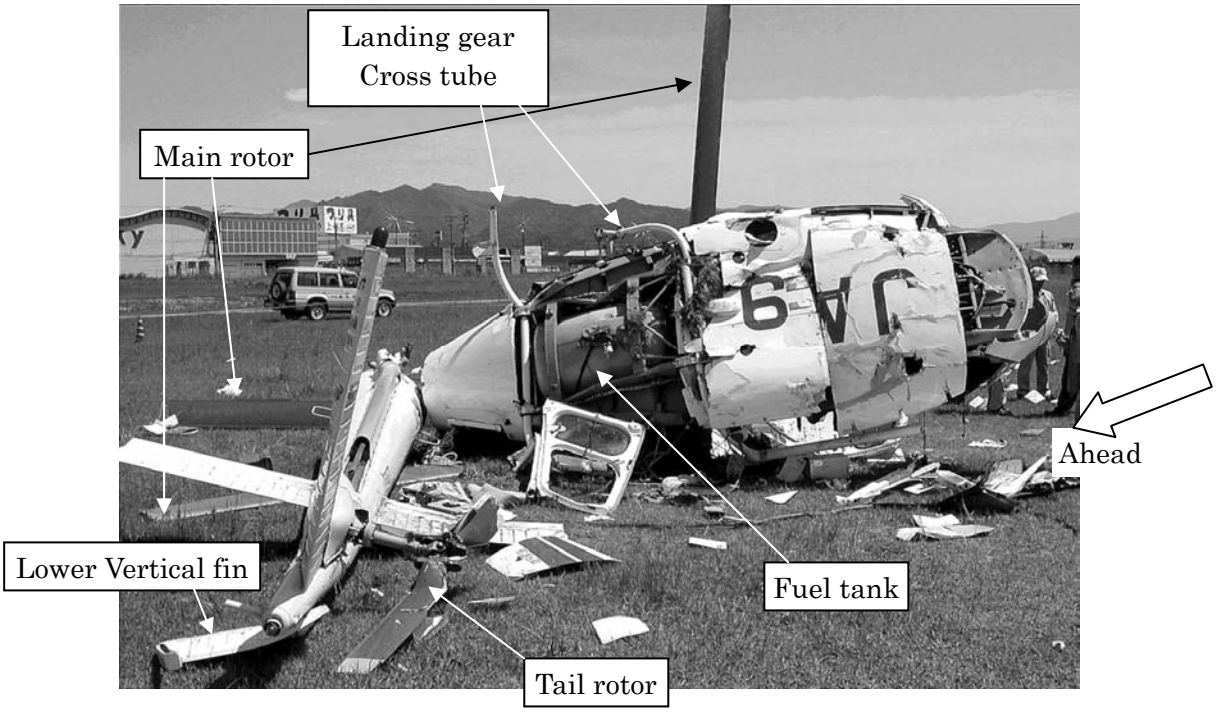
EUROCOPTERR AS350B

unit : m



Photograph　Accident Aircraft

(1)



(2)