AA2020-1

AIRCRAFT ACCIDENT INVESTIGATION REPORT

GUNMA PREFECTUAL DISASTER PREVENTION AVIATION UNIT
J A 2 0 0 G

February 27, 2020

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.

TAKEDA Nobuo
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 INTO MOUNTAIN SLOPE
GUNMA PREFECTURAL
DISASTER PREVENTION AVIATION UNIT
BELL 412EP (ROTORCRAFT), REGISTERED JA200G,
IN THE VICINITY OF ABOUT 2 KM NORTHEAST OF
MT. YOKOTE IN NAKANOJO TOWN,
AGATSUMA COUNTY, GUNMA PREFECTURE, JAPAN
AROUND 10:01 JST ON AUGUST 10, 2018

January 31, 2020

Adopted by the Japan Transport Safety Board

Chairman	TAKEDA Nobuo
Member	MIYASHITA Toru
Member	KAKISHIMA Yoshiko
Member	MARUI Yuichi
Member	MIYAZAWA Yoshikazu
Member	NAKANISHI Miwa

SYNOPSIS

< Summary of the Accident >

On Friday, August 10, 2018 around 10:01 JST (JST: UTC+9 hours; unless otherwise noted, all times are indicated in JST in this report on a 24-hour clock), a Bell 412EP, registered JA200G, operated by Gunma Prefectural Disaster Prevention Aviation Unit, took off from Gunma heliport in Shimoauchi-machi, Maebashi City, Gunma Prefecture to explore and identify dangerous spots in preparation for rescue activities on the trails on the ridge lines of Gunma Prefectural border and crashed into the mountain slope in the vicinity of about 2 km northeast of Mt. Yokote in Nakanojo Town, Agatsuma County, Gunma Prefecture.

There were nine persons in total were on board, consisting of a captain, a mechanic A in charge, a chief air rescuer, an air rescuer and five firefighters, and all of them were killed.

The helicopter was destroyed, however, there was no outbreak of fire.

< Probable Causes >

In this accident, it is probable that, while flying over mountainous areas for exploration of mountain climbing trail, the Helicopter entered the cloudy airspace and was unable to continuously recognize the ground surface due to lowered visibility, and the captain who was exposed to spatial disorientation could not perform an appropriate maneuvering to maintain the attitude of the Helicopter that subsequently crashed into the slope of the mountain.

It is probable that losing continuous visual recognition of the ground surface in the lowered visibility were caused by delayed decision to return and continuing flight in the situation that it was getting difficult to maintain VMC.

<Recommendations>

Recommendations to Minister of Land, Infrastructure, Transport and Tourism

In this accident, it is probable that, while flying in mountainous areas for exploration of mountain climbing trail, the helicopter entered the cloudy airspace and was unable to continuously visually recognize the ground surface due to lowered visibility that exposed the captain to spatial disorientation and disabled him to perform an appropriate maneuvering to maintain the attitude of the aircraft, which crashed into the slope of the mountain.

It is probable that the lowered visibility and losing continuous visual recognition of the ground surface were caused by delayed decision to return and continuing the flight in the situation that it was getting difficult to maintain VMC.

Pilots operating aircraft for fire and disaster prevention and police rescue activities have many opportunities due to the nature of their missions to fly mountainous areas where meteorological conditions are easy to change and it is difficult to predict localized meteorological conditions. It is important that, even in the case of abruptly worsened weather, pilots take appropriate actions to promptly leave air space in worsened weather conditions without being exposed to spatial disorientation. For that purpose, it is probable that pilots are required to regularly get acquainted with concrete preventive measures and coping ones by deepening understanding of danger in relation to spatial disorientation, to immediately switch to basic instrument flight, if required, and to properly use autopilot system, if equipped.

From what is described above, the Japan Transport Safety Board, pursuant to Article 26 (1) of the Act for Establishment of the Japan Transport Safety Board, recommends Minister of Land, Infrastructure, Transport and Tourism to take following measures in order to prevent an aircraft accident and to mitigate damage if an aircraft accident has occurred:

Civil Aviation Bureau of Ministry of Land, Infrastructure, Transport and Tourism should alert pilots operating aircraft engaged in rescue activities to danger of spatial disorientation and disseminate preventive measures not to be exposed to spatial disorientation, and coping measures to leave the situations if exposed to it by any chance.

Major abbreviations and acronyms used in this report are as follows:

AFCS: Auto Flight Control System

ATT: Attitude

CG: Center of Gravity

CRM: Crew Resource Management

DFCC: Digital Flight Control Computer

ELT: Emergency Locator Transmitter

FAA: Federal Aviation Administration

FT: Force Trim/feet

GPS: Global Positioning System

GS: Ground Speed

IAS: Indicated Air Speed

IMC: Instrument Meteorological Conditions

PC: Personal Computer

SAS: Stability Augmentation System

VFR: Visual Flight Rules

VMC: Visual Meteorological Conditions

Unit Conversions

1 ft: 0.3048 m

1 kt: 1.852 km/h (0.5144 m/s)

1 lb: 0.4536 kg

1 m: 3.281 ft

TABLE OF CONTENTS

1 PROCESS AND PROGRESS OF THE AIRCRAFT ACCIDENT INVESTIGATION

1.1 Summary of the Accident

On Friday, August 10, 2018 around 10:01 JST (JST: UTC+9 hours; unless otherwise noted, all times are indicated in JST in this report on a 24-hour clock), a Bell 412EP, registered JA200G, operated by Gunma Prefectural Disaster Prevention Aviation Unit, took off from Gunma heliport in Shimoauchi-machi, Maebashi City, Gunma Prefecture to explore and identify dangerous spots in preparation for rescue activities on the trails on the ridge lines of Gunma Prefectural border and crashed into the mountain slope in the vicinity of about 2 km northeast of Mt. Yokote in Nakanojo Town, Agatsuma County, Gunma Prefecture.

There were nine persons in total were on board, consisting of a captain, a mechanic A in charge, a chief air rescuer, an air rescuer and five firefighters, and all of them were killed.

The helicopter was destroyed, however, there was no outbreak of fire.

1.2 Outline of the Accident Investigation

1.2.1 Investigation Organization

On August 10, 2018, upon receipt of the notice of the accident, the Japan Transport Safety Board designated an investigator-in-charge and two investigators to investigate the accident.

1.2.2 Representatives of the Relevant States

An accredited representative and an adviser of the United States of America, as the State of Design of the helicopter involved in this accident, and an accredited representative and an adviser of Canada, as the State of Design and Manufacture of the engine and Manufacture of the helicopter, participated in the investigation.

1.2.3 Implementation of the Investigation

August 11 and 12, 2018:	On-site investigation
August 12 until 15:	Interviews and documents investigation
September 6 and 7:	Taking photographs of the accident site by drone and on-site investigation

October 15 and 16:	Recovery and detailed investigation of the airframe
November 8 until March 12, 2019:	Detailed investigation of DFCC (performed at the facility of the manufacturer of DFCC in the United States of America by the attendance of the investigator of the United States of America as the state of the design of the helicopter)
October 15 until November 19, 2019:	Simulation using flight training device

1.2.4 Comments from Parties Relevant to the Cause

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

1.2.5 Comments from the Relevant States

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

2. FACTUAL INFORMATION

2.1 History of the Flight

A Bell 412EP, registered JA200G (hereinafter referred to as "the Helicopter"), operated by Gunma Prefectural Disaster Prevention Aviation Unit (hereinafter referred to as "the Aviation Unit") planned to fly on August 9 and 10 over Gunma Prefectural boarder ridge line trails*1 (hereinafter referred to as "the Trails"), which were scheduled to be opened on August 11, 2018, to explore and confirm dangerous spots from the airspace in preparation for rescue activities prior to the opening. The planned flight was suspended on August 9 due to Typhoon No. 13 and the Helicopter took off from Gunma heliport on August 10 around 09:14. The Helicopter landed at a temporary helipad of Nishi-agatsuma Welfare Hospital (hereinafter referred to as "the Agatsuma Helipad") around 09:32 to let five firefighters board the Helicopter and took off around 09:36. In the Helicopter, the captain sat in the right pilot seat,

*1 Gunma Prefectural boarder ridge line trails (a tentative name) denote the ridge line trails from Tsuchiai, Mizukami Town of Gunma Prefecture passing through the prefectural boarder between Niigata Prefecture and Gunma Prefecture extending to Torii Pass at Tsubakoi Village, Gunma Prefecture located in the prefectural boarder between Nagano Prefecture and Gunma Prefecture and connecting mountains on the prefectural boarder.

the mechanic A in charge sat in the left pilot seat, and chief air rescuer, air rescuer and five firefighters of Agatsuma regional fire department headquarters were sitting on the floor in the cabin, thus a total of nine persons were on board. The chief air rescuer sat behind the captain's seat from Gunma heliport to the Agatsuma Helipad, and from the Agatsuma Helipad to the accident site sat the air rescuer who was familiar with the topography.

The captain and the mechanic A in charge did not wear helmets, but headsets. Seats in the cabin were removed and seven persons were sitting on the floor in the cabin without fastening seatbelts. Since the Helicopter took off from the Agatsuma Helipad until the engine was shut down after the occurrence of the accident, the scenes inside and outside the Helicopter were recorded in the video cameras attached to the helmets of two air rescuers and in the video camera carried by one of the firefighters.

The outline of the flight plan reported by the Aviation Unit to Tokyo Airport Office at 08:53 was as follows:

Flight rules: VFR

Departure aerodrome: Gunma heliport

Time to commence movement: 09:15

Cruising speed: 100 kt

Cruising altitude: VFR

Route: Agatsuma

Destination aerodrome: Gunma heliport

Total estimated elapsed time: 2 hours 00 minutes

Fuel load expressed in endurance: 2 hours 20 minutes

Persons on board: nine

However, the flight plan of the Helicopter used at the pre-flight briefing described following flight route:

Route: round flight from and to the Agatsuma Helipad, Torii Pass, Mt. Azumaya, Mt. Hafuudake, Mt. Yokote, Mt. Daikou, Mt. Shirasuna, and Mt. Inezutsumi

According to the flight record, the radar track record, statements of Operation controller in charge (dispatched from Toho Air Service Co., Ltd. in accordance with the Operation control service agreement as detailed in 2.15.1) and witnesses, GPS track record of the helicopter dynamic control system (hereinafter referred to as “the Dynamic Control System” as detailed in 2.13.3) and video cameras footage taken from the cabin, the history of the flight until the occurrence of the accident was summarized as follows:

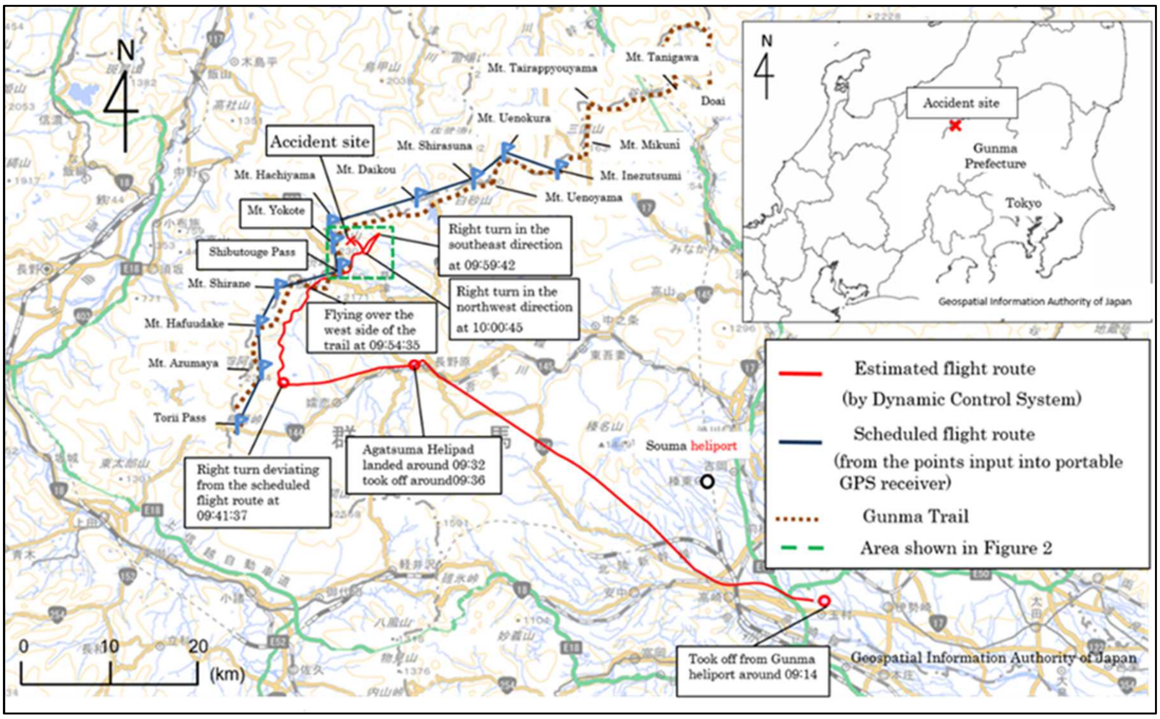


Figure 1: Estimated flight route of the Helicopter

2.1.1 The History of the Flight by Flight Record and Radar Track Record

Around 09:14	Took off from Gunma heliport
Around 09:32	Landed at the Agatsuma Helipad
Around 09:36	Took off from the Agatsuma Helipad after five firefighters went on board
09:41:37	Turned to the right short of Torii Pass and commenced flying on the east side of Gunma trail
09:54:35	Commenced flying on the west side of Gunma trail
09:57:49	Passed over Shibutouge Pass
09:59:42	Turned to the right in the southwest direction
10:00:45	Turned to the right in the northwest direction
10:01:12	Crashed into the mountain slope in the vicinity of about 2 km northeast of Mt. Yokote in Nakanojo Town, Agatsuma County,

Gunma Prefecture

2.1.2 Statements of Flight Controller in Charge, staff of the Aviation Unit and Witnesses A and B

(1) Flight Controller in Charge

According to the pilot A and the operation controller of the Aviation Unit who is in charge of flight control, the aerial exploration this time was planned to be performed by flying at a height more than the minimum safe altitude of 150m above the ground. The captain confirmed at the pre-flight briefing that there was no need to descend to a low altitude for the flight. This was the first time for the captain to fly this flight route and he prepared for the flight by inputting the scheduled turning points (the waypoints) of the flight route in the portable GPS receiver. Around 8 o'clock of the accident day, the captain obtained general weather conditions, radar echo pictures, Aviation Routine Weather Report, footage of live camera and information on the extent of view of the ridge lines of the mountains from Agatsuma fire department, and judged that the weather conditions were feasible for the flight.

On the accident day, the operation controller was not available and another the pilot A, not the captain of the Helicopter, stationing at the Aviation Unit was performing operating control, filing the flight plan monitoring and the Dynamic Control System (see 2.13.3) as appropriately. The flight plan of the Helicopter was filed at 08:53 and departure time was reported at 09:14. Presuming that describing in the flight plan was not required in the event that the engine was not shut down, the pilot A did not describe take-off and landing performed at the Agatsuma Helipad in the flight plan. When the pilot A confirmed the information of the Helicopter by the Dynamic Control System around 10:15, he confirmed that the information had halted at 10:01. However, because it sometimes happened that data of the Dynamic Control System halted, he decided to wait and see for a while. Around 10:40, the pilot A confirmed the terminal of the Dynamic Control System again, recognized that the data was not updated, and reported to other staff members of the Aviation Unit to that effect. After that, the pilot A attempted to confirm the movements of the Helicopter through Agatsuma regional fire department headquarters and called by fire department radio, however there was not any response. Then, although there was no radio communication coming in even at the scheduled arrival time of 11:14, the pilot A assumed that the Helicopter would land shortly, and reported the arrival to Tokyo Airport Office at 11:19. Because there was no response to the calling by both aeronautical radio and fire department one, the pilot A reported to Operation Control Department of Toho Air Service Co., Ltd. headquarters at 11:58 that he could not get in contact with the Helicopter although the scheduled arrival time had passed. At 12:11, Operation Control Department of Toho Air Service Co., Ltd. headquarters contacted Tokyo Airport Office to report that the contact with the Helicopter was lost and the arrival report sent previously was incorrect.

(2) Staff of the Aviation Unit

According to staff of the Aviation Unit, after being reported by the pilot A at 10:40 that the data of the Dynamic Control System had not been updated since 10:01, they attempted to call the Helicopter by fire department radio and simultaneously contacted Agatsuma regional fire department headquarters. Besides, they attempted to contact the rescuers on board by telephone that ended unsuccessfully. Because it took time for these arrangements, it was 11:45 when the staff reported the prefectural fire and security department that the Helicopter did not return.

(3) Witness A (around Shibutouge Pass)

The witness A who heard noise of the flying Helicopter inside a hotel and went out from the hotel to see it flying from Nagano Prefecture side and passing over the hotel toward Gunma Prefecture side at a fairly low altitude.

(4) Witness B (in the vicinity of the summit of Mt. Yokote)

According to the witness B, both Gunma Prefecture side and Nagano Prefecture side were clouded at altitudes of 1,500 m to 2,000 m when the witness was driving a vehicle in the vicinity of the summit of the mountain; however, it was fair in the surroundings when the witness arrived in the vicinity of the summit of Mt. Yokote at the height of 2,300 m around 09:30. While the witness B was unloading cargoes from the vehicle after arriving at the summit of the mountain, the witness B heard noise of the flying Helicopter from the direction of the cloudy area near the valley. Immediately after an abrupt change of the rhythm of the noise into an unfamiliar noise like a roaring engine, the noise became unheard.

2.1.3 GPS Information by the Dynamic Control System

The Helicopter did not establish communications with air traffic control because it was flying by VFR. The locational information by GPS information from the time of the take-off from Gunma heliport until the estimated time of the crash at 10:01:12 was recorded in the Dynamic Control System on board the Helicopter. In addition, the data in the Dynamic Control System on board was transmitted to the same on the ground every 20 seconds until 10:01:01. Locational and altitude information of the GPS included error by meters due to receiving condition of GPS signals.

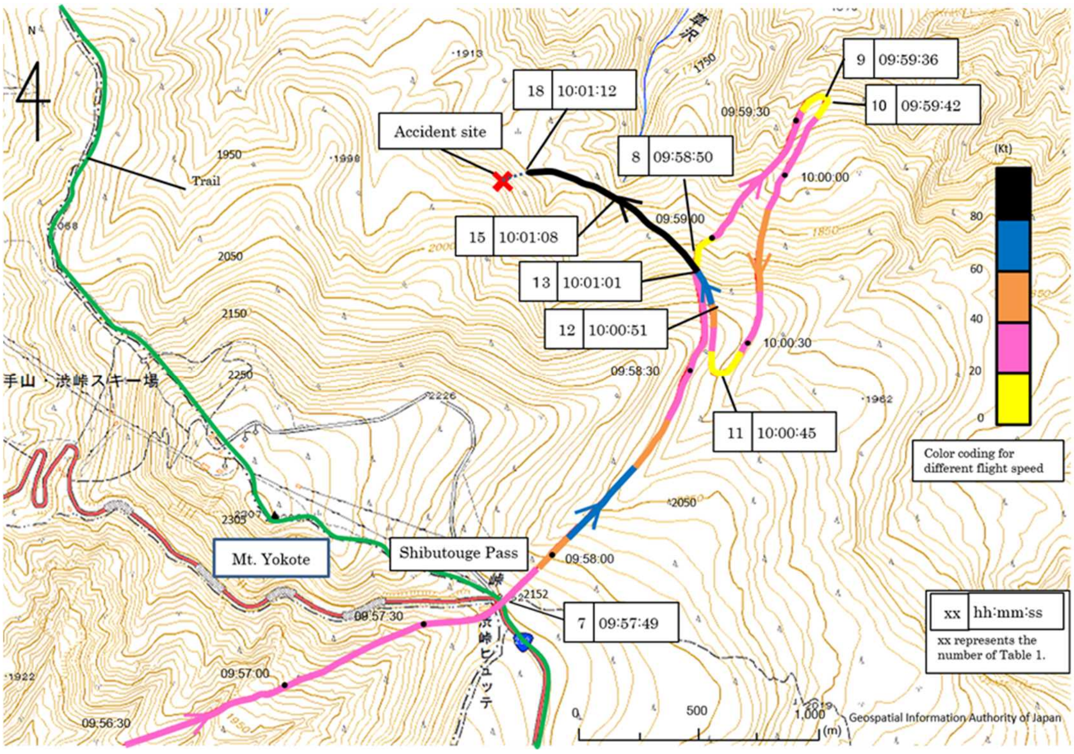


Figure 2: Flight track of the Helicopter by the Dynamic Control System

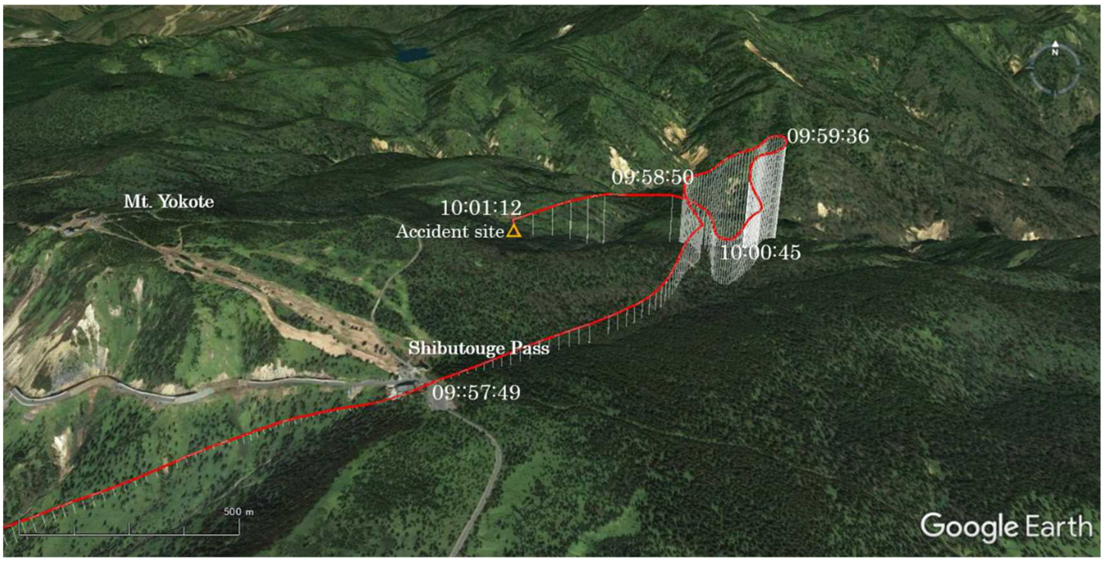


Figure 3: Estimated flight route immediately before the accident (bird's-eye view)

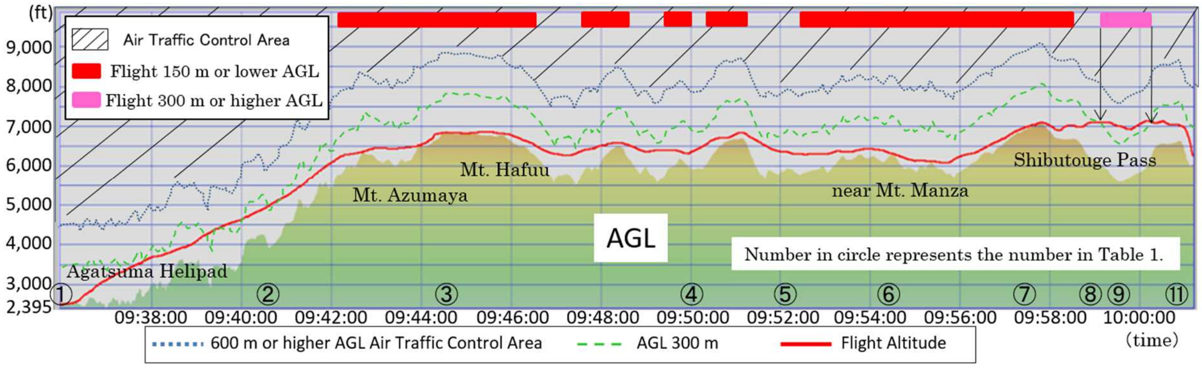


Figure 4: Cross-sectional view of the flight from the Agatsuma Helipad until immediately before the crash

2.1.4 Video Camera Information

Video cameras carried by two air rescuers and a firefighter recorded the footage after take-off from the Agatsuma Helipad until the collision crash against trees. Besides, the video cameras recorded acting noises such as engine noise and rotor rotation noise via a microphone and the changing situations were confirmed; however, due to disconnected video cameras to intercommunication system in the cockpit, the conversations in the cockpit could not be confirmed except some part.

Table 1*2: Information obtained from video camera footage and GPS data

No.	Time	History of the flight and situations in the cockpit	Situations outside the Helicopter	Ground speed (kt)	Orientation (°)	Flight altitude (ft)
1	09:36:00	Took-off from the Agatsuma Helipad.	Fair sky with the sunshine coming into the plain area down to the skirts of the mountains.			2,483
2	09:41:37	Turned to the right short of Torii Pass and commenced flight in the east side of the Trails. After completion of the turn, the captain operated the map display device.	The ridge lines of the mountains were visible and cloud was approaching the ridge lines located far away.	93	264	5,741
3	09:44:20	Flew on the east side of the Trails at 30 kt – 50 kt in a	Cloud was scattering on the ridge lines of the	29	348	6,794

*2 Ground speed, orientation and flight altitude shown in Table 1 were obtained by computing GPS position and altitude information, and include an error affected by receiving condition of GPS signals.

No.	Time	History of the flight and situations in the cockpit	Situations outside the Helicopter	Ground speed (kt)	Orientation (°)	Flight altitude (ft)
		way to avoid cloud getting close to the mountain slope.	mountains.			
						
4	09:50:00	Flew on the east side of the Trails in the vicinity of the Mt. Shirane.	The ridge lines of the mountains were visible and the horizontal visibility was gradually lowering. The ground surface was visible.	35	028	6,331
5	09:52:05	After pointing at the mountain on the west side, the air rescuer input the position of Mt. Yokote in the tablet device.	The ridge lines of the mountains were visible and the horizontal visibility was gradually lowering. The horizon was visible.	68	052	6,348
6	09:54:35	Coming close to the mountain slope avoiding low-lying cloud, passed over the ridge lines at about 30 m AGL and kept flying to Shibutouge Pass on the west side of the Trails.	Despite a large amount of cloud, the sunshine was coming in from the spaces of the cloud. The ground surface was visible.	32	011	6,272
7	09:57:49	Passed over the vicinity of Shibutouge Pass.	Ground facilities of Shibutoge Pass was visible from the spaces of cloud underneath the aircraft; however, the amount of the cloud covering the	34	052	7,082

No.	Time	History of the flight and situations in the cockpit	Situations outside the Helicopter	Ground speed (kt)	Orientation (o)	Flight altitude (ft)
			ground surface was increasing.			
8	09:58:50	Turned to the right in the northeast direction and flew on the east side of the Trails.	The ridge lines on the west side were invisible, and only a limited part of the ground surface on the east side was visible.	28	008	7,040
9	09:59:36	Gradually turned to the right at a low speed and heading for Shibutouge Pass on the south side. During the turn, the voice of "ROGER" from the air rescuer was recorded, mixed in operating noise of the engine and so on.	The horizontal visibility was lowered and only a limited part of the ground surface was visible from the right window.	19	067	6,990
10	09:59:42			16	185	6,941
11	10:00:45 to 10:00:48	Turned to the right at a low speed and heading for the north. Gradually turned to the right accelerating at the increasing rate of 3 – 5 kt/second.	Horizontal visibility was low and the ground surface was barely visible.	14 to 15	265 to 320	7,030 to 7,040

No.	Time	History of the flight and situations in the cockpit	Situations outside the Helicopter	Ground speed (kt)	Orientation (°)	Flight altitude (ft)
						
12	10:00:51 to 10:00:55	After gradually turning to the right, the captain was moving his head and searching for the ground surface in the right underneath moving his head with while commencing the left turn.	Horizontal visibility was low and the ground surface was almost invisible.	30 to 43	002 to 005	7,040 to 7,026
13	10:01:01	Commenced the left descending turn. Roll angle became 10 ° to the left and pitch angle became – 20 °.	Horizontal visibility was low and the ground surface was almost invisible.	83	328	6,954
						

No.	Time	History of the flight and situations in the cockpit	Situations outside the Helicopter	Ground speed (kt)	Orientation (°)	Flight altitude (ft)
14	10:01:07	Continued the left descending turn. Roll angle became 45° to the left and pitch angle became -20°. After watching the front instruments, the captain activated the FT and selected mode selector. The FT off caution light was turned off (see 2.12 (2) for detail).	Horizontal visibility was low and the ground surface was almost invisible (see Figure 5).	106	311	6,695
						
15	10:01:08	While continuing the left descending turn, the captain applied cyclic stick to the left and pulled it backward. RPM light and cyclic center light were illuminated (see 2.12 (3) for detail). The descent rate reached about 3,000 ft/minute and rotation noise of the engine and the rotor became elevated.	The front visibility abruptly turned clear.	123	300	6,620
16	10:01:09	The captain applied cyclic stick to the right backward. Roll angle became 45° to	The mountain slope became visible on the left.	127	296	6,534

No.	Time	History of the flight and situations in the cockpit	Situations outside the Helicopter	Ground speed (kt)	Orientation (°)	Flight altitude (ft)
		the left and pitch angle became – 10°. RPM light and cyclic center light continued illuminating.				
						
17	10:01:10 to 10:01:11	Roll angle became 20° to the left and pitch angle became 0°, and RPM light and cyclic center light were turned off. Roll angle became 5° to the left from 20° to the left and pitch angle became 0°. “Be careful” was recorded, mixed in operating noise of the engine, but it is unknown who said so.	The mountain slope on the left continued to be visible.	131 to 135	289 to 281	6,433 to 6,331

No.	Time	History of the flight and situations in the cockpit	Situations outside the Helicopter	Ground speed (kt)	Orientation (°)	Flight altitude (ft)
18	10:01:12	RPM light and cyclic center light were illuminated. Roll angle became 0° and pitch angle became +20°. The Helicopter crashed from the left side contacting trees at the air speed of about 100 kt and the descent rate of less than 100 ft/minute.	The mountain slope was coming close on the left and in the front and the Helicopter collided with trees.	Air speed of 100 kt	275	6,239
19	10:02:40	After the aircraft was destroyed at the time of the crash, rotation of the engines was decreased and then stopped, which was recorded.				

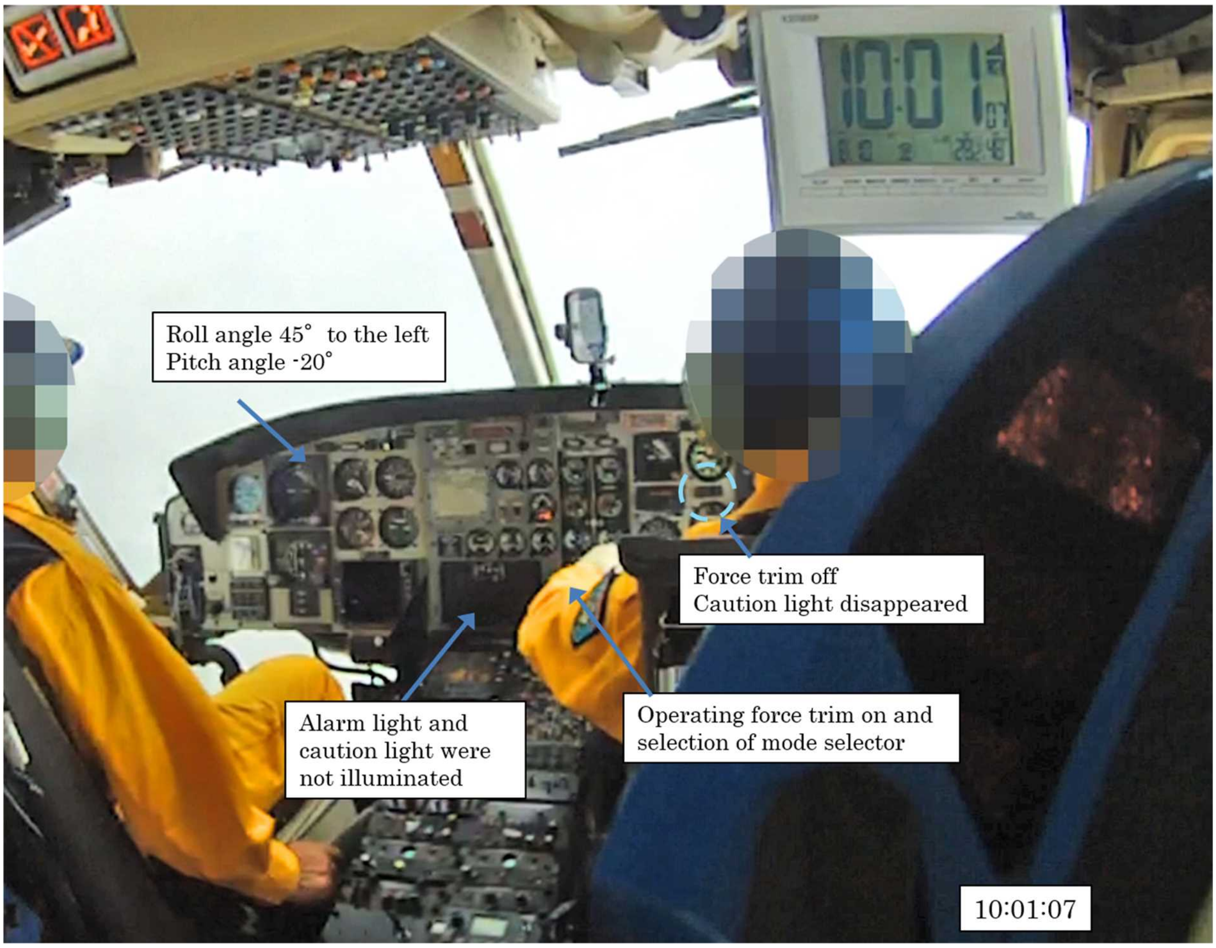


Figure 5: FT and mode selector maneuvering before the crash

The accident occurred in the vicinity of about 2 km northeast of Mt. Yokote in Nakanojo Town, Agatsuma County, Gunma Prefecture (36 °40’44” N, 138 ° 32’03” E) on August 10, 2018 around 10:01 (see Figure 1 and 2).

2.2 Injury to Persons

A total of nine persons consisting of the captain, the mechanic A in charge, the chief air rescuer, the air rescuer and five firefighters were on board and all of them were killed.

2.3 Damage to the Aircraft

2.3.1 Extent of Damage

Destroyed.

2.3.2 Damage to the Aircraft Components

(1) Fuselage: deformed and destroyed

(2) Empennage: separated and damaged

(3) Engines: damaged

(4) Rotor system: damaged and destroyed

(5) Control system: deformed and destroyed

Figure 6: Damaged condition of the airframe at the accident site

2.4 Other Damage

About 40 trees were cut or fell down.

2.5 Personnel Information

The captain was employed by the entrusted air service company in 2001 and operated a type of helicopter that is mainly used for press services. The captain received training as a company staff member at Sendai airport in October 2017 until February 2018 for Bell 412EP type helicopter and obtained the rating for the type. The captain thereafter received training necessary to become a pilot for the Aviation Unit and was assigned to the Aviation Unit in April 2018. Besides, the captain's total time of basic instrument flight training of the same type of the helicopter using hood*3 was one hour and 30 minutes as of the time he obtained the rating for the type. The captain neither received the basic instrument flight training since April 2018 when he was assigned to the Aviation Unit nor he held the instrument flight certificate.

*3 "hood" denotes the visibility restriction device to blind the external scenes for instrument flight operation training and is used in the basic instrument flight training.

The captain (PIC) male, age 57	
Commercial pilot certificate (rotorcraft)	March 5, 1991
Pilot competence assessment Expiry of practicable period for flight	
September 14, 2018	
Type rating for single turbine engine (land)	October 14, 1987
Type rating for multi turbine engine (land)	February 10, 2004
Type rating for Aerospatiale SA365	January 21, 2008
Type rating for Bell 212	March 7, 2018
Class 1 aviation medical certificate	
Validity	April 1, 2019
Total flight time	4,609 hours 10 minutes
Flight time in the last 30 days	28 hours 35 minutes
Total flight time on the type of the helicopter	108 hours 00 minutes
Flight time in the last 30 days	28 hours 35 minutes

2.6 Aircraft Information

2.6.1 Aircraft

Type	Bell 412EP
Serial number	36132
Date of manufacture	July 10, 1996
Airworthiness Certificate	TO-29-575
Validity	March 28, 2019
Total flight time	7,239 hours 11 minutes

(see Appended Figure: Three-angle drawing of Bell 412EP)

2.6.2 Weight and Balance

The weight of the Helicopter immediately before the accident is estimated to have been 10,125 lb and the position of the CG is estimated to have been 138.0 in, both of which are estimated to have been within allowable range (maximum take-off weight of 11,900 lb).

2.7 Meteorological Information

2.7.1 General Weather Forecast

General weather forecast issued by Maebashi Local Meteorological Observatory at 04:48 on the accident day was as follows:

Typhoon No. 13 was heading east-northeast toward the offing of Sanriku. It was cloudy and fair in Kanto District.

It was forecasted that it would be covered by high pressure on August 10 and the condition of the atmosphere would become unstable in the afternoon affected by humid air. Due to this, it would be fair gradually becoming cloudy and would partly be heavily raining accompanying thunder from early afternoon in Gunma Prefecture. In addition, it would be heavily raining in a certain region from evening until around early night.

In Agatsuma area, it would be covered by high pressure and would change from fair to cloudy from early afternoon affected by humid air and would be heavily raining accompanying thunder in a certain area.

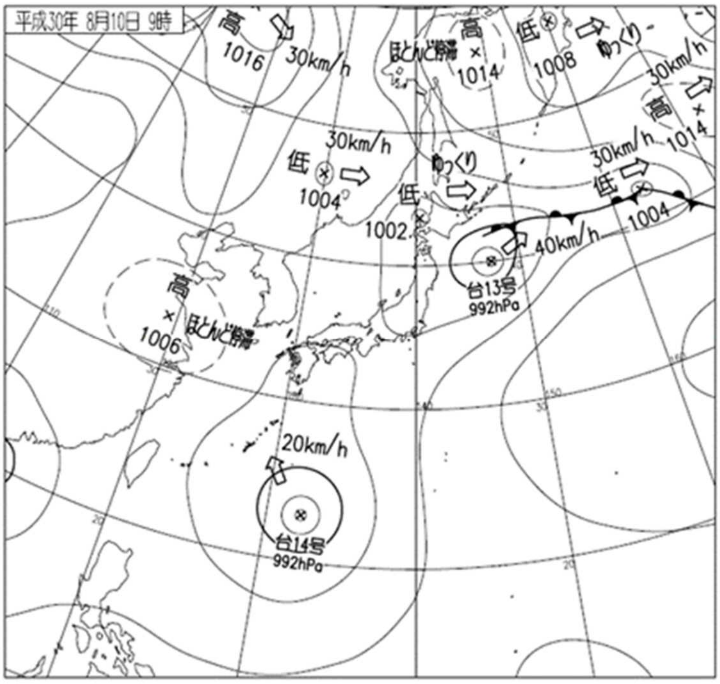


Figure 7: Surface weather chart as of 09:00, August 10, 2018

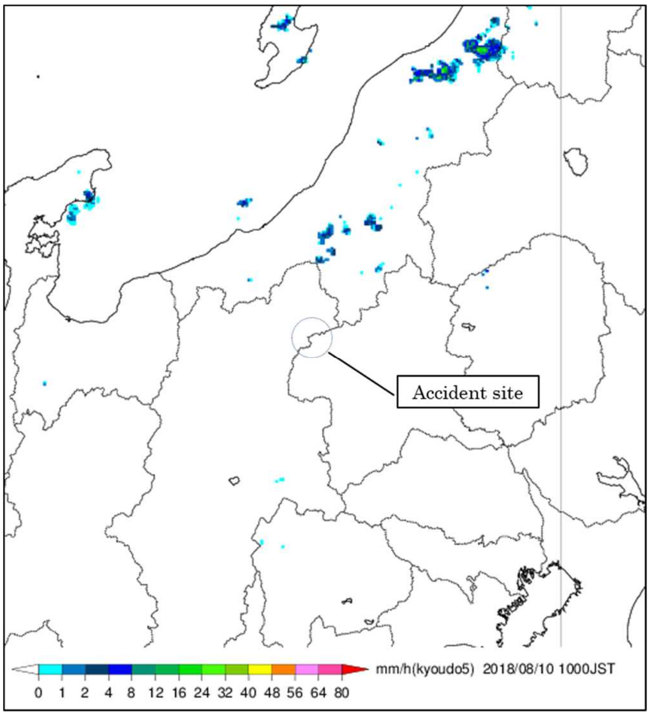


Figure 8: Radar echo composite chart as of 10:00, August 10, 2018

According to the surface weather chart as of 09:00 on the day of the accident, the typhoon No. 13 was passing through and it was gradually being covered by high pressure. In addition, from the radar echo chart as of 10:00, there existed no radar echo in the vicinity of the accident site.

2.7.2 Aeronautical Weather at the Aerodrome and Observations of Local Weather Observatory

Aeronautical weather observations for Soumagahara aerodrome, located about 46 km southeast of the accident site, around the time of the accident were as follows:

09:00 Wind direction: 120 °, Wind velocity: 2 kt, Visibility: 10 km or more Prevailing weather

Cloud: Amount 1/8, Type Cumulus, Cloud base 3,000 ft

Amount 4/8, Type Stratus, Cloud base 5,000 ft

Temperature: 28 °C, Dew point 21 °C

Altimeter setting (QHN) 29.66 inHg

10:00 Wind direction: 210 °, Wind velocity: 1kt, Visibility 10 km or more Prevailing weather:

Cloud: Amount 1/8, Type Cumulus, Cloud base 3,000 ft

Amount 4/8, Type Stratus, Cloud base 6,000 ft

Temperature: 28 oC, Dew point 21 oC

Altimeter setting (QHN) 29.67 inHg

Observations for Kusatsu Local Weather Observatory, located about 10 km southeast of the accident site, around the time of the accident were as follows:

10:00 Wind direction: South, Wind velocity: 0.5 m/s, Weather: Cloudy

Temperature: 25 °C, Sunshine duration: 0.5 hours, Precipitation 0 mm

2.7.3 Meteorological Change using Footage Taken by Volcano Monitoring Cameras Set in the Surrounding Area of the Accident Site

In the surrounding area of the accident site, there are three volcano monitoring cameras at the locations shown in Figure 9 to monitor the vicinity of the crater of Mt. Shirane, and the comparison on the situations of cloud generation during the time from 09:00 until 10:00 was performed as shown in Figure 10.

The monitoring camera at Mt. Okuyamada (2,168 m) in the south of Shibutoge Pass, recorded that the area was covered by cloud around 09:30, the rest two cameras recorded that the area was gradually being covered by cloud from the west side, and the ridge lines in the vicinity of the crater of Mt. Sirane were covered by cloud around 10:00.

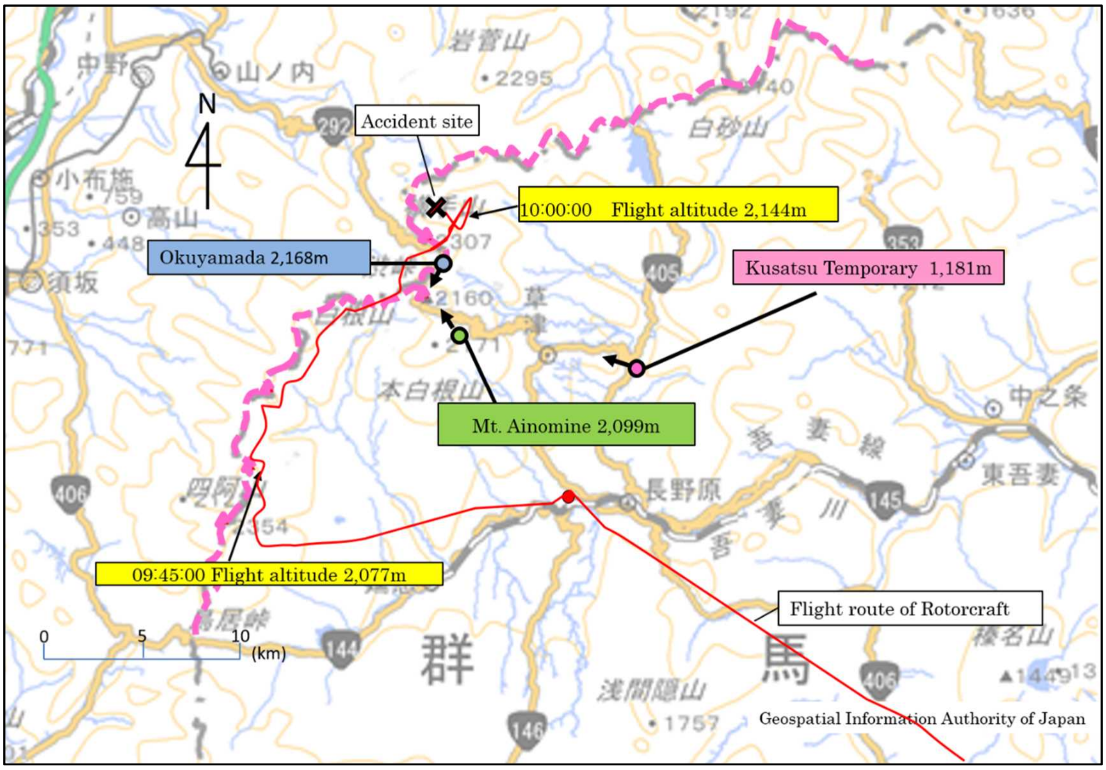


Figure 9: Volcano monitoring cameras location map

Figure 10: Meteorological situations by volcano monitoring cameras images

2.8 Communication Information

Since reporting the location after take-off from the Agatsuma Helipad, the Helicopter did not communicate with the Aviation Unit and the locational information of the Helicopter by the Dynamic Control System was disconnected at 10:01:01.

Emergency Locator Transmitter (ELT) was installed in the airframe structures of aft fuselage and was found together with the fractured airframe structures at about 20 m short of the wreckage of the main airframe at the accident site. Distress signal was transmitted from the ELT main body, however, rescuing aircraft and so on were unable to receive ELT signal because ELT had been disconnected from the antenna on the aircraft.

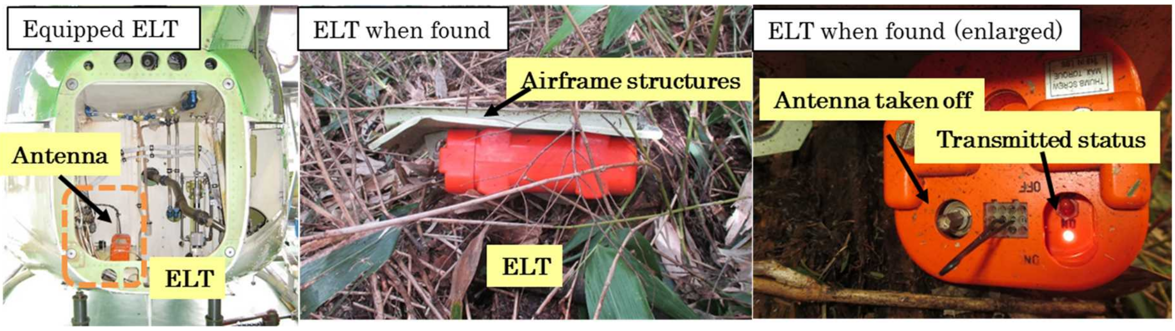


Figure 11: Position of installed ELT and the condition of ELT when found

2.9 Accident Site and Wreckage Information

2.9.1 Accident Site Situations

The accident site was the northern slope located 2 km northeast from the summit of Mt. Yokote and coniferous trees with a height over 10 m grew there. The wreckage was scattered in an area of about 40 m longitudinally and about 60 m laterally.

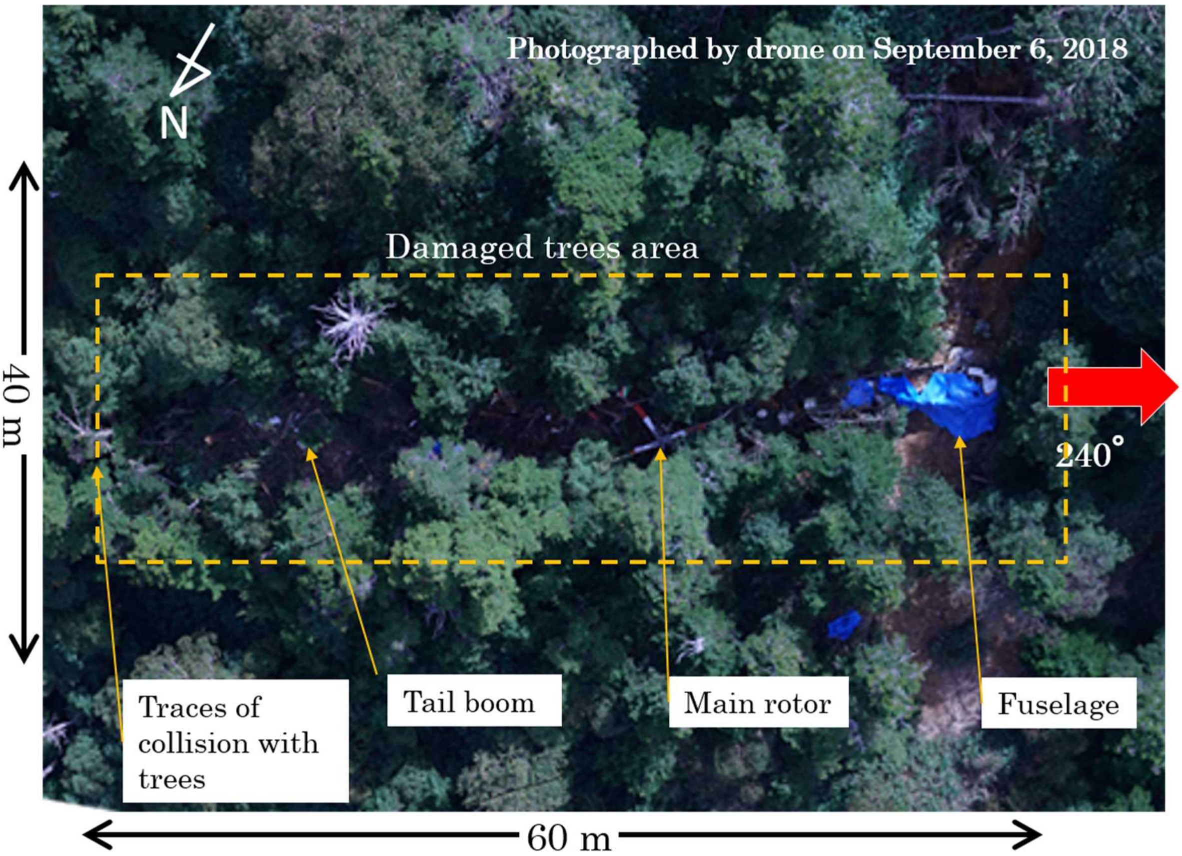


Figure 12: Scattered airframe at the accident site

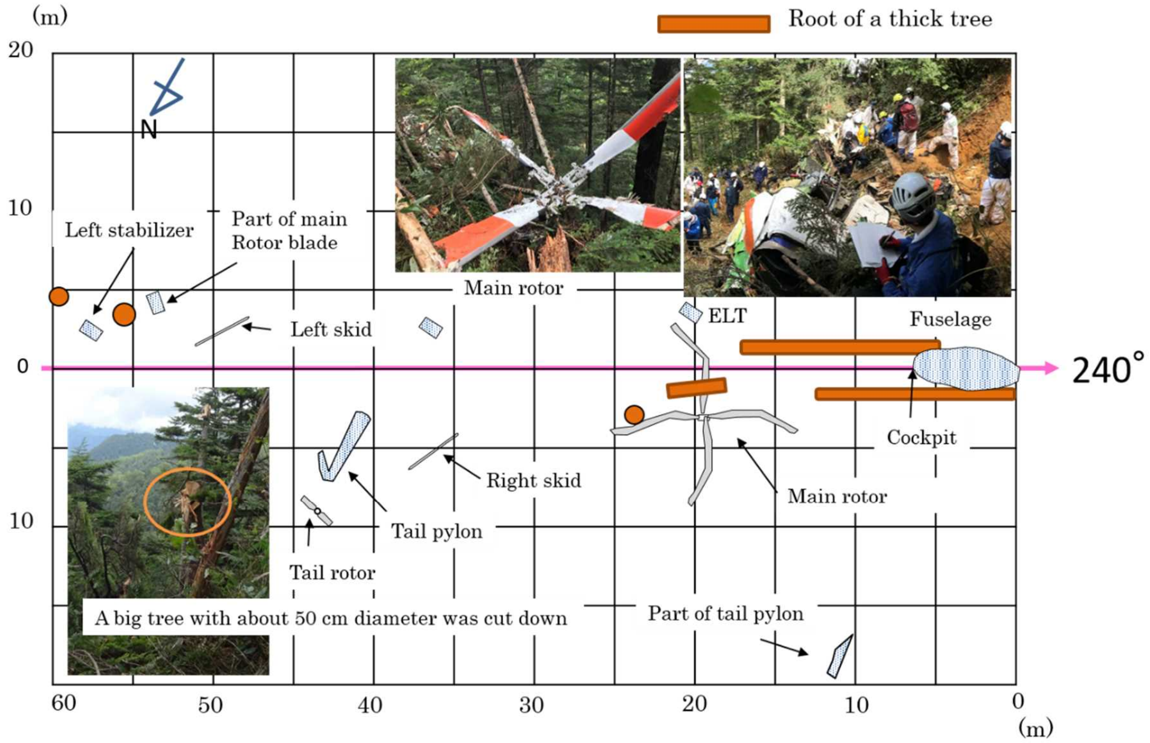


Figure 13: Accident site and wreckage distribution chart

2.9.2. Detailed Condition of Damage

(1) Entire Airframe

Main rotor, transmission, tail pylon and fuselage were separated and scattered. Fuselage from nose to cabin was severely deformed and destroyed in a vertical direction. Two engines remained in the upper fuselage in a deformed condition. Damage to the lower part of the forward fuselage was severe and the panels on the lower part were damaged and scattered.

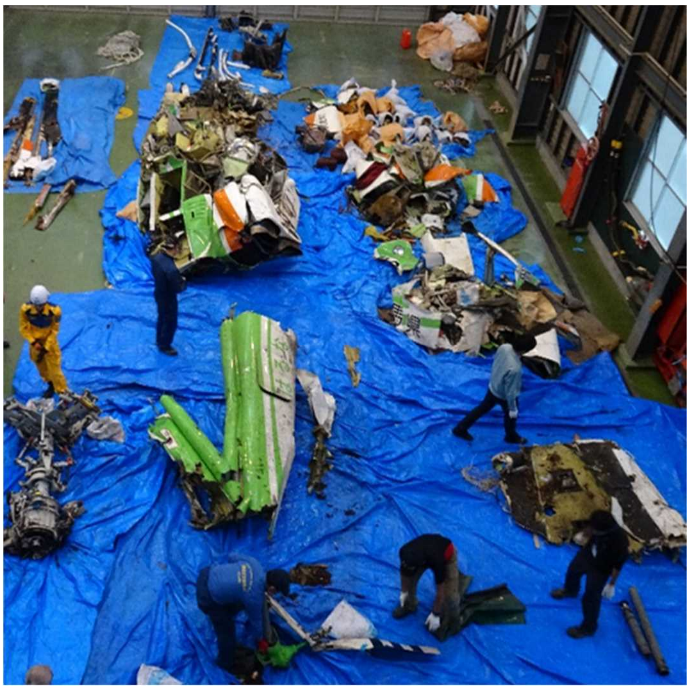


Figure 14: Reallocation of wreckage by detailed investigation

Figure 15: Damage from nose to aft fuselage

Figure 16: Nose

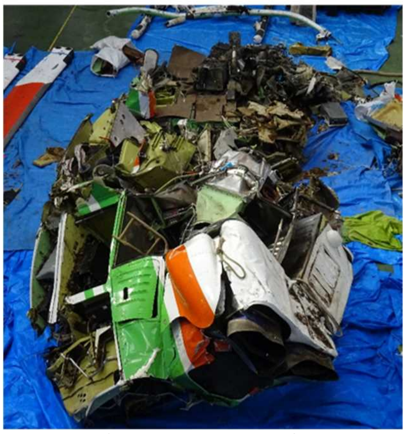


Figure 17: Fuselage

Figure 18: Tail boom

(2) Empennage

Tail boom was fractured and separated at the attached section connected by bolts and aft side was bent to the left with traces of collision with trees remained.

(3) Engines

Engines were deformed and damaged with drive shaft separated although the rotation section was not severely damaged, and traces of leaked fuel and oil from the engines were not recognized.

(4) Main Transmission and Rotor System

The main transmission and the main rotor head were separated from the airframe and dropped in connected condition 20 m short of the fuselage. The main transmission was deformed and did not show abnormality other than one caused by the crash. The hubs in blue and yellow colors of the main rotor head, to which

Figure 19: Main transmission

four color coded main rotor blades in red, green, blue and yellow were attached, were severely deformed.

The main rotor blades were fractured from near one third of the attached section of the blades to the tip of the blades. The tail rotor had its blades fractured, and was able to rotate by manual operations.

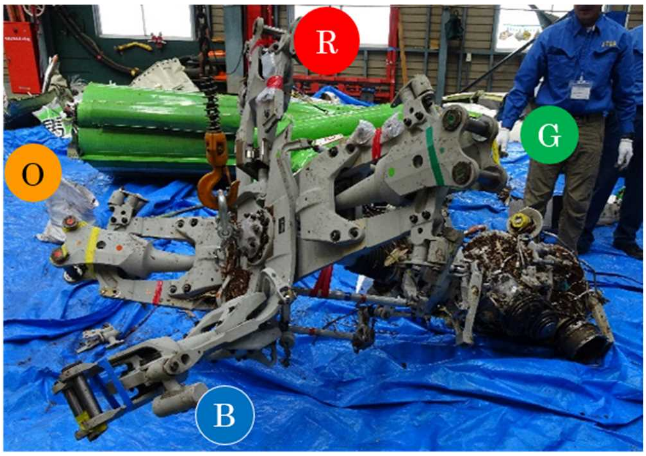


Figure 20: Main rotor head

Figure 21: Main rotor blades


Figure 22: Tail rotor

(5) Landing Gear System

The cross tube was severely deformed and the tip of the left skid was fractured as if it had been smashed. Some part of the fractured left skid could not be found.

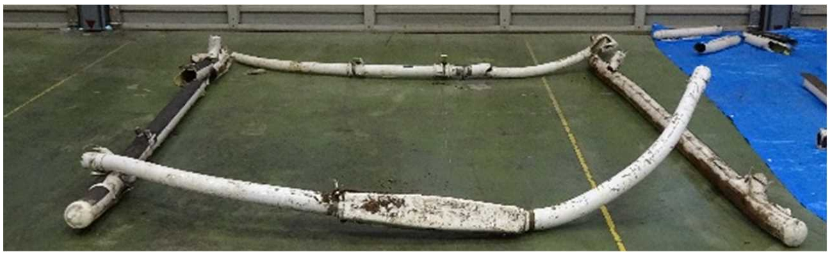


Figure 23: Cross tube


Figure 24: Tip of left skid

(6) Pilot Seat

Instrument panel in the pilot seat was destroyed in a smashed condition. The airspeed indicator in the left seat was found in the condition of being detached from the instrument panel and the needle moved between 101 kt and 123 kt when it was shaken.

The shoulder harness equipped in the right pilot seat was movable and the upper portion of the backrest was fractured. The left pilot seat was deformed and the backrest did not suffer a severe damage.

Figure 25: Airspeed indicator in the left seat

Figure 26: Right pilot's seat

2.10 Medical Information

According to the information from Gunma Prefectural Police, the cause of the death of all nine persons of the captain, the mechanic A in charge, the chief air rescuer, the air rescuer and five firefighters was traumatic shock.

2.11 Search and Rescue Information Related to Dead or Live Persons

2.11.1 History of the Search and Rescue Activities

According to Tokyo Rescue Coordination Center (Tokyo RCC) and Fire and Disaster Management Agency, the history of the search and rescue activities is as follows: (excerpt)

11:19 Tokyo RCC received the report of arrival at Gunma heliport from the operator.

12:11 Tokyo RCC, after receipt of another report that the previous report of arrival was incorrect, confirmed the monitored operator and judged it was "on the distress phase".

12:21 Tokyo RCC confirmed the operational status and issued "DETRESFA" (fuel run out).

12:24 Contact by telephone from Gunma Prefecture to Fire and Disaster Management Agency stating that the Helicopter went missing.

12:32 Tokyo RCC requested National Police Agency to search the Helicopter

12:45 Tokyo RCC requested Central Air Defense Force to dispatch units as part of disaster relief operation.

12:57 Fire and Disaster Management Agency requested wide-area aviation and fire aids (Tochigi Prefecture, Saitama Prefecture, Niigata Prefecture and Tokyo Metropolis).

13:20 Tokyo RCC deployed sending the search area map by e-mail to the parties concerned.

14:30 Rescue helicopter of Saitama Prefecture confirmed the airframe so appeared from the airspace.

15:21 Rescuers disembarked from the helicopter of Japan Self-Defense Forces confirmed a total of eight persons who were in need of help.

16:35 Rescuers disembarked from the helicopter of Japan Self-Defense Forces identified the Helicopter as one that went missing from the wreckage of the airframe.

13:05 on following day

Tokyo RCC confirmed the death of all nine persons on board and ended search and rescue activities.

2.11.2 Seating Positions and Seat Belts Fastening of Crew Members

Seating positions and seat belt fastening of the crew members were as shown in Figure 27. From video camera footage, the mechanic A in charge sitting in the left pilot seat did not fasten shoulder harness and crew members in the cabin were sitting on the floor and were in the situation that did not allow them to fasten seat belts.

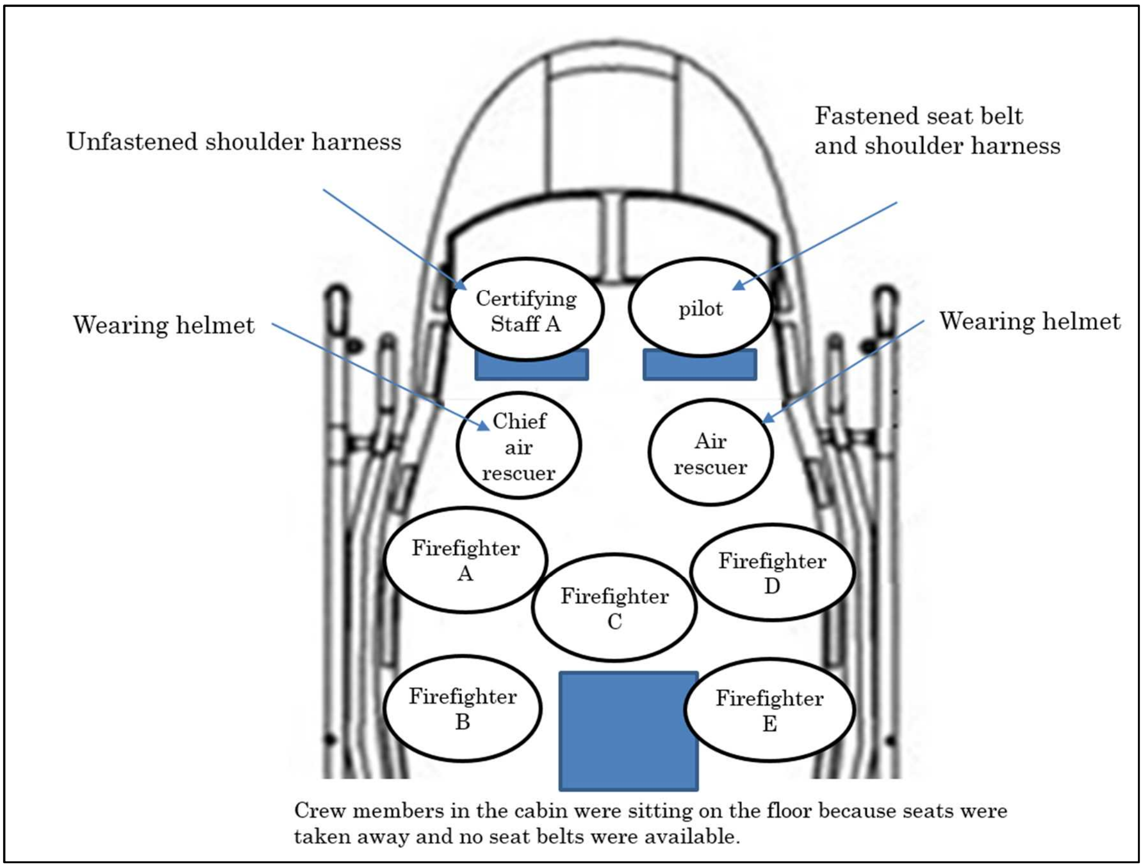


Figure 27: Seating Positions and Seat Belts Fastening of Crew Members

2.11.3 Condition of the Helicopter at the Time of the Accident

From the video footage, the condition of the Helicopter at the time of the crash was as follows:

ATT of the airframe was pitch angle +20 ° and roll angle 0 °, airspeed was decelerated to about 100 kt, descent rate was less than 100 ft/minute, and the Helicopter collided with trees from the left side of the aircraft and crashed.

2.11.4 Outbreak of Fire

There was no outbreak of fire although there occurred a fuel leakage.

2.12 Features of Autopilot System of the Same Type of the Aircraft and Caution Light of Operation System

The same type of the helicopter is equipped with autopilot system, which that mitigates work load of a pilot by selecting a mode suitable for type of flight. Flight manual of the same type of the helicopter (amended on November 4, 2015) and DFCC manual*[4] contain following descriptions.

(1) Autopilot Function

Dual digital autopilot flight control system (AFCS) is equipped to augment stability and control of aircraft and to mitigate work load of a pilot. AFCS consists of two independent autopilot systems, both of which have ATT control function of the airframe. Autopilot system is operated by ATT retention mode or SAS (stability augmentation) mode.

(i) Operation by ATT mode

ATT retention mode stabilizes short-term rate of yaw ATT and enables complete autopilot (hands-off flying) of pitch and roll ATT. Operation by ATT mode is for flight in IMC or for complete autopilot (hands-off flying) operation, if a pilot wishes so.

ATT mode is equipped with automatic trim function that retains the linear actuator near the central position so that the most suitable control authority can be obtained. Automatic turn coordination function selects flight director and actuates at 60 kt or more.

(ii) Operation by SAS mode

Stability augmentation system (SAS) offers short-term rate stability without sacrificing motion. Response of airframe to operation input is designed to limit ATT fluctuation rate so that pitch, roll and motion around yaw axis can be smooth and be harmonized. Whenever helicopter makes ground roll, hovering or take-off, or in the event that a pilot intends to maneuver aircraft by manual operation, SAS needs to be connected.

(iii) Operation by dual flight director

The Helicopter was equipped with dual flight director (three axes of pitch, roll and yaw). This system assists a pilot with operations of helicopter and navigational operations. Nine different kinds of flight director modes can be operated by linking with AFCS:

Maintaining of pressure altitude (ALT) when the mode is selected

Maintaining of indicated airspeed (IAS) when the mode is selected

Maintaining of climb or descent of vertical speed (VS) when the mode is selected

Turning to selected HSI heading (HDG) and its maintaining

Capture and tracking of selected VOR station (NAV)

---

*[4] "DFCC manual" denotes pilot manual of Integrated Flight Control System for the Bell 412 SPZ-7600 of Honeywell International, Inc.

Approaching selected VOR station (VOR APR)

Capture and tracking of ILS localizer and glideslope (ILS)

Capture and tracking of localizer back course (BC)

Commencement of go-around climb (GA)

Operations of flight director must be performed by mode selector in the instrument panel and control of complete auto flight route must be performed by ATT mode. When these modes are selected, modification of roll and pitch ATT is restricted to an angle speed of five degrees/second.

(2) Force Trim

Cyclic control that controls the lean of the airframe and anti-torque control that controls the direction of the airframe include the FT system, which provides artificial reaction force of operation when the pilot system is manually operated from its standard position, and are associated with AFCS motion. In the event that the FT is activated while SAS mode is in use, the trim actuator sets the position of the pilot system at this time as a standard position, and operating from the standard position generates artificial steering resistance.

Use of the FT while operating by SAS mode is optional, and the FT needs to be activated while operating by ATT mode.

(3) Caution Light of Operation System

Operating conditions of the caution light of operating system that was illuminated before the crash are as follows:

(i) Force trim off (FT OFF)

This illuminates when the FT is not activated.

(ii) Cyclic center light

This light illuminates when an excessive input of operation beyond the normal operating limit has been entered when operating on the ground. This light normally does not illuminate; however, it illuminates by being judged on the ground in the event that rotor rotation speed is under condition of illuminating RPM light.

(iii) RPM light

This light illuminates when rotation speed of the rotor is either not more than 95% or not less than 103.5%.

2.13 Devices or Equipment to Obtain Locational Information Used in the Helicopter

2.13.1 DMS-80 Map Display Device

Map display device was equipped in the left side of the center console of the pilot seat of the Helicopter (see Figure 28). The device consists of map image generator, display controller, memory card, GPS antenna, the first officer encode altimeter and wiring, and it displays latitude, longitude, altitude, heading and the direction and distance to any point desired on the display panel utilizing GPS signal. Furthermore, map image generator is a device that displays a map on the display panel and can overlap the location of the aircraft on the panel in real time. Besides, the Helicopter flight manual limitation section stipulates that it must not be used as a navigation device and a ground anti-collision device due to lack of necessary accuracy of navigation.

2.13.2 Portable GPS Receiver

The captain brought his private portable GPS receiver on board and clipped it on the top of the central instrument panel for use as a reference of the flight route (see Figure 28). The portable GPS receiver recorded GPS data from the time of the take-off from Gunma heliport until 10:00:56, 16 seconds before the estimated time of the crash as well as the scheduled turning points (waypoints) that is believed to have been input before the take-off.

There were nine waypoints on the Trails that had been input into the GPS receiver; Torii Pass, Mt. Azumaya, Mt. Shirane, Shibutouge Pass, Mt. Yokote, Mt. Hachiyama, Mt. Daikouyama, Mt. Shirasuna and Mt. Inezutsumi.

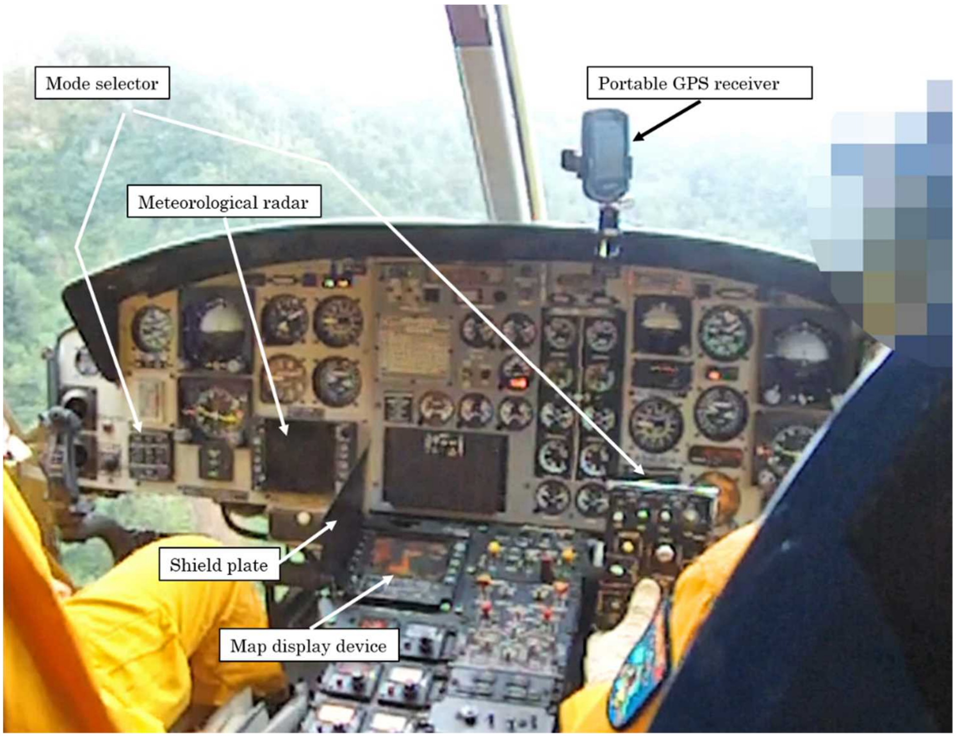


Figure 28: Meteorological radar and locational information-related equipment

2.13.3 The Dynamic Control System of Fire and Disaster Prevention Helicopter

(1) Outline

The Dynamic Control System of fire and disaster prevention helicopter is a system that PC and other terminal on the ground can grasp in real time locational information (dynamic) of a helicopter transmitted by onboard device loaded in the helicopter, and at the same time, textual messages and disaster point information can mutually be transmitted by and shared between the onboard device and the ground terminal. In the event of a massive disaster, operational status of many helicopters that gather in the disaster area can be grasped simultaneously on the ground. Interval between transmitting and receiving information can be set at any duration desired between 20 seconds and 180 seconds. There are two kinds of onboard devices of the Dynamic Control System; one can confirm locational information in the pilot seat, and the other one is a main unit and a tablet device that monitors data and operates inputs and outputs, both of which are brought into the cabin for use.

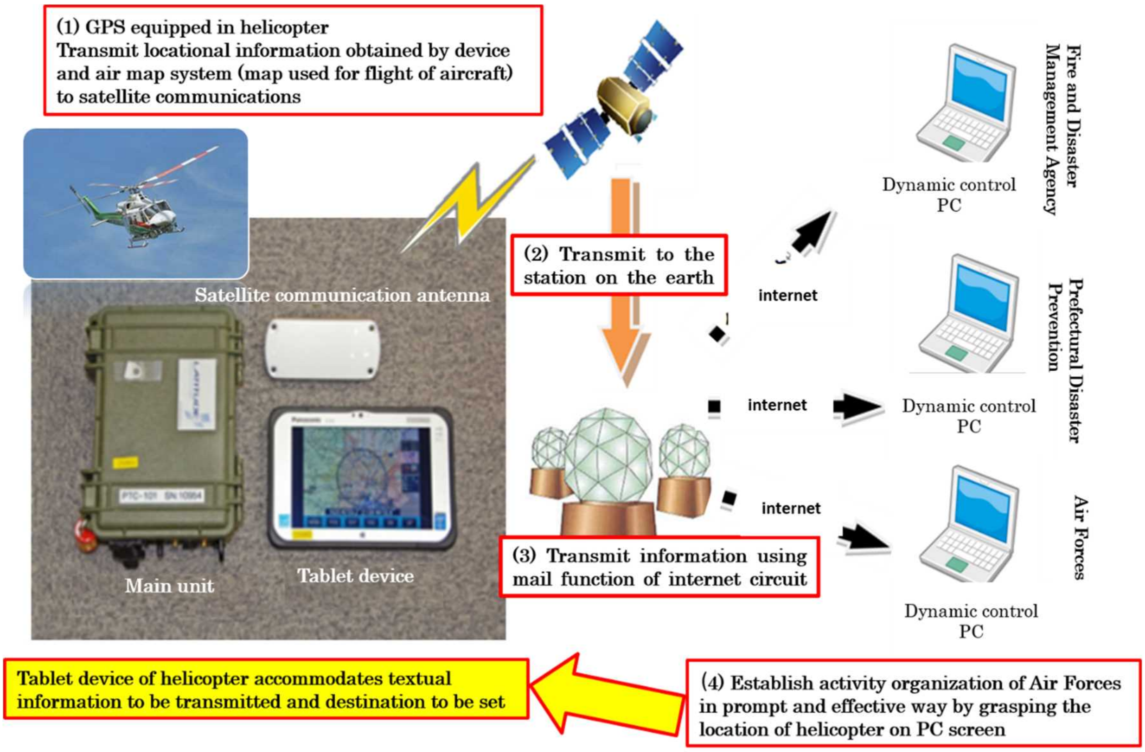


Figure 29: Outline of the Dynamic Control System of helicopter

(2) Flight Track Chart of the Helicopter

The onboard device brought in the Helicopter set the interval of 20 seconds for transmitting to and receiving from the terminal on the ground. The onboard tablet device restored GPS data of every second up until 10:01:01. Besides, a memory of the main unit retained GPS data that was before transmitted to the ground, i.e. GPS data of every second from 10:01:01 until the time of the crash of 10:01:12. Furthermore, the tablet device stored the flight track of the Helicopter from May 2018 until the occurrence of the accident as shown in Figure 30. The flight track included every flight route the captain flew since he had joined the Aviation Unit until the occurrence of the accident; however, the flight track of the Helicopter flying over the vicinity of the accident site during the period was not in the record.

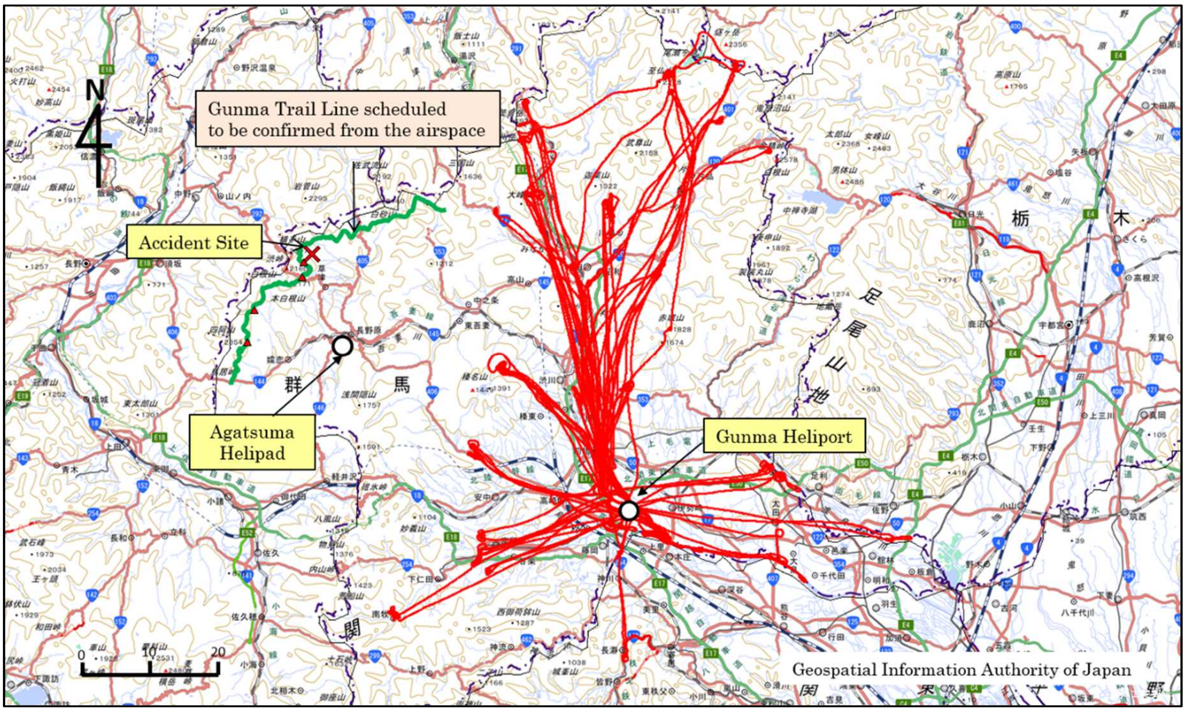


Figure 30: Flight route of the Helicopter in May through August 2018

2.13.4 Meteorological Radar

The meteorological radar was equipped in the left pilot seat of the Helicopter, however, it was not used because the power was not on.

2.14 Examination and Research Information

2.14.1 Investigation of Error Code of Digital Flight Control Computer

Two units of Digital Flight Control Computer (DFCC) equipped in the Helicopter were examined at the facility of the manufacturer by the presence of the National Transport Safety Board (NTSB) with following result.

(Examination result)

Examination of the two units of DFCC detected error code related to YAW SERVO from one unit and the error code is considered to have existed in several flights before the accident.

Based on the result described above, a mechanic B in charge was asked whether malfunction displaying "YAW SERIES SERVO FAIL" had ever been recorded. A mechanic B responded that there had been no related record reported from pilots, and the message had sometimes been displayed when warming up had not been enough in test run, however that had disappeared in the ground test performed again after warming up.

2.14.2 Confirmation of Recovery Operations from Abnormal Attitude Using Flight Training Devices

Simulations of recovery operations from abnormal ATT by each mode of AP and manual operations using flight training devices were performed with the results described in Table 2.

Table 2: Simulations of restoring movements by flight training devices

Initial condition	
Air speed: 90 kt Pressure altitude: about 3,000 ft Airframe ATT: roll angle 45 degrees to the left, pitch angle – 20 degrees Descent rate: 3,000 ft/minute	
Restoring procedures	Time and altitude required for restoration and observations
<Use of ALT and HDG modes> Force Trim: on ATT mode: engaged Flight director ALT & HDG: on	Time required and altitude lost from FT on to complete restoration*5 were 22 – 30 seconds and 900 – 1,000 ft, respectively. Time required for the restoration was significantly affected by heading bug setting position and vertical speed. Besides, the restoration from 2,000 ft/minute needed about 10 seconds.
<Use of go-around (GA) mode> Force Trim: on ATT mode: engaged Flight director GA mode: on	Time required and altitude lost from FT on to complete restoration were 15 – 22 seconds and about 1,000 ft, respectively. GA mode suffers restriction on the angle speed of pitch and roll; however, the restoration could be achieved most effectively by horizontal roll ATT and climbing at 750 ft/minute.
<Restoration by manual operations> Operations for abnormal ATT Operating cyclic stick in the right roll direction and aft pitch	Time required for restoration: approximately eight seconds Altitude lost until restoration: about 300 ft The restoration was performed most quickly; however, this bases on that pilots are familiar with operation procedures and situational awareness of the attitude and power setting of the helicopter at the time flight control corrections are made to restore normal flight conditions.

*5 Complete restoartion denotes the time when roll attitude becomes horizontal and climbing apparently commences.

2.15 Organization and Management Information

2.15.1 Operation Control System and Safety Management System of the Aviation Unit

The aviation fire and disaster management unit in Prefectures is stipulated in Article 30 of Fire and Disaster Management Organization Act as follows:

Fire and Disaster Management Organization Act (Aviation fire and disaster management unit in Prefectures)

Article 30 Other than what is stipulated in the preceding Article, Prefectures, in response to the request from Mayor of city, town or village of the region, may assist the fire and disaster management unit's activities using aircraft.

(ii) Governor of Prefectures and Mayor of city, town or village may conclude an agreement with regard to the assistance of the regional fire and disaster management unit's activities based on the stipulation in the preceding paragraph.

(iii) In order to fulfill assistance for the fire and disaster management unit's activities based on the stipulation in the first paragraph, Governor of Prefectures shall establish the aviation fire and disaster management unit in accordance with rules of the Prefecture.

In order to fulfill duties of the aviation fire and disaster management unit, Gunma Prefecture established "Operation Control Guideline for Gunma Prefectural Disaster Prevention Helicopter" and "Safety Procedures for Gunma Prefectural Disaster Prevention Aviation Unit" for the purpose of safe and effective operations of disaster prevention helicopter, assigned responsible persons for Operational Control and Safety Control and allocated Operational Control Administrator holding additional post of Safety Control Administrator in the Prefectural Government and Deputy Operational Control Administrator holding additional post of Safety Controller in Disaster Prevention Aviation Unit Base as in Figure 31.

Gunma Prefecture and Toho Air Service Co., Ltd. concluded the service agreement for operation control services of disaster prevention helicopter owned by Gunma Prefecture, and the company was conducting operation control services following instructions from Prefectural staff in accordance with Operation Control Guideline for Gunma Prefectural Disaster Prevention Helicopter.

The operation control services included in the service agreement are mainly; principally operations of disaster prevention helicopter, inspection for airworthiness certificate, submission of flight plan, education and training for pilots and mechanics and application for permission based on Civil Aeronautics Act and Regulation. In order to maintain the operation system, the company designated two pilots (requirement: total flight time of helicopter is 2,000 hours or more, flight time of twin engine helicopter is 200 hours or more, holding type rating for Bell 412 and passing audit for specific pilot competence), three mechanics and one operation controller.

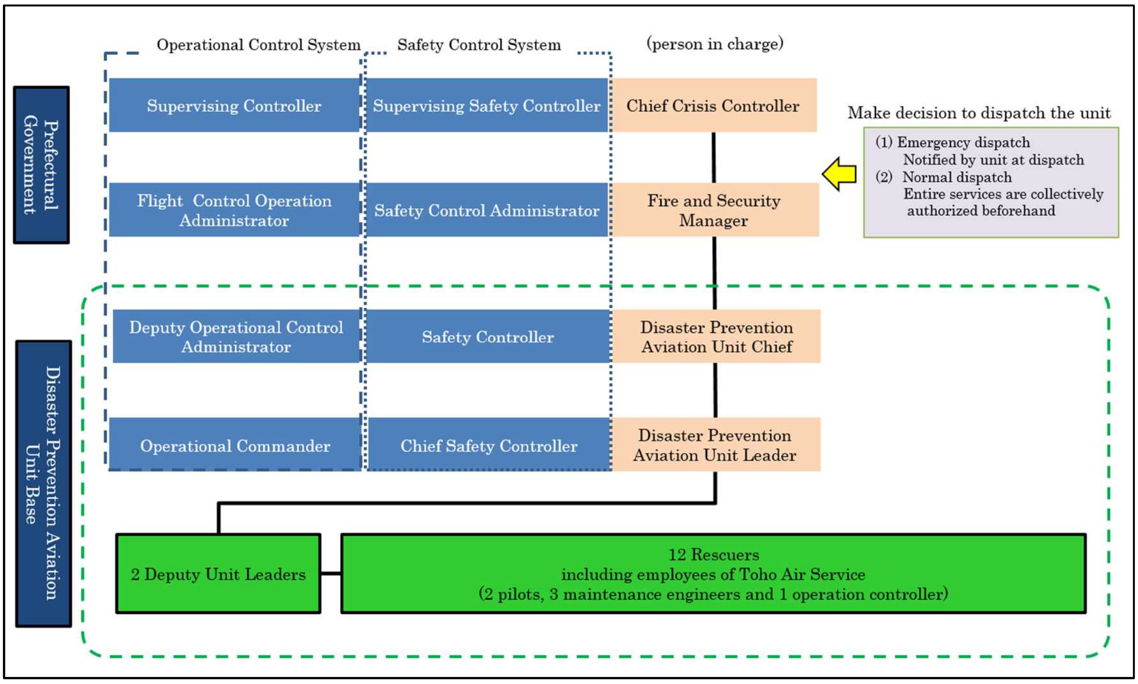


Figure 31: Organization and operational control and safety control system

2.15.2 Organizing and Operational Command of the Aviation Unit

Operation Control Guideline for Gunma Prefectural Disaster Prevention Helicopter stipulates following:

Article 12 Assignment of Operational Commander

Unit Leader is assigned as Operational Commander. However, in the event that Unit Leader is not on board disaster prevention helicopter, Deputy Unit Leader takes over the missions.

Article 13 Duties of Operational Commander

Operational Commander, while on board disaster prevention helicopter, shall strive to direct and supervise rescuers to fulfill the purpose of the flight in an appropriate manner except for the duties that the pilot in command shall undertake by the provision of Article 73 *of the Act.*

With regard to the flight of the Helicopter, Unit Leader was on board as Operational Commander and directed and supervised air rescuers to fulfill the purpose of the flight. "*the duties that the pilot in command shall undertake by the provisions of Article 73 of the Act*" stipulated in Article 13 of the Guideline described above stands for "*Authority of Pilot in Command*" in Article 73 of Civil Aeronautics Act and the actions based on the duties.

2.15.3 Education and Training in the Aviation Unit

In the Aviation Unit, newly assigned air rescuers received ground school training and practical training for about one month when they had been assigned. Ground school training was performed on general items (outline of training, organizing, operation system and laws relating to fire and disaster management), flight operation (aeronautical engineering, aeronautical laws and aeronautical weather), maintenance (aeronautical laws relating to maintenance and aeronautical maintenance) and operation (safety management, disaster rescuing activities and aeronautical communications), and the practical training was divided into basic training and taxiing and flight training, and training for technique required for rescue activities was performed. Rescue training was periodically performed, however, education equivalent to human factors education and CRM*6 training was not performed.

2.15.4 Decision of Dispatch and Operation Control Situations In-Flight

(1) Decision of dispatch was made by person in charge for operational control, a captain, an chief air rescuer after they had confirmed meteorological conditions. The confirmation included suitability to meteorological conditions required for take-off from the base (prevailing visibility of 1,500 m or more and wind velocity of 17 m/second or less) and weather conditions in the vicinity of the destination by means of meteorological support services and live cameras.

(2) Regular position reporting at a certain fixed time in-flight was not required by rules or regulations and was implemented as needed. Particularly, in the event of mission flights, information on rescue activities was used as position reporting. Besides, there were no concrete procedures for utilization of the Dynamic Control System to monitor dynamics of helicopter in-

---

*6 "CRM" is dictated as "utilization of all available human resources, hardware and information in an effective manner in order to achieve safe and efficient flight operations " in AIM-JAPAN.

flight, and person in charge for operational control confirmed the dynamics as appropriately by the terminal on the ground for the Dynamic Control System allocated on the corner of the office.

2.15.5 Operation Control of the Aviation Unit

(1) Reporting of Flight Plan Inconsistent with Actual Flight Route

The Helicopter landed at Agatsma Helipad as shown in Figure 32, which was not in the flight plan reported in advance to Civil Aviation Bureau pursuant to Article 97-2 of Civil Aeronautics Act, and took off again there after loading the firefighters on board. In the Aviation Unit, it was prevailingly conducted to file the flight plan omitting stop over and take-off heliports from the flight route based on the incorrect recognition of “no need to report unless the engine was shut down” in heliports other than Gunma heliport, and according to the report of the investigation implemented by Gunma Prefecture after the accident, landing at and take-off from heliports other than Gunma heliport in fiscal 2017 and 2018 aggregated 386 cases, among which and flight plans were improperly processed in 293 cases.

Article 97 of Civil Aeronautics Act (Flight Plan and Approval Thereof)

(1) An aircraft shall, when departing from an aerodrome pertaining to an air traffic control zone or an air traffic information zone, or flying in an air traffic control area, an air traffic control zone, or an air traffic information zone, under instrument flight rules, report its flight plan to the Minister of Land, Infrastructure, Transport and Tourism, pursuant to the provision of Ordinances of the Ministry of Land, Infrastructure, Transport and Tourism, and obtain his/her approval. The same shall apply to any intended changes to the approved flight plan.

(2) Any aircraft shall, before engaging in a flight (except such cases as may be specified by Ordinances of the Ministry of Land, Infrastructure, Transport and Tourism), except the case under the preceding paragraph, file its flight plan to the Minister of Land, Infrastructure, Transport and Tourism pursuant to the provision of Ordinances of the Ministry of Land, Infrastructure, Transport and Tourism; provided, however, that an aircraft may, when it is difficult to file a flight plan in advance as may be specified by Ordinances of the Ministry of Land, Infrastructure, Transport and Tourism, file the flight plan to the Minister of Land, Infrastructure, Transport and Tourism even after starting flight, pursuant to the provision of Ordinances of the Ministry of Land, Infrastructure, Transport and Tourism.

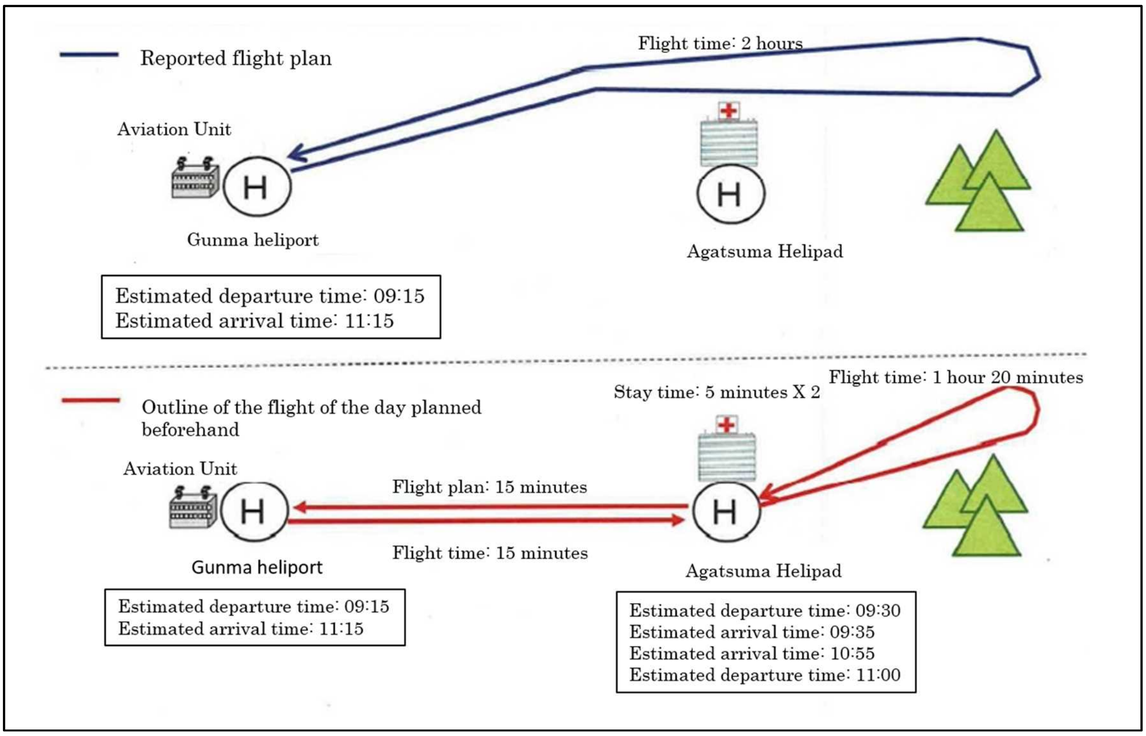


Figure 32: Flight plan submitted by the Aviation Unit and the actual flight plan

(2) Report of Arrival when Flight Has Not Been Completed

Pilot A of the Aviation Unit reported the arrival to Civil Aviation Bureau pursuant to Article 98 of Civil Aeronautics Act at the time he had not been informed of the completion of the flight described in the flight plan from the captain of the Helicopter.

The pilot A of the Aviation Unit stated the reason why he reported the arrival as follows:

(i) In the situation, where the estimated arrival time had passed and each rescuer was attempting to call the Helicopter with fire department radio and to reach crew members by phone, he presumed that it was simply taking longer for arrangements at the site for some reason because a sufficient amount of the fuel was left and there was no report from Tokyo Airport Office implying distress of the Helicopter.

(ii) He informed of arrival report as he thought that it would confuse many parties concerned if he leaves it uniformed despite the Helicopter not being in distress, considering that Tokyo Rescue Coordination Center would start search activities if there is no report of arrival after 30 minutes from the estimated arrival time.

(3) Unloaded Documents to be Carried in Helicopter

The Helicopter did not carry Flight logbook that is obligated to be carried in aircraft pursuant to Article 59 of Civil Aeronautics Act. Besides, the captain did not carry a competence certificate and an aviation medical certificate that are obligated to be carried pursuant to Article 67 of Civil Aeronautics Act.

2.16 Additional Information

2.16.1 Flight in Visual Flight Rules

(1) Visual Meteorological Conditions

Article 5 of Ordinance for Reinforcement of the Civil Aeronautics Act stipulates with regard to "Visual Meteorological Conditions" as follows: (excerpt)

(ii) Aircraft that flies at an altitude less than 3,000 m

Each listed weather condition according to the classification of aircraft listed in the following items

(a) Aircraft that flies in air traffic control area, air traffic control zone or air traffic information zone: Weather conditions that meet requirements;

1. that flight visibility is over 5,000 meters

2. that no cloud is within the vertical distance of 150 meters above and 300 meters below the aircraft

3. that no cloud is within the horizontal distance of 600 meters from the aircraft.

(b) aircraft flies in the airspace other than control area, control zone and information zone: Weather conditions that meet requirements;

1. that flight visibility is over 1,500 meters.

2. that no cloud is within the vertical distance of 150 meters above and 300 meters below the aircraft.

3. that no cloud is within the horizontal distance of 600 meters from the aircraft.

(iii) Aircraft that flies at an altitude less than 300 meters from the ground surface or the water surface in the airspace other than the control area, the control zone and the information zone (excluding aircraft listed in the following item): Weather conditions that meet requirements; (Regarding helicopter that flies at the speed of which collision with other object is avoidable, excludes the item listed in (a))

(a) that flight visibility is over 1,500 meters.

(b) that aircraft may fly away from clouds and that the pilot may visibly recognize the ground surface or the water surface.

Aircraft flew the airspace other than control area, control zone and information zone at an altitude of less than 3,000 ft as seen in Figure 4. In this airspace, (ii) (b) is applied at an altitude over 300 m from the ground surface, and (iii) (b) is applied at an altitude of 300 m or less from the ground surface.

(2) IMC and Flight under IMC

Article 2 (14) of Civil Aeronautics Act stipulates with regard to "instrument meteorological condition" as follows:

The term "instrument meteorological condition" as used in this Act means bad weather conditions with a range of vision, specified by Ordinances of the Ministry of Land, Infrastructure, Transport and Tourism, taking the visibility and cloud conditions into consideration.

Article 94 of Civil Aeronautics Act stipulates with regard to "Flights under Instrument Meteorological Conditions" as follows:

Article 94 Any aircraft under instrument meteorological conditions shall be navigated in accordance with instrument flight rules within an air traffic control area, air traffic control zone or air traffic information zone, and shall not fly in any other airspace; provided, however, that the same shall not apply when there is an unforeseeable rapid deterioration in weather conditions or other compelling reasons, or when permitted by the Minister of Land, Infrastructure, Transport and Tourism.

(3) Ensuring Safety of Flight in VFR

Ensuring safety of flight in VFR (Kokukuko No. 1045 dated March 7, 2014)

When evaluating meteorological conditions for flight in VFR, the decision on the flight shall be made taking following into consideration:

1. To collect latest meteorological information, analyze meteorological conditions in flight route and in destination area at the estimated arrival time as well as the current meteorological conditions both in departure area and destination area, predict meteorological conditions where aircraft will be flying and allow the aircraft to depart only if VMC are judged to be feasible to maintain at any time in the flight and safety of flight is judged to be ensured. Besides, in the event that information on meteorological conditions in the flight route and destination area is not obtainable, analysis shall be made in an appropriate manner, for instance, by utilizing meteorological information provided by local meteorological observatory

located in the flight route and near destination airport.

2. In the event that change in meteorological conditions is predictable, to consider an alternative plan, prior to departure, for the case to encounter meteorological conditions that it is difficult to maintain, and to strive to continuously collect meteorological information even in the flight and to recognize changing meteorological conditions.

3. In the event that a sign of unpredictable deterioration of meteorological conditions is observed, not to lose a chance to make a decision to continue flight or not, followed by returning or landing at an appropriate aerodrome located in the flight route.

(4) Circulars in Relation to Accidents Involved by VFR Operations

Circulars issued by Civil Aviation Bureau of the MLIT after accidents involved by VFR operations are as shown in Table 3.

Table 3: Circular issued after accidents involving flight operations in VFR

No.	Document No. (date of issue)	Title	Relevant Accidents	Addressed to
1	Kokukuko No. 86 (April 3, 2002)	Ensuring safety of flight operations in VFR	Crash of privately owned Piper PA-28-181 on March 25, 2001	All Japan Air Transport and Service Association, and Japan Aircraft Pilot Association
2	Kokukuko No. 931 (November 29, 2002)	Night time flight in VFR	Crash of privately owned Cessna 172P on January 4, 2002	All Japan Air Transport and Service Association
3	Kokukuko No. 857 (November 30, 2007)	Ensuring safety of flight operations for transport of personnel by helicopter	Crash of Fuji Bell 204 B2 owned by Akagi Helicopter Co., Ltd. on April 9, 2007	All Japan Air Transport and Service Association
4	Kokukuko No. 616 (September 30, 2010)	Ensuring safety of flight operations of Helicopter	Crash of privately owned Robinson R44 II F on July 21, 2009	All Japan Air Transport and Service Association, and Japan Aircraft Pilot Association
5	Kokukuko No. 516 and Kokukuki No. 280 (June 30, 2011)	Implementation Standard for flight operations using GPS for VFR (amendment)	———	Circular effective on July 1, 2011
6	Kokukuko No. 359 (August 2, 2012)	Ensuring safety of flight operations in VFR	Crash of Cessna TU206G operated by Nakanihon Air Service Co., Ltd. on July 28, 2010	All Japan Air Transport and Service Association, and Japan Aircraft Pilot Association
7	Kokukuko No. 738 (December 2, 2013)	Thorough accident prevention of flight operations in VFR	Crash of privately owned Piper PA-46-350P on January 3,	All Japan Air Transport and Service Association, Japan Aircraft Pilot

No.	Document No. (date of issue)	Title	Relevant Accidents	Addressed to
		(including pamphlet)	2011	Association, and each judge of pilot competence assessment
8	Kokukuko No. 1045 (March 7, 2014)	Ensuring safety of flight operations in VFR	Crash of privately owned Cessna 172M on March 5, 2014	All Japan Air Transport and Service Association and Japan Aircraft Pilot Association
9	Kokukuko No. 837 (August 3, 2018)	Ensuring safety of flight operations of small aircraft	Crash of Cessna 172P operated by New Central Airservice Co., Ltd. on June 3, 2017	Relevant authority and body including Japan Aircraft Pilot Association and All Japan Air Transport and Service Association
10	Kokukuko No. 2141, Kokukuki No. 837 and Kokukuyo No. 474 (October 24, 2018)	Ensuring safety of flight operations of small aircraft (including leaflets)	Crash of Cessna 172P operated by New Central Airservice Co., Ltd. on June 3, 2017	Relevant authority and organization including Japan Aircraft Pilot Association and All Japan Air Transport and Service Association, and each judge of pilot competence assessment

2.16.2 Use of GPS

In case of using GPS in VFR flight, following must be noted:

(1) Implementation Standard for Use of GPS in VFR Flight

Implementation standard for use of GPS in VFR flight (Kuko No. 878 and Kuki No. 1279 established on December 5, 1995 and Kokukuko No. 516 and Kokuki No. 280 amended on June 30, 2011)

4-1-2 Those who intend to newly install a satellite aviation device that is not approved by technical standards or does not obtain approval described in Chapter 2 and to use such a device in VFR flight shall confirm that the device conforms to the technical standards and the airworthiness requirements in Chapter 3, and shall define necessary information related to the device in flight manual.

(2) Auxiliary Use of GPS in VFR Flight

Ensuring safety of flight operations in VFR (Kokukuko No. 86 dated April 30, 2002) (excerpt)

2 In the event of using GPS in an auxiliary way in VFR flight, "Implementation standard for use of GPS in VFR flight (Kuko No. 878 and Kuki No. 1279 dated December 5, 1997)" shall be complied with as well as following shall be noted.

(1) When using GPS device and other map image on board as a means of navigation in a supplementary way, limitations section in flight manual shall be complied with, and conditions for use and functions including performance and accuracy of the map image shall be thoroughly realized before use.

(2) In the event that meteorological conditions that are difficult to maintain VMC are predicted, do not judge to commence or to continue flight relying on the GPS device or on condition of using it.

(3) Civil Aviation Bureau of Ministry of Land, Infrastructure, Transport and Tourism provides information regarding the use of GPS as safety information of small aircraft at;

http://www.mlit.go.jp/koku/15_bf_000162.html#03

3. Implementation of operations adhering to the fundamentals

In the event of using GPS device in VFR flight, do not rely on the device or do not use it to commence or continue flight on condition of using it. In the event of using GPS device in a supplementary way, comply with relevant rules and use it after thoroughly realizing its functions.

2.16.3 Minimum Safe Altitude

(1) Article 81 of Civil Aeronautics Act stipulates as the minimum safe altitude of aircraft as follows:

Article 81 No aircraft shall be flown, except during taking off or landing, at an altitude lower than that specified by Ordinances of the Ministry of Land, Infrastructure, Transport and Tourism, taking into consideration the safety of persons or objects on land or water as well as the safety of aircraft; provided, however, that the same shall not apply when permitted by the Minister of Land, Infrastructure, Transport and Tourism.

(Special Exceptions for Search or Rescue)

Article 81-2 The provisions of the preceding three articles*[7] shall not apply to flights

*[7] The provisions of the preceding three articles refer to the provisions relating to place of take-off and landing, flight prohibited area and the minimum safety altitude.

conducted by aircraft specified by Ordinances of the Ministry of Land, Infrastructure, Transport and Tourism for search and rescue operations in case of aircraft accidents, maritime disasters, and other accidents.

(2) Article 174 of Ordinance for Enforcement of the Civil Aeronautics Act stipulates with regard to the minimum safety altitude in VFR flight as follows: (excerpt)

(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) In the case of a space over a densely populated area with human beings or houses, an altitude higher by 300 meters than the top edge of the highest object located within an area with a horizontal distance of 600 meters with the aircraft at its center.

(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 on water.

(c) In the case of a space over an area other than that prescribed under (a) and (b), an altitude of 150 meters from the ground or water surface. (the remainder omitted)

2.16.4 Spatial Disorientation

(1) Knowledge on Spatial Disorientation

With regard to a perceptional error that is prone to be fell into when visibility is low, “Aviation Medicine and Safety” (co-written by Kenichi Azuma and Masaoki Tsuchiya published by Houbun Shorin in 1997 pp. 41 – 55) contains following descriptions as spatial disorientation:

Spatial disorientation does not mean a physiological abnormal condition of spatial orientation but a confused condition of spatial orientation of those who own normal sensory functions. Concretely, as in the case of losing a correct cognition of motion of aircraft against the earth similar to an illusion caused by acceleration speed, spatial disorientation includes illusions by visual sense, by somatic sense and by equilibrium sense.

(i) Structure of ear

Ear has functions to perceive rotational motion and linear motion as described below.

a. Structure and roles of the semicircular canal

The semicircular canal consists of three round canals of horizontal, vertical and rearward and the inside of the canals is filled with the lymphatic fluid. The lymphatic fluid moves by the inertia against motion of the head, which is perceived by hair cell in ampulla of the base of the semicircular canal, and then, is recognized as a rotational sense. When the rotation starts, the lymphatic fluid inside the semicircular canal moves and the rotational sense generates. When the rotation speed has reached a certain level, the rotational sense is lost, and furthermore, when the rotation has stopped, the lymphatic fluid flows in the reverse direction, which generates the illusion of rotational sense in the reverse direction.

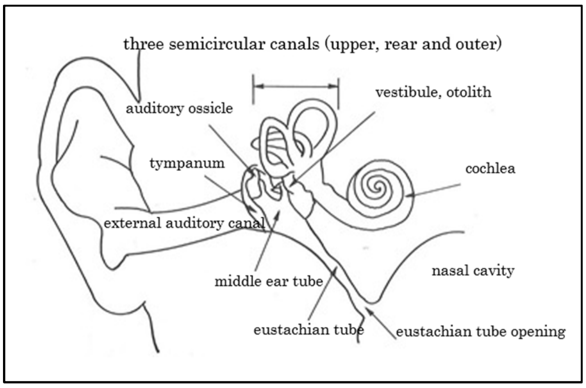


Figure 33: Structure of ear

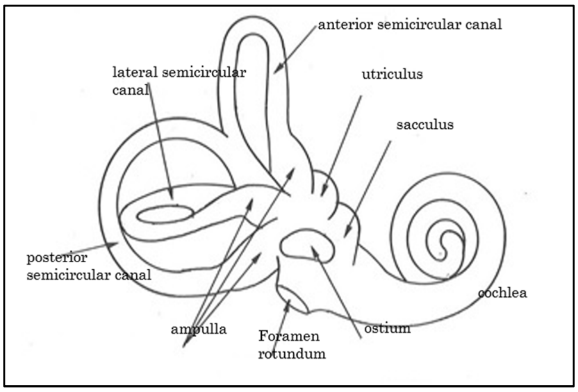


Figure 34: Structure of auris interna

b. Structure and roles of otolith

The surface of otolith is made of calcium carbonate particles, and motion of the particles is propagated to the brain by stimulating the nerve cell, which perceives leaning of the body and acceleration speed in the linear direction.

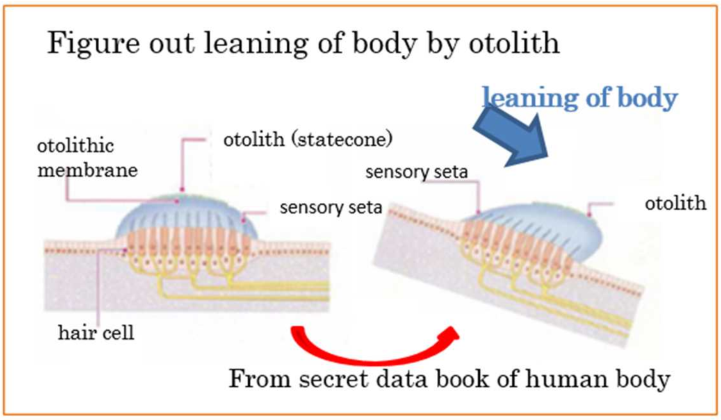


Figure 35: Effect of otolith

(ii) Various illusions

There are three kinds of senses that confuse spatial orientation as described below, and insufficient amount of information of each sense or discrepancy in cognition of information causes confusions in judgment of spatial orientation.

a. Illusion by visual sense

Visual sense is the most important sense in forming spatial orientation, and position and ATT can be correctly judged as far as the visual sense is correct, even if somatic sense or equilibrium sense other than visual sense has been hindered.

There are two senses in the visual sense; central vision with keen function and peripheral vision with vague function, and illusion occurs when each sense is insufficient or erroneously recognizes.

b. Illusion by somatic sense

Somatic sense is divided into cutaneous sense and deep sensibility. Cutaneous sense relating to the spatial orientation is an oppressive feeling. It is feeling that hip or planta pedis receives when sitting in the seat, and can perceive the situation of climbing or accelerating by being pushed down in the seat by varying G.

Deep sensibility is feeling generated by expansion and contraction of muscle or articular, and can perceive positional relationship of hands and feet. Besides, in the case that an aircraft leans, tension is added to muscle or tendon on one side. In this way, a pilot can judge ATT or direction of his/her body. Even if other senses are hindered, a pilot can retain his/her spatial orientation to some extent as far as the somatic sense and the deep sensibility are normal. In a very short period of time, a pilot can even operate flight keeping the control stick to neutral position.

c. Illusion by equilibrium

Otolith is stationary without stimulation of linear acceleration to it, and the sense of increased speed is generating if acceleration is added to it. When this sense of increased speed is stabilized at a certain speed, the sense of acceleration is lost. Besides, Otolith acts in the reverse direction and the sense of progressing in the reverse direction generates, if the linear motion decelerates or halts.

(iii) Spatial disorientation by acceleration speed

In the event that the outer scenery is invisible, spatial orientation could possibly be lost by the illusion described in (ii) above. Particularly, the spatial disorientation by equilibrium illusion described in (ii) c. above includes following:

a. Spatial disorientation by linear acceleration speed

Spatial disorientation by linear acceleration speed is illusion caused by increasing speed of acceleration or deceleration during the flight. In the event that an aircraft in level flight accelerates by increasing the output, the resultant force of gravity and inertial force act aft downward as shown in Figure 36. At this moment, the acceleration by progressing aircraft pushes the back of a pilot to the seat, and otolith also catches the progressing acceleration speed of an aircraft. At this moment, particularly when the outer scenery is invisible, a pilot receives sense that an aircraft is in nose up ATT and is climbing due to the illusion that the direction of resultant force is in the central direction of the earth, i.e. in the direction of gravity, as shown in Figure 37.

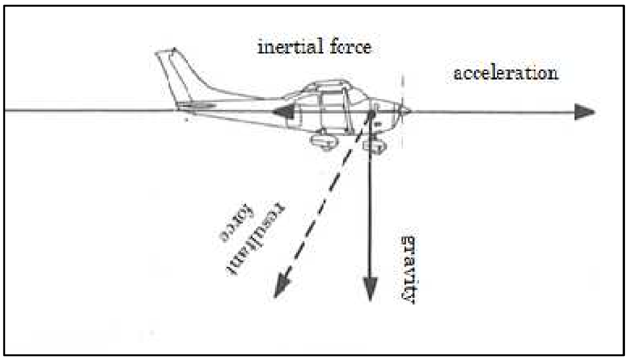


Figure 36: In the case of accelerating in level flight

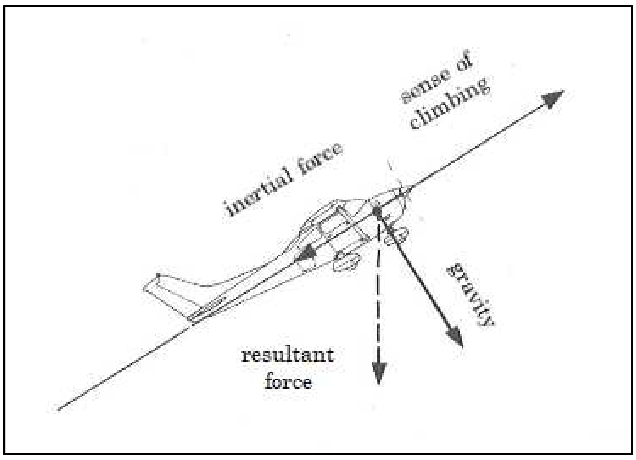


Figure 37: Sense of climbing by acceleration

Due to this sense of climbing, if a pilot takes nose down ATT, an aircraft goes into descending ATT and leads to increasing accelerating speed further. If a pilot continues the maneuvering as he/she is deluded, it occasionally results in abnormal ATT of nose down.

b. Spatial disorientation by rotational acceleration (Illusion of lean)

When an aircraft entered a gradual turn, the semicircular canal can be unaware of a turn due to its small rotational acceleration*8. A pilot is occasionally unaware of a gradual bank of an aircraft when it is in level flight under IMC. In due course, the illusion of lean is occurring

*8 With regard to "can be unaware of a turn", Aeromedical Safety Brochures/Spatial Disorientation: Why You Shouldn't Fly By the Seat of Your Pants/https://www.faa.gov/pilots/safety/pilotsafetybrochures/media/spatiald.pdf of FAA contains following descriptions on the illusion of lean.

The reason a pilot can be unaware of such a gradual turn is that human exposure to a rotational acceleration of 2 degrees per second or lower is below the detection threshold of the semicircular canals.

when a pilot becomes aware of the lean by instructions of instruments followed by abrupt modification of the lean.

For instance, when an aircraft returned to the level flight by maneuvering for modification, the roll out for this modification is erroneously perceived by semicircular canal as the roll in to the opposite side. At this moment, a pilot still held, as feeling, illusion of lean to the direction in which maneuvering for modification was performed although he/she realized the aircraft returned to the level flight by instruments. This is the reason why the pilot attempts to lean his/her body to the opposite side from the direction taken for modification. This is the illusion of lean.

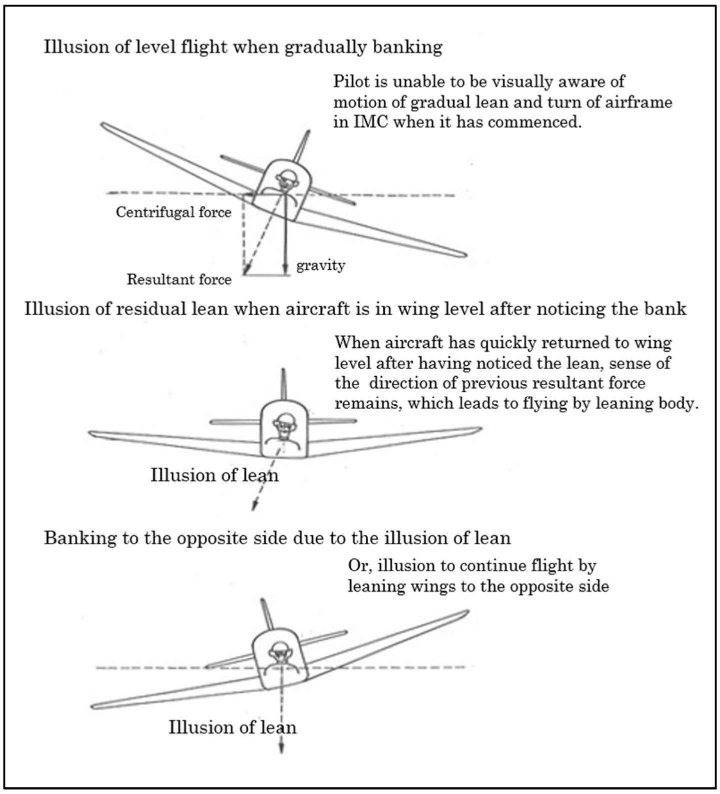


Figure 38: Illusion of lean

(iv) Preventive measures for spatial disorientation

Page 8 of Aeromedical Safety Brochures/Spatial Disorientation/ https://www.faa.gov/pilots/safety/pilotsafetybrochures/media/spatia-lD.pdf, March 10, 2019 of FAA contains following descriptions:

The following are basic steps that should help prevent spatial disorientation:

a. Before flying with less than 3 miles visibility, obtain training and maintain proficiency in airplane control by reference to instruments.

b. When flying at night, or in reduced visibility, use the flight instruments.

c. If intending to fly at night, maintain night-flight currency. Include cross country and local operation at different airports.

d. If only Visual Flight Rules-qualified, do not attempt visual flight when there is a possibility of getting trapped in deteriorating weather.

e. If you experience a vestibular illusion during flight, trust your instruments and *disregard your sensory perceptions.*

b. Countermeasures with spatial disorientation

In the video footage of FAA TV: Spatial Disorientation - Vestibular Illusions (Part 1) /https://www.faa.gov/tv/?mediaid=462, following are listed as countermeasures from spatial disorientation:

a . *The benefit of 180 degree turn before entering IMC conditions.*

b . *If you find yourself in instrument conditions, concentrate on flying basic instruments and disregard your body sensations.*

c . *Concentrate on your instruments, remove yourself from the peripheral vision environment and it's cues and distractions.*

d . *Increase instrument cross check rate.*

e . *Ask A.T.C for help as soon as you recognize a problem.*

f . *While under instrument conditions, avoid head movements during turns.*

g . *Use your eyes rather than your head.*

h . *Defer non-essential tasks, concentrate on flying the aircraft.*

i *If you are one of two pilots in an aircraft and you begin to experience a sensory illusion, transfer control of the aircraft to the other pilot. It is seldom that pilots experience sensory illusions at the same time. If an autopilot is available, use it until the sensory illusion dissipates.*

(2) Confirmation of Knowledge and Skill of Helicopter Pilots for Spatial Disorientation

(i) Various maneuverings assuming an emergency in low visibility according to Details for pilot practical maneuvering tests for commercial pilots (helicopter operated by a single pilot) (Kokukuko No. 556 on November 8, 2013) are as shown in Table 4.

Table 4: Details of pilot practical maneuvering tests for commercial pilots (helicopter)

Flight by Basic Instrument
(Objectives) To evaluate various maneuverings assuming an emergency in low visibility. Note 1:Various maneuverings assuming proficiency certificate for private pilots is evaluated. Note 2: Pilots holding certificate for instruments flight rules are exempted. Note 3:Pilots holding proficiency certificate (except for helicopter) for different kinds of aircraft shall undergo (6 – 1) and (6 – 2) below.

No.	Subject	Implementation Procedures	Criteria
6 – 1	Basic Maneuverings	Repeat a series of subjects in cruising status in the order described below. 1. Level and linear flight for one minute 2. 180 ° level turn to the right or to the left 3. After climbing 500 ft while turning180° to the right or to the left, descend 500 ft while turning 180 ° to the right or to the left	1. Various factors during the flight are to stay within the variances described below: Altitude; +/–100 ft Speed; +/–10 kt Heading; +/–10 ° (in level and linear flight and when halting turn)
6 – 2	Flight by radar-vector (omitted)		
6 – 3	Recovery from abnormal ATT	After taking abnormal ATT, examinees shall recover to the level and linear flight status. Note: Abnormal ATT shall be performed simulating the lack of care to the instruments and the outcome from inappropriate harmonization of disturbance and steering, the speed is 40 kt or more, speed prohibited to exceed within –10 kt, lean angle of within 30 ° to the right and to the left, and pitch angle within +/–10 °.	1. To be able to promptly perform recovery maneuvering from abnormal ATT solely depending on the instruments. 2. Not to run into dangerous status.

(ii) Dictation guidance for pilot competence assessment (helicopter) (Kokukuko No. 1548 on October 6, 2017) contains following descriptions with regard to spatial disorientation:

Paragraph 7 With regard to human ability and limitations

(4) Illusion during the flight (spatial disorientation, illusion of lean, and illusion causing a landing failure)

There exists a risk that a pilot occasionally experiences various illusion in flight that could lead to spatial disorientation or failure in landing.

External force acting in flight and changes in outer scenery could occasionally cause a pilot illusion on position and motion. Spatial disorientation arising from the illusion can be prevented only by secure visual recognition of reliable fixed objects on the ground or flight instruments.

(3) Ensuring safe operation of aircraft in relation to spatial disorientation

(i) Ensuring safe operation of aircraft (spatial disorientation) (Kuko No. 800 issued on October 8, 1999) contains following descriptions:

Spatial disorientation means that a pilot is forced to lose correct ATT and location of an aircraft in flight, and there occurred several accidents other than this accident in our country that were probably involved by spatial disorientation, and it is said that many pilots experienced to have been brought to spatial disorientation. Spatial disorientation is said to be prone to occur in the situation that information from visual sense is limited such as at night, in the cloud and on the snowy ground. The preventive measures include, other than education on spatial disorientation as well as, to follow the indication of flight instruments, not relying on pilot own sense of ATT, while flying under the condition of limited information by ocular vision, unless objects on the ground are explicitly recognized by ocular vision.

(ii) Ensuring safety of personnel transportation by helicopter (Kokukuko No. 857 issued on November 30, 2007) contains following descriptions: (excerpt)

3. Retaining basic instrument flying skills

Pilots flying over such a high mountainous area as the site of this accident*9 are required to regularly receive training in order to retain their basic instrument flying skills and to have their skills evaluated in periodically held assessment as practical as possible.

Furthermore, pilots are required to equip for the competency on a regular basis to switch to basic instrument flight for prompt leaving the situation, if required.

(4) Circulars issued after accidents involved by spatial disorientation

Circulars issued by Civil Aviation Bureau after accidents involved by spatial disorientation are as shown in Table 5.

Table 5: Circulars issued after accidents involved by spatial disorientation

No.	Document No. (date of issue)	Title	Relevant Accident	Addressed to
1	Kuko No. 800 (October 8, 1999)	Ensuring safe operation of aircraft (spatial disorientation)	Crash of privately owned Cessna P210N on September 23, 1998	All Japan Air Transport and Service Association and Japan Aircraft Pilot Association
2	Kokukuko No. 808 (January 27, 2006)	Ensuring safe operation of helicopter	Crash of Robinson R44 owned by SGC Saga Aviation Co., Ltd. on December 24, 2004	Japan Aircraft Pilot Association, All Japan Air Transport and Service Association and AOPA–JAPAN

*9 This accident denotes the accident that occurred in the vicinity of Mt. Suishoudake in Toyama City, Toyama Prefecture on April 9, 2007 as referenced in No. 3 in Table 5. This was the accident that the helicopter failed to retain its attitude and crashed into mountain slope after taking off for human transport in low visibility, and is considered that the captain's low competence of basic instrument flight was involved.

3	Kokukuko No. 857 (November 30, 2007)	Ensuring safe human transport by helicopter	Crash of Fuji Bell 204B2 owned by Akagi Helicopter Co., Ltd. on April 9, 2007	Japan Aircraft Pilot Association

2.16.5 Ensuring Safety of Fire and Disaster Prevention Helicopters by Fire and Disaster Management Agency

Fire and Disaster Management Agency reviewed recent accidents of fire and disaster prevention helicopters and issued notification in relation to ensuring safety of flight operations of fire and disaster prevention helicopters as described in Table 6 to Prefectures all over the country, and defined "Standard for flight operations of fire and disaster prevention helicopters" (Fire and Disaster Management Agency notice No. 4 on September 24, 2019) (see Attachment). The Standard aims to contribute to safe and smooth operations of aviation fire prevention activities by stipulating fundamental items with regard to flight operations of fire and disaster prevention helicopters. The Standard includes such items as flight operations system of fire and disaster prevention helicopters, education and training, aviation fire prevention activities, measures for aircraft accident and mutual aid agreement, and it is set that each flight operation organization defines necessary manuals and plans.

Table 6: Notices issued by Fire and Disaster Management Agency during the last seven years with regard to ensuring safety of fire and disaster prevention helicopters

No.	Document No.	Title	Relevant Accidents
1	Shouboko No. 17, Notice issued by Senior Specialist for Mutual Aid Management (May 29, 2012)	Study report with regard to mountain rescue activities by fire and disaster prevention helicopters	Crash of Bell 412EP operated by Gifu Prefectural Disaster Prevention Aviation Unit on September 11, 2009. Crash of Eurocopter AS365N3 operated by Saitama Prefectural Disaster Prevention Aviation Unit on July 25, 2010.
2	Shouboko No. 67, Notice issued by Senior Specialist for Mutual Aid Management (March 8, 2017)	Thoroughly ensuring safety of fire and disaster prevention helicopters (reminder)	Crash of Bell 412EP operated by Nagano Prefectural Disaster Prevention Aviation Unit on March 5, 2017

No.	Document No.	Title	Relevant Accidents
3	Shouboko No. 67, Notice issued by Senior Specialist for Mutual Aid Management (April 27, 2017)	Investigation of situations of thoroughly ensuring safety of fire and disaster prevention helicopters	
4	Shouboko No. 158, Notice issued by Senior Specialist for Mutual Aid Management (May 10, 2017)	Implementation of hearing in relation to thoroughly ensuring safety of fire and disaster prevention helicopter (reminder)	
5	Shouboko No. 332, Notice issued by Senior Specialist for Mutual Aid Management (September 26, 2017)	Establishment of safety management system utilizing helicopter dynamic management system (notice)	
		(excerpted contents) Communication interval shall be within 30 seconds and shall be activated all the time during the flight irrespective of type of operation of training or rescue activity	
6	Shouboko No. 6, Notice issued by Senior Specialist for Mutual Aid Management (January 9, 2018)	Study result of "the Study Committee in relation to prerequisite for pilots boarding helicopter ambulance and fire and disaster prevention helicopters and training program"	
		(excerpted contents) Familiarization of topographical characteristics of flight operating area and coping with unpredicted weather conditions (including unexpected IMC) are included as pilot assignment item	
7	Shouboko No. 150, Notice issued by Senior Specialist for Mutual Aid Management (March 30, 2018)	Study report on enhancement and strengthening of safety of fire and disaster prevention helicopters	
8	Shouboko No. 259, Notice issued by Senior Specialist for Mutual Aid Management (August 13, 2018)	Thoroughly ensuring safety of fire and disaster prevention helicopters (reminder), and early implementation of proposal in "Study report on enhancement and strengthening of safety of fire	Crash of Bell 412EP operated by Gunma Prefectural Disaster Prevention Aviation Unit on August 10, 2018

No.	Document No.	Title	Relevant Accidents
		and disaster prevention helicopters”	
9	Shouboko No. 271, Notice issued by Senior Specialist for Mutual Aid Management (September 14, 2018)	Implementation of hearings in relation to ensuring safety of fire and disaster prevention helicopters	
10	Shouboko No. 275, Notice issued by Senior Specialist for Mutual Aid Management (September 27, 2018)	Implementation of on-site hearings in relation to ensuring safety of fire and disaster prevention helicopters	
11	Shouboko No. 323, Notice issued by Senior Specialist for Mutual Aid Management (December 14, 2018)	Introduction of two-pilot flight system and CRM in a planned manner	
12	Shouboko No. 51, Notice issued by Senior Specialist for Mutual Aid Management (March 7, 2019)	Convening the 1st meeting to study standard for flight operations of fire and disaster prevention helicopters	
13	Shouboko No. 25, Notice issued by Senior Specialist for Mutual Aid Management (June 3, 2019)	Convening the 2nd meeting to study standard for flight operations of fire and disaster prevention helicopters	
14	Shouboko No. 138, Notice issued by Senior Specialist for Mutual Aid Management (October 1, 2019)	Establishment of standards for operation of firefighting helicopters	

3. ANALYSIS

3.1 Qualification of Personnel

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

3.2 Airworthiness Certificate

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

3.3 Situations of Aircraft

It is certain from the examination of the aircraft and so on that damage to the Helicopter described in 2.9 was caused by the crash at the time of the accident. It is probable that the error code of YAW SERVO of DFCC described in 2.14 did not affect the flight because the mechanic B in charge stated that the record had occurred at test run and there was no other record of malfunction. Furthermore, it is probable that there was no abnormality in the aircraft because the video camera information described in 2.1.4 did not include the footage showing the error code of YAW SERVO in flight and there was no information that indicated the occurrence of other malfunction occurred to the airframe.

3.4 Situations of Engine

The video camera information described in 2.1.4 indicated that the noise of the engine and rotor rotation varied in response to the change of the engine outputs. It is probable that the engine operated normally and had no abnormality because it stopped the operation while it was turning in line with the damage to the aircraft after the crash and from the damaged conditions of the engine described in 2.9.2 (3).

3.5 Effects of Meteorological Phenomena

3.5.1 General Weather Conditions and Aviation Routine Weather Report in the Western Part of Gunma Prefecture

As described in 2.7.1, it was forecasted in Agatsuma area near the accident site where the typhoon No. 13 passed through the previous day that it would be covered by high pressure in the morning of the day of the accident and the condition of the atmosphere would become unstable, affected by humid air leading to cloudy weather in the early afternoon and heavy raining accompanying thunder in some areas. There was not a strong radar echo around the time of the accident, and Aviation Routine Weather Report for Soumagahara aerodrome at the time of 09:00 to 10:00 and the weather observations of Kusatsu Local Weather Observatory near the accident site described in 2.7.2 showed the existence of cloud of 4/8 or so near the altitude of 5,000 ft to 6,000 ft, it is probable that the similar amount of cloud existed also near the accident site.

3.5.2 Weather Conditions near the Accident Site according to Volcano Monitoring Camera

According to the footage of the volcano monitoring cameras set in the surrounding area of the accident site as described in 2.7.3, the surrounding area of the monitoring camera set at Mt. Okuyamada that is closest to the flight route and at the height of 2,168 m (7,113 ft) was covered by fog or cloud around 09:30. From the footage of Mt. Ainomine located in the east of the flight route and Kusatsu temporary camera, it is highly probable that the summit of the mountains was gradually being covered from the west side. When the Helicopter was flying around the camera set at Mt. Okuyamada at an altitude of 7,040 ft (2,145 m) around 10:00, it is probable that the cloud amount at the same altitude had been increased.

3.5.3 Situation of Cloud near the Trails

From the video camera information as described in 2.1.4 it is certain that there existed cloud near the accident site. Furthermore, it is probable that there existed cloud at the altitudes of 5,000 ft to 6,000 ft and 7,000 ft to 7,500 ft near the accident site because it was fair near the summit of Mt. Yokoteyama (height of 7,546 ft) from the statement of the Witness B as described in 2.1.2 (4).

3.6 Situations of Flight of the Helicopter until the Accident Occurrence

3.6.1 From Take-off from Gunma Heliport to Torii Pass

As described in 2.1.1 and 2.1.4, after taking off from Gunma heliport at 09:14, the Helicopter landed at the Agatsuma Helipad at 09:32 to let five firefighters board and took off there. After taking off, the Helicopter continued climbing at cruising speed of 100 kt and headed for the first turning point of Torii Pass. From the situations outside the Helicopter as described in 2.1.4, it is probable that the Helicopter judged that cloud was commencing to cover the ridge lines of the mountains, altered the scheduled flight route 8 km short of Torii Pass at an altitude of about 5,500 ft around 09:41 and commenced the flight in the east side of the

Trails. Besides, it is probable that the captain continued the flight while he was visually recognizing the ground surface and confirming the position of the Helicopter by the flight route that had been pre-input into the portable GPS receiver and the display screen of the map display device.

3.6.2 From Torii Pass to Shibutouge Pass

As described in 2.1.4, it is probable that the vicinity of the ridge lines of the Trails were partly covered by cloud, the Helicopter decelerated to 30 kt ~ 50 kt from the cruising speed of 100 kt of the flight plan, and, as shown in the estimated flight route in Figure 1 and the cross sectional view of the flight in Figure 4, it was flying while frequently altering flight direction and flight altitude to avoid cloud after climbing to an altitude of about 8,000 ft. During the flight from Torii Pass to Shibutouge Pass, the altitude above the ground level of the Helicopter was temporarily below the minimum safe altitude of 150m or less as described in 2.16.3 several times. It is probable that the ground surface could be visually recognized and there existed almost no cloud below the Helicopter at that time.

3.6.3 From Shibutouge Pass to the Crash

(1) From 09:57:49 until 09:59:40

As described in 2.1.3 and 2.1.4, the Helicopter passed over Shibutouge Pass at an altitude of about 7,000 ft around 09:57:49. After passing over Shibutouge Pass, it is probable that the Helicopter accelerated to about 70 kt and maintained an altitude of about 7,000 ft due to increased cloud amount below the Helicopter. Then, it is probable that the horizontal visibility ahead was lowered, the Helicopter gradually turned to the left while decelerating to 20 kt or less, making a turn around the north side of Mt. Yokote around 09:58:50, and halted the flight to the north east and flew to the direction of the northeast after confirming the weather conditions in the northwest. It is probable that, around 09:59:36 after turning to the northeast direction, the Helicopter turned around by the right turn at a low speed of 20 kt or less and headed for Shibutouge Pass in the southwest direction while accelerating to about 50kt because the visibility was further lowered to the extent that only part of the ground was visible. Besides, it is probable that the captain possibly determined to suspend the flight plan and to return and reported to the chief air rescuer the suspension of the flight plan because the voice of "ROGER" was recorded in the video camera of the air rescuer during the right turn.

During the period of around 09:59:05 until around 10:00:13, the Helicopter maintained an altitude of 300 m or more above the ground level, to which VMC in Article 5 (ii) (b) 2. of Ordinance of the Civil Aeronautics Act is applied in order to maintain VMC as described in 2.16.1. However, it is highly probable from the situations outside the Helicopter of the video camera information described in 2.1.4 that the Helicopter did not maintain VMC because it did not ensure the flight visibility of 1,500 m or more and cloud was confirmed within the vertical distance of 150 m above and 300 m below the aircraft and horizontal visibility of 600 m.

(2) From 09:59:41 until 10:00:46

As described in 2.1.3 and 2.1.4, the Helicopter headed for the southwest direction after completion of the right turn and decelerated again to 20 kt or less due to lowered horizontal visibility ahead. It is probable that the Helicopter commenced the right turn again at a low speed because part of the ground surface was visually recognized in the northwest direction from the right window around 10:00:46.

(3) From 10:00:46 until 10:01:01

As described in 2.1.3 and 2.1.4, it is highly probably that, after right turn at a low speed around 10:00:46, the Helicopter flew over the valley in the north side of Mt. Yokote and commenced the flight toward the west side. It is probable that from 10:00:48 the Helicopter gradually continued the right turn at the acceleration rate of 3 to 5 kt/second in the situation that the horizontal visibility ahead was lowered and the ground surface was barely visible. During the period of 10:00:50 until 10:00:55, the Helicopter gradually turned to the right followed by the left turn thereafter, and during that period the captain seemed to watch the ground surface in the lower right shaking his head. It is probable, however, that the captain possibly operated the Helicopter without sufficiently confirming ATT indicator, altimeter and other indicators during the period. It is highly probable that the Helicopter was brought into an abnormal ATT of left roll angle of 10 degrees and pitch angle of –20 degrees around 10:01:01 and commenced the left descending turn while accelerating the speed. Then, it is probable that the Helicopter descended from an altitude of 6,954 ft to 6,239 ft in 12 seconds until 10:01:12 when it collided with trees.

(4) From 10:01:02 until 10:01:12

As described in 2.1.3 and 2.1.4, it is highly probable that the captain set the FT on and after visual recognition of the front instrument in order to use ATT mode while the Helicopter was continuing the left descending turn at roll angle of 45 degrees and the pitch angle of –20 degrees around 10:01:07. It is probable that RPM light and cyclic center light were illuminated because the front visibility abruptly turned clear around 10:01:08 and the captain instantaneously maneuvered cyclic stick to the left backward and collective stick upward. It is probable that the front visibility that abruptly turned clear was caused by that the Helicopter came out of and went below the cloud by continuing to descend. It is probable that RPM light was temporarily disappeared around 10:01:10 because the captain further maneuvered cyclic stick to the right backward that restored the ATT of the Helicopter to the roll angle of 20 degrees to the left and the pitch angle of zero degree. It is probable that RPM light and cyclic center light were illuminated again around 10:01:11 and at this moment the Helicopter was at the roll angle of three degrees to the left and the pitch angle of zero degree at the GS of 135 kt. It is highly probable that around 10:01:12 the Helicopter was at zero degree roll angle and +20 pitch angle with the GS abruptly descending to about 100 kt or so and the descend rate was reduced to less than 100 ft/minute, however, due to lack of a sufficient margin of an altitude, it collided with trees on the left slope of the mountain and crashed there.

It is probable, from the situation of RPM light illuminations, that the abrupt change of the rhythm of the noise of the Helicopter to an unfamiliar noise stated by the witness B as described in 2.1.2 (4) was caused by an abrupt change of the number of rotation of the main rotor due to the maneuvering of avoidance the captain took immediately before the crash. It is probable that illuminated cyclic center light was caused by excessive maneuvering of cyclic stick over normal operating limit in the situation that the rotor rotations were judged to have exceeded the normal operating limit as described in 2.12 (3) (iii) because RPM light was also illuminated simultaneously.

It is highly probable, from the video camera information described in 2.1.4 and the situation of the accident site and the wreckage information described in 2.9, that while the Helicopter was rotating to the left after the main rotor contacted the trees on the left, the left skid contacted the ground surface, the main rotor blade contacted the trees and the ground surface while the airframe was rolling to the left, the tail boom was separated from the airframe at the time of the crash, and then, the fuselage collided with the trees with ELT antenna being separated after the main rotor and transmissions were separated from the aircraft and was inverted with the front reversed to the rear.

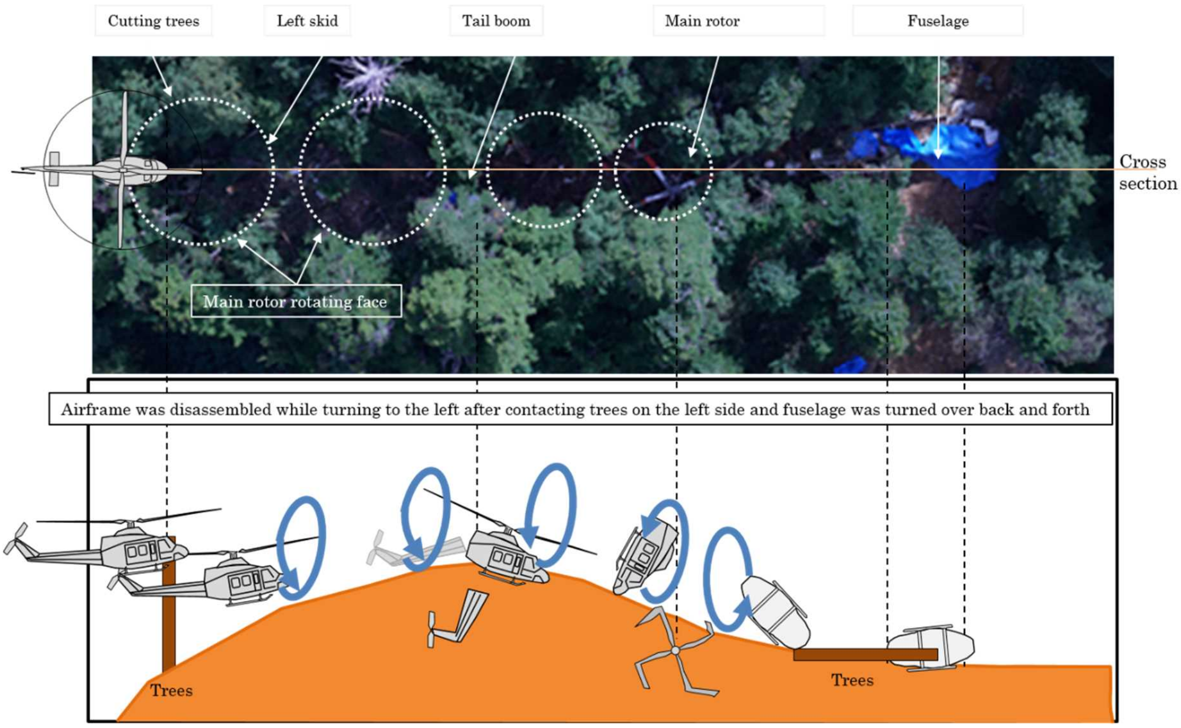


Figure 39: Figure showing inverted airframe when crashed

3.7 Judgment of the Captain

3.7.1 Judgment of Weather Conditions

As described in 2.1.2, the captain confirmed, from general weather conditions of the day of the accident, aviation routine weather report as of 8 o'clock and the live camera, that the ridge lines of the mountains could be visually recognized, and furthermore, from the information he obtained from staff of Agatsuma fire and disaster management headquarters, that the weather conditions in the vicinity of Agatsuma were good, it is probable that he judged that the flight for the exploration was feasible to perform, however, it could not be determined how he got prepared to cope with possible change in the meteorological conditions occurring during the flight.

3.7.2 Visual Meteorological Conditions and Maintaining Minimum Safety Altitude

As described in 3.6, the captain performed flight operations at the cruising speed of 30 to

50 kt in the east side of the Trails until reaching the airspace over Shibutouge Pass after turning to the north while frequently altering flight direction and flight altitude in order to avoid cloud and flew at the altitude above the ground level temporarily below the minimum safe altitude several times. It is probable that the captain continued the flight that was below the minimum safe altitude because there existed almost no cloud below and the ground surface could visually be recognized. The Helicopter continued the flight, maintaining the flight altitude of about 7,000 ft near the cloud base after passing over Shibutouge Pass. In the meanwhile, the amount of cloud covering the ground surface was increasing and the front visibility was lowering. The captain thereafter decelerated the speed to as slow as less than 20 kt that is close to hovering and inverted twice to avoid entering cloud. It is probable that the Visual Weather Conditions stipulated in Article 2 (ii) (b) of Ordinance for Enforcement of the Civil Aeronautics Act as described in 2.16.1 (1) were not maintained at this moment. Besides, as described in 2.1.2 (1), it is probable that the captain should have judged that it was infeasible to continue his mission and should have returned any time soon when he recognized that the flight at the minimum safe altitude or less was required to explore the ground situations because he had confirmed in the pre-flight briefing that there was no need to descend to a low altitude to accomplish the mission.

3.7.3 Maintaining and Selection of Flight Route

As described in 3.6.1 and 3.6.2, the Helicopter commenced the flight to the north at 8 km short of Torii Pass and was flying in the east side of the Trails. Around 09:52, the air rescuer pointed the mountain in the west side and the position in the vicinity of Mt. Yokote was input into the tablet device of the Dynamic Control System. Then, because the Helicopter flew over the mountains around 09:54 and passed over Shibutouge Pass around 09:57 while it was confirming the ground surface after once flying in the west side of the Trails, it is probable that the captain judged that it was feasible to maintain and select the flight route for exploration of the Trails by referencing to GPS position and continued the flight while he was coordinating with the air rescuer as described in 2.15.2, and the Helicopter entered the airspace where it was difficult to visually recognize the ground surface.

3.7.4 Factors Exposing to Spatial Disorientation and Dealing with It

3.7.4.1 Factors Exposing to Spatial Disorientation

As described in 3.6.3 (3) and (4), it is probable that the abnormal ATT of the Helicopter was caused by spatial disorientation the captain was exposed to with following possible causes:

(1) Illusion by Linear Acceleration

As described in 3.6.3 (3), the Helicopter accelerated in level flight at the acceleration rate of 3 to 5 kt/second from around 10:00:48 in the condition of a low visibility of outer scenes, and then, the ATT abruptly changed to the pitch angle of –20 degrees that continued. It is probable that the captain was possibly exposed to spatial disorientation by linear acceleration as described in 2.16.4 (1) (iii) a. and he continued nose down maneuvering by being brought into the illusion of climbing sense.

(2) Illusion by Gradual Turning

As described in 3.6.3 (3), the Helicopter gradually turned at 10:00:51 until 10:00:55, and then, it entered the left descending turn and took an abnormal ATT of left roll angle of 45 degrees by the increased roll angle. It is possible that this implies that the captain was possibly exposed to spatial disorientation by rotational acceleration as described in 2.16.4 (1) (iii) b. and he was brought into the illusion of lean that erroneously modifies the roll angle.

3.7.4.2 Dealing with Spatial Disorientation

As described in 3.7.4.1, it is probable that the captain was exposed to spatial disorientation from around 10:00:48 by linear acceleration and rotational acceleration when he accelerated and gradually turned after completing the second right turn at a decelerated speed. It is probable that the captain should have concentrated on instruments flight and should have grasped and securely controlled the ATT of the Helicopter to avoid getting into spatial disorientation as described in 2.16.4 (1) (iv) at the time the horizontal visibility was reduced and the ground surface on the lower side was almost invisible. The captain, however, accelerated the speed from a low speed and performed a gradual turn, moving his head to visually recognize the ground surface from the right window in an attempt to maintain VMC instead of concentrating on instruments flight. It is probable that this caused the captain to be exposed to spatial disorientation and disabled him from performing an appropriate maneuvering to maintain the ATT of the Helicopter, leading to abnormal ATT. Besides, as described in 3.6.3 (4), the captain instantaneously maneuvered cyclic stick reversely to the left, not to the right that he should have maneuvered to correct the aircraft attitude leaning to the left when the front visibility abruptly turned clear four seconds before the crash. It is probable that the captain performed the maneuvering without escaping from spatial disorientation.

3.7.5 Use of Autopilot System

As described in 3.6.3 (4), it is probable that the captain performed the flight using SAS mode of the autopilot system setting the FT off until five seconds before the crash. As described in 2.12, it is probable that the FT was set off when flying at a low speed of less than 60 kt because SAS mode is used when flying at a low speed and use of the FT at a low speed is optional.

It is probable that the captain possibly intended the flight by coupling ATT mode with flight director when attempting to select the mode selector with the FT set on in recognition of the abnormal ATT of the left roll angle of 45 degrees and the pitch ATT of –20 degrees and the situation of spatial disorientation when he visually recognized instruments five seconds before the crash. It is probable that the captain expected the flight by autopilot system because he recognized that the Helicopter was in the abnormal ATT and he was unable to recover from it by his own maneuvering. As described in 2.12 (2), however, coupling ATT mode with flight director requires the FT to be set on, followed by selecting a desired flight director mode after selecting ATT mode. It is probable that the sense of maneuvering was changed by the FT and maneuvering devices were retained in the standard position, however, the expected function was not obtained. Even in the case that ATT mode could be coupled with flight director under the condition of the left roll angle of 45 degrees, it is probable that the crash could not be avoided by use of autopilot system five seconds before the crash because at least 15 seconds of recovery time were needed as described in 2.14.2 even if go-around mode, which enabled recovery most effectively from the left descending turn condition, was selected.

As described in 2.16.4 (1) (iv) b., it is probable that the use of autopilot system as a countermeasure for spatial disorientation is effective. For this reason, it is somewhat likely that it was effective to escape from airspace of low visibility and, at the same time, prevent exposure to spatial disorientation if the captain predicted a possible exposure to spatial disorientation and promptly switched to autopilot by ATT mode at the stage of entering a stable condition of 60 kt or more described in 2.12 (1) (i) and (iii), followed by setting high altitude mode of dual flight director.

3.7.6 Use of Onboard Devices and Portable GPS Receiver

It is probable that, immediately before flying the mountainous area, the captain several times operated the switches beside the display panel of the map display device described in 2.13.1, but never watched the panel of the device after weather conditions had been deteriorated. It is probable that the device was used within the limitation of the restriction that it was not authorized to be used as a navigation device and a ground anti-collision device by the flight manual although the panel display of the device illuminated red that indicated the low ground altitude immediately before the crash.

It is probable that the captain continued the flight in the lowered visibility confirming the location of the Helicopter using the portable GPS receiver as a reference because the GPS receiver was installed on the instrument panel having a good visibility as described in 2.13.2.

The meteorological radar described in 2.13.4 was installed in the left pilot seat, and the captain had difficulty in confirming the radar while maneuvering due to the position of operation switches and a narrow viewing angle from the captain in the right seat of the captain. Furthermore, it is probable that the meteorological radar was not utilized because it was hard to distinguish radar echo of the ground surface from the same of cloud.

3.8 Operation System in the Aviation Unit

3.8.1 Flight Command

As described in 2.15.2, the captain was performing operations under the direction and supervision by operational commander (chief air rescuer) except for the duties that the pilot in command shall undertake by laws and regulations. As described in 3.6.3 (1), it is probable that the captain judged to suspend the flight plan and to return, which was possibly reported to the chief air rescuer because the video recorder of the air rescuer recorded the voice of “ROGER” at 09:59:36 during the right turn. It could not be determined, however, how the concrete instructions and adjustments were performed because the conversations between the chief air rescuer and the captain were not recorded in the onboard intercommunication device.

3.8.2 Operation Control

As described in 2.15.5 (1), the Helicopter reported the flight plan that omitted stopover at the Agatsuma Helipad in the actual flight route. To perform research and rescue activities, if by any chance, in an appropriate manner, it is required to separate the flight plan or to file the flight plan including scheduled stopover in the event of landing 9 km far away from the departure aerodrome, however, it is probable that inappropriate operation control had prevailingly been conducted based on the incorrect recognition of no need to include the stopover in the flight route unless the engine was shut down.

As described in 2.15.5 (2), the flight plan of the Helicopter delayed commencing the search activities due to the report of arrival at Gunma heliport made at 11:19 despite that the Helicopter went missing. The Aviation Unit was not continuously monitoring the Dynamic Control System despite that it confirmed at 10:15 that the system had been halting since 10:01. It is probable that this implies that the Aviation Unit presumed from previous experiences that there occurred some malfunction in the Dynamic Control System, and it did not come to realize a possible occurrence of abnormal situation of the Helicopter operation. It is probable that the Aviation Unit should have commenced to confirm the safety of the Helicopter by message function of the Dynamic Control System and radio calling in accordance with the fundamentals of operation monitoring at the time they lost the movements of the Helicopter, and in the event of the failure to obtain the confirmation, they should have reported the situation to the airport office without delay and needed to commence the search and rescue activities promptly.

As described in 2.15.5 (3), it is certain that the fact that flight logbook was not carried in the Helicopter against Article 59 of Civil Aeronautics Act and the captain did not carry a competence certificate against Article 67 of the same Act indicates that the compliance was not securely followed.

3.8.3 Management of Pilots' Competence

As described in 2.16.1. (2), any aircraft in IMC shall be navigated in accordance with instrument flight rules within an air traffic control area, air traffic control zone or air traffic information zone, and shall not fly in any other airspace; provided, however, that the same shall not apply when there is an unforeseeable rapid deterioration in weather conditions or other compelling reasons, or when permitted by the Minister of Land, Infrastructure, Transport and Tourism. Pilots flying in IMC are required to hold instrument flight certificate.

As described in 2.15.3, education and training of pilots of the Aviation Unit were conducted as obligation of the operation entrusted company. As described in 2.5, the captain obtained the type rating after receiving training for the type of the helicopter for three months at the entrusted company. Besides, the captain did not hold instrument flight certificate, the aggregated time of basic instrument flight training the captain received using hood of the same type of the helicopter as of the time he obtained the rating for the type was one hour and 30 minutes, and he did not receive basic instrument flight training since he had been assigned to the Aviation Unit.

As described in 2.16.4 (1) (iv), it is required to fly concentrating on instruments in order not to be exposed to spatial disorientation when unpredictable worsened weather conditions were encountered. It is considered important that pilots of the Aviation Unit, who fly over mountainous region where weather conditions are easy to change, take thorough countermeasures for spatial disorientation, and acquire the custom to fly while confirming ATT of own aircraft as well as the judgment to switch to basic instruments flight by cross-checking ATT indicator and altimeter instead of simply relying on the horizontal line only in regular flights in VFR.

3.9 Ensuring Safety of Flight of Small Aircraft

3.9.1 VFR Flights in Mountainous Areas

As described in 2.16.1 (3), in the event that a sign of unpredictable worsened meteorological conditions is observable, it is required to make a decision to continue flight or not without losing a time, followed by returning to the departure aerodrome or landing at an appropriate aerodrome located in the flight route. In this accident, the Helicopter was flying at an altitude of the minimum safe altitude or less and at a decelerated speed to avoid cloud. It is required to predict change in surroundings in flight and to determine to return without delay in the event that a possible difficulty to maintain VFR flight is predictable because weather conditions in mountainous areas are generally easy to change in a short period of time and own their inherent characteristics. Ensuring safety of flights of small aircraft in VFR has been enlightened so far by circulars described in Table 3 in 2.16.1 (4) issued by Civil Aviation

Bureau; nevertheless, accidents in VFR flight in mountainous areas in relation to meteorological conditions including this accident were repetitively occurring. It is considered important to fully disseminate the cautionary points to ensure safety of flight in mountainous areas in VFR through continuously convening training sessions and utilizing website.

3.9.2 Use of GPS Devices

As described in 2.16.2 (2), in case of using GPS device supplementary in VFR, no judgment is to be made to commence or to continue flight in reliance on GPS devices or on condition of using the devices when meteorological conditions that are difficult to maintain VMC are predictable.

It is possible that flight route is maintained and selected by relying on portable GPS receivers, which runs a risk of guiding aircraft to areas where visual recognition of the ground surface is difficult because use of portable GPS receivers makes it easy to grasp the current location and displays the heading to the goal.

It is probable that full attention is required to be paid in use of the devices in order not to enter areas where VMC cannot be maintained.

3.9.3 Dealing with Abruptly Worsened Weather

As described in 2.16.4 (2), knowledge and skill for spatial disorientation are confirmed in pilot practical maneuvering tests and pilot competence assessments; however, it is probable that the captain was exposed to spatial disorientation and was unable to escape from it in this accident as described in 3.7.4.

Particularly, pilots of aircraft performing search and rescue activities by fire and disaster prevention and police have in the nature of their missions not a few opportunities to fly over mountainous areas where meteorological conditions are easy to change and meteorological conditions in local areas are difficult to predict. Even in the case that weather is abruptly worsened, it is important to take appropriate actions to promptly escape from such a worsened weather conditions in airspace without being exposed to spatial disorientation. It is considered important to get regularly acquainted with concrete preventive measures and countermeasures for spatial disorientation including deepening understanding of the danger of spatial disorientation, immediately switching to basic instrument flight if required, and appropriate use of autopilot system if equipped, as demonstrated in FAA safety enlightening documents and FAA website described in 2.16.4(1) (iv).

3.10 Effectiveness of Two-Pilot Operation System in Fire and Disaster Prevention Helicopters

As described in 2.16.5, Fire and Disaster Management Agency defined and notified Standard for flight operations of fire and disaster prevention helicopters on September 24, 2019 based on previous fire and disaster prevention helicopters accidents. According to the standard, two-pilot operation system is required for fire and disaster prevention helicopters engaged in fire and disaster prevention activities effectively on April 1, 2022. From analysis of factors of this accident, two-pilot operation system is considered effective in terms of following:

(1) Prompt Coping with Spatial Disorientation

As described in 2.16.4 (1) (iv), in the event that two pilots are on board, it is said to be seldom that both pilots experience spatial disorientation at the same time due to differences in experience and the sensor of the pilots. Accordingly, it is probable that transferring control of the aircraft quickly to the other pilot when a pilot realized sensory illusion in flight is effective in avoiding the aircraft to take abnormal ATT.

(2) Mitigating Work Load by Effective Use of Onboard Equipment

As described in 3.7.6, the map display device was equipped in the Helicopter, and it is probable that eye line needed to be moved to the console for operation or confirmation of display panel due to its location in the console. Besides, visual point needed to be moved for operation of the control panel to alter autopilot mode because it was located in the lower part of instrument panel of right and left pilot seats and in the console. It is probable that, in the event that two pilots are on board, a pilot not maneuvering an aircraft can perform works related to input and display of navigation devices and easily perform necessary autopilot mode alterations that can mitigate work load of the pilots.

(3) Effect of Appropriate Decision Making

It is probable that two-pilot operation system enables appropriate work sharing between the captain and the co-pilot in relation to maneuvering, and appropriate decision making can be expected in such cases as judging to return at weather conditions changed and judging compliance to the minimum safe altitude.

4 CONCLUSIONS

4.1 Summary of Analysis

(1) It is probable that weather conditions in the vicinity of the accident site had cloud at altitudes from 5,000 ft to 6,000 ft and from 7,000 ft to 7,500 ft (3.5.3).

(2) It is probable that the Helicopter, after taking off from Agatsuma heliport, altered scheduled flight route short of the first turning point in the situation that cloud began to cover the ridge lines of the mountains, and commenced flight on the east side of the Trails (3.6.1).

(3) It is probable that the Helicopter was flying frequently altering the flight direction and flight altitude to avoid cloud, and flew temporarily at the minimum safety altitude of 150 m or less AGL several times from Torii Pass to Shibutouge Pass (3.6.2).

(4) It is probable that the Helicopter once halted flight for northwest after passing over Shibutouge Pass, inverted by right turning at a low speed after flying in the northeast direction, and the captain judged to suspend flight. It is probable that, after heading toward Shibutouge Pass, the Helicopter commenced flight in the northwest direction due to lowered horizontal visibility ahead. It is probable that the Helicopter did not maintain VMC during the period from around 09:59:05 until 10:00:13 according to the outside information recorded by the video camera. (3.6.3 (1) and (2)).

(5) It is highly probable that, during the flight in the northwest direction, the Helicopter performed acceleration and turning, continued descending in abnormal ATT of left roll angle of 45 degrees and pitch ATT of –20 degrees, came out of the conditions supposed to be in the cloud and went below the cloud and crashed due to lack of a sufficient margin of an altitude despite performing recovery operations (refer to 3.6.3 (3) and (4)).

(6) It is probable that the captain should have judged that it was infeasible to continue his mission and should have returned when he realized that flight at the minimum safe altitude or less was required to confirm the ground situations because he had confirmed at the pre-flight briefing that there was no need to descend to a low altitude to accomplish the mission (3.7.2).

(7) It is probable that, while the maintaining and selection of the flight route were adjusted between the captain and the air rescuer, the captain judged that it was feasible to continue

flight by referring to the dynamic management system, and the Helicopter entered the airspace where visual recognition of the ground surface was difficult (3.7.3).

(8) It is probable that the captain was exposed to spatial disorientation originating from linear acceleration and rotational acceleration when he maneuvered acceleration and gradual turning after the second right turn at a low speed after passing over Shibutouge Pass (3.7.4).

(9) It is probable from the voice recorded in the video camera that the captain judged to suspend the flight plan and to return, which was reported to the chief air rescuer; however, it could not be determined how the concrete instructions and adjustments were performed because the conversations between the chief air rescuer and the captain were not recorded in onboard intercommunication device (3.8.1).

(10) It is probable that the captain recognized that he was exposed to spatial disorientation five seconds before the crash, and altered autopilot mode; however, he failed to properly select the mode. Even if he properly selected the mode, it is probable that he had been unable to avoid the crash. (3.7.5)

(11) It is considered important that pilots of the Aviation Unit, who fly over mountainous region where weather conditions are easy to change, take thorough countermeasures for spatial disorientation, and acquire the custom to fly while confirming ATT of own aircraft as well as the judgment to switch to basic instruments flight. (3.8.3)

(12) It is considered important that caution to secure safety of flight in mountainous areas in VFR be thoroughly disseminated through convening training sessions and utilizing website. (3.9.1)

(13) When using portable GPS receivers, it is possible that flight route is maintained and selected by relying on portable GPS receivers, which runs a risk of guiding aircraft to areas where visual recognition of the ground surface is difficult. It is probable that full attention is required to be paid in use of the device (3.9.2).

(14) It is considered important to get regularly acquainted with concrete countermeasures for spatial disorientation including deepening understanding of the danger of spatial disorientation, immediately switching to basic instrument flight if required, and at the same time appropriate use of autopilot system, if equipped. (3.9.3)

(15) From analysis of the factors of this accident, two-pilot operation system of fire and disaster prevention helicopters is considered effective because it enables to cope with spatial

disorientation in a prompt manner, it mitigates work load in relation to operation of on board equipment, and appropriate decision making is expected to be made in a timely manner. (3.10)

4.2 Probable Causes

In this accident, it is probable that, while flying over mountainous areas for exploration of mountain climbing trail, the Helicopter entered the cloudy airspace and was unable to continuously recognize the ground surface due to lowered visibility, and the captain who was exposed to spatial disorientation could not perform an appropriate maneuvering to maintain the attitude of the Helicopter that subsequently crashed into the slope of the mountain.

It is probable that losing continuous visual recognition of the ground surface in the lowered visibility were caused by delayed decision to return and continuing flight in the situation that it was getting difficult to maintain VMC.

4.3 Other Identified Safety Issues

(1) Report of Inappropriate Flight Plan

In this accident, the Helicopter notified the flight plan omitting landing at and take-off from the transit point of the Agatsuma Helipad. Besides, verifications of the flight plans during the last two years revealed that 293 cases were inappropriately processed. Furthermore, in this accident, the delay in commencing the search and rescue activities was caused by the arrival report that had been made when the flight described in the Helicopter’s flight plan.

The flight plan notification and arrival report needs to be performed in an accurate and prompt manner because they are important information for search and rescue activities.

(2) Unloaded documents to be carried in aircraft

In this accident, it was certain that flight logbook, which is required to be carried in aircraft pursuant to Article 59 of Civil Aeronautics Act, was not loaded on board. Besides, Article 67 of Civil Aeronautics Act stipulates that a competence certificate and an aviation medical certificate are required to be carried when engaging in aviation work, however, it was certain that the captain did not carry these documents.

Documents to be carried in aircraft need to be confirmed pursuant to the relevant laws and regulations.

5 SAFETY ACTIONS

5.1 Safety Actions Considered Necessary

(1) Prompt Judgment to Maintain Visual Meteorological Conditions

It needs to be aware that flying over mountainous areas requires the prediction of peripheral changes taking abrupt changes in weather conditions and regional inherent characteristics of weather into consideration, not relying on GPS devices, and the judgment of prompt return maintaining VMC.

(2) Coping with Abruptly Worsened Weather

When encountering abruptly worsened weather, flight concentrating on basic instrument without hesitation is required not to be exposed to spatial disorientation.

It is considered necessary that pilots flying over mountainous areas where weather is easy to change take thorough countermeasures for spatial disorientation and get acquainted with the judgement to shift to basic instrument flight and the ability to maneuver the aircraft by basic instrument flight through regular flight operations.

(3) Two-Pilots Operation System in Fire and Disaster Prevention Helicopters

It is desirable that two-pilot operation system in fire and disaster prevention helicopters be implemented because it is expected to bring about an effect enabling prompt coping with spatial disorientation by transferring control of the aircraft to the other pilot, to mitigate work load of pilots by effective use of equipment on board, and to make appropriate decisions.

5.2 Safety Actions Taken by Civil Aviation Bureau of Ministry of Land, Infrastructure, Transport and Tourism after the Accident

On August 16, 2018, Civil Aviation Bureau of the MLIT issued a guidance letter to Gunma Prefecture and a circular to the operating organizations asking for the compliance to the report of flight plan based on the accident of Gunma Prefectural Aviation Unit.

5.3 Safety Actions Taken by Fire and Disaster Management Agency after the Accident

Fire and Disaster Management Agency defined basic items in relation to flight operations of fire and disaster prevention helicopters, and defined “Standard for flight operations of fire and disaster prevention helicopters" (Fire and Disaster Management Agency notice No. 4 on September 24, 2019) with the aim to contribute to safe and smooth implementations of aviation fire prevention activities.

5.4 Safety Actions Taken by the Aviation Unit after the Accident

From the study results by the committee reviewing the Aviation Unit system, the Aviation Unit has been taking following safety actions:

(1) Review of Organizational System

To establish "Disaster Prevention Aviation Center" in Gunma heliport with assigning operational control administrator (director of Disaster Prevention Aviation Center) as well as safety operation controller (chief safety operation controller) with expertise.

(2) Clarification of Judgments of Dispatch and Flight

(i) To establish system that can verify the process up to the point that authorized persons decide to dispatch by utilizing the check sheet in which chief air rescuer and captain fill out necessary information for dispatch. To implement education for new assignees so authorized persons can make appropriate judgments.

(ii) To add sources of weather information including establishment of communication system with mountain cottages for confirmation of weather conditions in addition to operation assistance services and live camera footage.

(iii) To enhance safety measures by expressing concrete risk factors in pre-dispatch briefing and estimating risks according to proficiency level of each pilot and air rescuer for sharing such information within the unit to find preventive measures.

(iv) To review necessary manuals to report flight plan and arrival jointly by two persons when re-starting the operation.

(3) Load Mitigation of Captain and Assistance of Helicopter in Flight

(i) To consider adoption of double pilot system in order to mitigate load of captain by preparing for unpredictable situation when occurred with captain and assisting instrument operations, and to enhance safety by performing peripheral monitoring by multiple persons.

(ii) To establish rules, as logistic support from the base, for performing constant monitoring of helicopter dynamic control system and regular communications with the base to constantly grasp dynamics of disaster prevention helicopter from the base and the prefectural government. To provide information on meteorological conditions by mail function of helicopter dynamic control system and satellite phone.

(4) Review of Operational System and Entrusting Management System

From stand point of ensuring compliance and safe operations by the entrusted service operating company, hold seminars for prefectural staff stationing at the base to educate them to learn expertise so they can realize the ongoing situation of entrusting operations. Furthermore, hold monthly "Safety Operation Meeting" hosted by supervising administrator to establish system to receive and review reports regarding ongoing situations of entrusting operations.

(5) Training and Seminars

(i) Implement familiarization training of inherent topography and weather conditions of mountainous areas in Gunma Prefecture for pilots as part of regular training. Besides, implement human factors training for all staff of the Aviation Unit for their comprehension of human characteristics. Furthermore, implement CRM training for all staff members of the Aviation Unit so they can acquire skills to communicate with air rescuers and operational control administrator at the base in order to make their decision as the team instead of relying on competence and judgment of pilots.

(ii) Establish procedures for coping with crisis such as outage of communication with helicopter and implement map exercise assuming emergency situations.

(6) Study of Loading Following Safety Equipment On Board

(i) four-axis autopilot device adding auto hovering function

(ii) aircraft-collision warning system

(iii) ground proximity warning system

(iv) flight recorder and voice recorder

6 RECOMMENDATIONS

6.1 Recommendations to Minister of the MLIT

In this accident, it is probable that, while flying in mountainous areas for exploration of mountain climbing trail, the Helicopter entered the cloudy airspace and was unable to continuously visually recognize the ground surface due to lowered visibility that exposed the captain to spatial disorientation and disabled him to perform an appropriate maneuvering to maintain the attitude of the aircraft, which crashed into the slope of the mountain.

It is probable that the lowered visibility and losing continuous visual recognition of the ground surface were caused by delayed decision to return and continuing flight in the situation that it was getting difficult to maintain VMC.

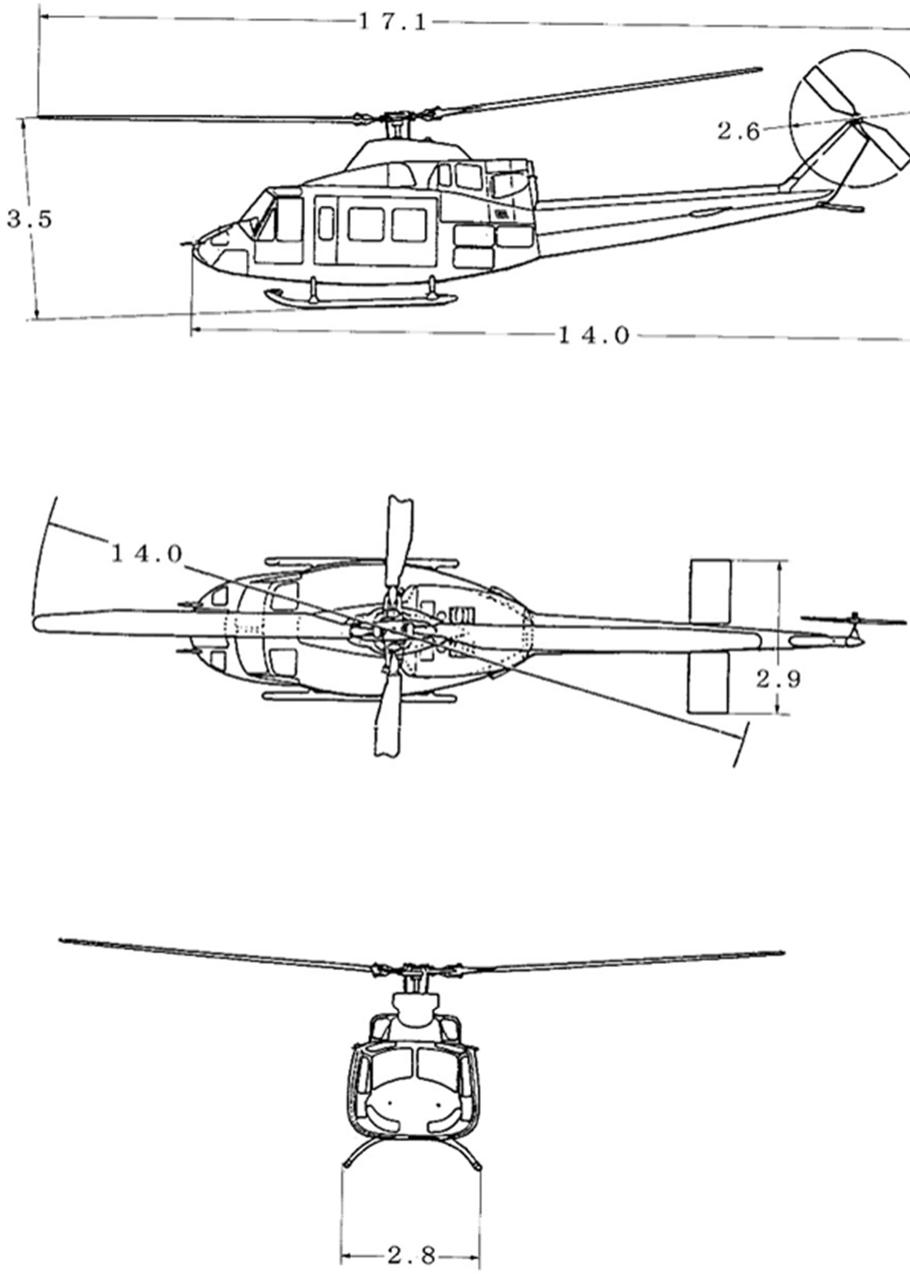
Pilots operating aircraft for fire and disaster prevention and police rescue activities have many opportunities due to the nature of their missions to fly mountainous areas where meteorological conditions are easy to change and it is difficult to predict localized meteorological conditions. It is important that, even in the case of abruptly worsened weather, pilots take appropriate actions to promptly leave air space in worsened weather conditions without being exposed to spatial disorientation. For that purpose, it is probable that pilots are required to regularly get acquainted with concrete preventive measures and coping ones by deepening understanding of danger in relation to spatial disorientation, to immediately switch to basic instrument flight, if required, and to properly use autopilot system, if equipped.

From what is described above, the Japan Transport Safety Board, pursuant to Article 26 (1) of the Act for Establishment of the Japan Transport Safety Board, recommends Minister of Land, Infrastructure, Transport and Tourism to take following measures in order to prevent an aircraft accident and to mitigate damage if an aircraft accident has occurred:

Civil Aviation Bureau of Ministry of Land, Infrastructure, Transport and Tourism should alert pilots operating aircraft engaged in rescue activities to danger of spatial disorientation and disseminate preventive measures not to be exposed to spatial disorientation, and coping measures to leave the situations if exposed to it by any chance.

Appended　Three-view Drawing of Bell 412EP

Scale:m



Appendix　Standards for Operation of Firefighting Helicopters

September 24, 2019

○Public Notice No. 4 of the Fire and Disaster Management Agency

The standards for the operation of firefighting helicopters are provided as follows.

Hayashizaki Osamu, the Commissioner of the Fire and Disaster Management Agency

Standards for Operation of Firefighting Helicopters

Table of Contents

Chapter I　General Provisions

(Purpose)

Article 1　The purpose of these Standards is to specify the basic matters pertaining to the operation of firefighting helicopters and thereby contribute to the safe and smooth implementation of aerial firefighting activities.

(Definition of Terms)

Article 2　In these Standards, the terms listed in the following items shall be as defined in the respective items:

(i) the term “firefighting helicopter” means a rotorcraft operated by a local government (limited to rotorcraft used for firefighting);

(ii) the term “operating organization” means a local government that operates a firefighting helicopter;

(iii) the term “aerial firefighting activity” means the use of a firefighting helicopter to extinguish a fire, perform an ambulance service, rescue a human life, collect information, carry out transportation, or conduct other firefighting activities (including training in these activities); and

(iv) the term “person engaged in aerial firefighting activities” means a person who boards a firefighting helicopter and operates it or engages in aerial firefighting activities.

Chapter II　Operating Structure for Firefighting Helicopters

(Development and Enhancement of Operating Structure)

Article 3　An operating organization shall promote the development and enhancement of the necessary organs, facilities, and installations to ensure the safe operation of firefighting helicopters.

(Establishment of Operation Manual, etc.)

Article 4 (1)　An operating organization shall establish a manual for the operation of firefighting helicopters (referred to as the “operation manual” in Article 16), which shall describe criteria for approving the takeoff of firefighting helicopters, operational considerations, and other matters necessary for managing the operation of firefighting helicopters.

(2)　An operating organization shall establish guidelines for implementing measures to effectively utilize all available personnel, materials, equipment, and information for the safe and efficient operation of firefighting helicopters (CRM).

(3)　An operating organization shall establish guidelines for implementing measures to remind persons engaged in aerial firefighting activities to monitor their surroundings and measures to call the attention of the pilot in command during the flight of a firefighting helicopter (voice procedures).

(4)　For mountain rescue, water rescue, and each type of other aerial firefighting activity for which it is deemed particularly necessary to ensure safety, an operating organization shall, taking regional characteristics into account, establish activity guidelines that describe the number of persons engaged in aerial firefighting activities to board a firefighting helicopter, the materials and equipment to be loaded onto a helicopter, the methods of rescuing persons in danger, and other matters necessary for carrying out aerial firefighting activities.

(Assignment of Flight Operations Officer and Operational Safety Manager)

Article 5 (1) An operating organization shall assign a flight operations officer and an operational safety manager to its site at which a firefighting helicopter is placed.

(2) A flight operations officer shall approve the takeoff of firefighting helicopters, direct the discontinuance of aerial firefighting activities, and be responsible for other administrative work related to the management of firefighting helicopter operations.

(3) An operational safety manager shall have expert knowledge of aircraft flight operations and other aerial firefighting activities and shall provide the flight operations officer, pilots in command, and other relevant persons with advice on the operation of firefighting helicopters, the implementation of aerial firefighting activities, the health management of persons engaged in aerial firefighting activities, and other matters deemed necessary to ensure the safe operation of firefighting helicopters; formulate basic plans for education and training as prescribed in Article 13 and implementation plans for education and training as prescribed in Article 14; and conduct research and studies necessary for these duties.

(4) An operating organization shall assign necessary personnel to assist in the administrative work of its flight operations officer.

(Two-Pilot System)

Article 6 (1) With regard to each firefighting helicopter that engages in aerial firefighting activities, two pilots (airmen who are capable of operating the relevant firefighting helicopter pursuant to the provisions of Article 28 of the Civil Aeronautics Act (Act No. 231 of 1952) (limited to those airmen who hold the competence certification for qualification as airline transport pilots or commercial pilots); the same shall apply hereinafter) shall board a firefighting helicopter.

(2) A flight operations officer shall designate one of the pilots referred to in the

preceding paragraph as the pilot in command and the other pilot as the copilot.

(3) A copilot shall assist in the helicopter operation of the pilot in command, monitor their surroundings, and also perform the duties of the pilot in command on behalf of the pilot if the pilot is unable to attend to those duties.

(Crewing Requirements for Pilot in Command and Copilot)

Article 7 (1) In addition to the requirements prescribed by the Civil Aeronautics Act and other applicable laws and regulations, and on the basis of the results of deliberation by the "Examination Committee on Crewing Requirements and Training Programs for Pilots of Medical Helicopters and Firefighting/Disaster-Prevention Helicopters" (Notice No. 6 of FDMA Mutual Aid Management Office, dated January 9, 2018: Notice of the Director of the Mutual Aid Management Office, Disaster Management Division, Civil Protection and Disaster Management Department, Fire and Disaster Management Agency), an operating organization shall prescribe flight experience requirements and other requirements that its firefighting helicopter pilots in command are required to meet.

(2) If an operating organization that has formulated a plan and has provided pilots with developmental training pursuant to the provisions of Article 11 finds it necessary for its developmental training, and only in relation to certain aerial firefighting activities that the operating organization specifies with safety taken into consideration, the operating organization may prescribe separate requirements from those referred to in the preceding paragraph for firefighting helicopter pilots in command who are to perform those aerial firefighting activities.

(3) An operating organization shall prescribe the flight experience requirement and other requirements that its firefighting helicopter copilots are required to meet.

(4) Pilots in command and co-pilots must meet the respective requirements prescribed by their operating organization pursuant to the provisions of paragraph (1) or the preceding paragraph; provided, however, that if the operating organization has prescribed requirements under paragraph (2), pilots in command to perform certain aerial firefighting activities as prescribed in the same paragraph must meet those requirements.

(Aerial Firefighting Activity Leader)

Article 8 (1) For the implementation of aerial firefighting activities, a flight operations officer shall designate an aerial firefighting activity leader.

(2) An aerial firefighting activity leader shall board a firefighting helicopter and direct and supervise persons engaged in aerial firefighting activities in relation to the implementation of aerial firefighting activities, except for the authority to be exercised by the pilot in command pursuant to the provisions of the Civil Aeronautics Act and other applicable laws and regulations.

(Gear with Which to Equip Firefighting Helicopters)

Article 9 (1) In addition to the gear, devices, materials, and equipment required by the provisions of the Civil Aeronautics Act and other applicable laws and regulations, an operating organization shall equip its firefighting helicopters with the gear, devices, materials, and equipment specified in Appended Table 1 in order to contribute to ensuring the safety of their operation.

(2) In accordance with the actual situation of its region, an operating organization shall strive to equip its firefighting helicopters with the gear, devices, materials, and equipment specified in Appended Table 2 in order to contribute to ensuring the safety of their operation.

Chapter III Education and Training

(Education and Training)

Article 10 An operating organization shall provide the following education and training:

(i) the necessary flight training for pilots to acquire and maintain flight skills and emergency operation training with a simulator;

(ii) training to ensure the smooth implementation of the measures prescribed in Article 4, paragraph (2); and

(iii) Other than those specified in the preceding two items, training that contributes to ensuring the safety of persons engaged in aerial firefighting activities.

(Developmental Training of Pilots)

Article 11　An operating organization shall formulate a plan and provide necessary developmental training to pilots so as to be able to secure pilots in a stable manner in the future.

(Confirmation of Flight Skills of Pilot)

Article 12　An operating organization shall confirm the flight skills of its pilots each year in order to contribute to the efficient development of pilots and safe and reliable aerial firefighting activities.

(Basic Plan for Education and Training)

Article 13 (1)　When implementing the education and training prescribed in Article 10, the developmental training of pilots as prescribed in Article 11, and the confirmation of the flight skills of pilots as prescribed in the preceding Article (hereinafter collectively referred to as "education and training"), an operating organization shall prepare a basic plan for education and training that specifies the following matters:

(i) objectives, contents, and implementation methods of education and training;

(ii) safety control measures for education and training;

(iii)　a development plan for the facilities and installations necessary for education and training;

(iv)　measures to secure and foster instructors who are to provide education and training; and

(v) other than the matters specified in the preceding items, matters necessary for effective and safe implementation of education and training

(2)　An operating organization shall annually review and, if deemed necessary, modify its basic plan for education and training

(Implementation Plan for Education and Training)

Article 14　On the basis of its basic plan for education and training, an operating organization shall annually prepare an implementation plan for education and training that specifies the following matters:

(i) objectives, contents, and implementation methods of the annual education and training;

(ii) target recipients of the annual education and training;

(iii) the number of hours of the annual education and training, and the implementation dates; and

(iv) other than the matters specified in the preceding three items, matters necessary for the smooth implementation of the annual education and training.

Chapter IV Aerial Firefighting Activities

(Investigation)

Article 15 In order to ensure the safe and smooth implementation of aerial firefighting activities, an operating organization shall investigate the following matters associated with the area of the operating organization, the areas of other local governments with which the operating organization has executed agreements on mutual support with regard to the implementation of aerial firefighting activities (referred to as “mutual support agreement” in Article 22), and other areas in which its firefighting helicopters are expected to operate:

(i) geographical features;

(ii) places in which a disaster necessitating aerial firefighting activities is likely to occur, and topography and weather conditions of these places;

(iii) situations, locations, structures, and management conditions of off-airfield landing/take-off sites, water supply sites for mountain/forest fire extinguishment, refueling facilities for firefighting helicopters, and other facilities and installations necessary for the implementation of aerial firefighting activities; and

(iv) other than the matters specified in the preceding three items, matters that the operating organization deems necessary.

(Approval for Take-off of Firefighting Helicopter)

Article 16 (1) When flying a firefighting helicopter, the pilot in command shall obtain the approval of the flight operations officer in accordance with the operation manual.

(2) The flight operations officer shall be aware of the weather conditions, the details of the relevant aerial firefighting activities, and the circumstances of the place in which these activities are to be carried out in as much detail as possible, and determine whether or not to give the approval referred to in the preceding paragraph in accordance with the operation manual.

(3) When a pilot in command is to operate a firefighting helicopter to carry out aerial firefighting activities, the pilot in command shall start flying a firefighting helicopter only after having conducted the confirmation prescribed in Article 73-2 of the Civil Aeronautics Act and after the aerial firefighting activity leader has finished explaining to other persons engaged in the relevant aerial firefighting activities about the objective, details, and site situation of the aerial firefighting activities.

(4) When flying a firefighting helicopter to carry out aerial firefighting activities, the flight operations officer shall pay sufficient attention to cooperation with any other firefighting team or ambulance team.

(Safety Measures Taken by Pilot in Command and Aerial Firefighting Activity Leader during Flight)

Article 17 (1) During the flight of a firefighting helicopter, the pilot in command and the aerial firefighting activity leader shall pay sufficient attention to safety management in light of the operating structure, the surrounding weather conditions and geographical conditions, the characteristics of the firefighting helicopter, the flight skills of the pilots, and the like, and decide to discontinue the relevant aerial firefighting activities if necessary.

(2) If the pilot in command or the aerial firefighting activity leader has decided to discontinue the aerial firefighting activities, the pilot in command or the aerial firefighting activity leader shall promptly report the decision to the flight operations officer.

(Safety Measures Taken by Flight Operations Officer during Flight)

Article 18 During the flight of a firefighting helicopter, the flight operations officer shall monitor the flight situation of the helicopter and collect information about the situation of the aerial firefighting activity site, the weather conditions, and other relevant information regarding the aerial firefighting activities by using, for example, a system that utilizes satellite communications for managing the behavior of firefighting helicopters; provide such information to the pilot in command and the aerial firefighting activity leader as necessary; and direct the pilot in command and the aerial firefighting activity leader to discontinue the aerial firefighting activities if the flight operations officer finds it difficult to safely implement those activities.

(System to Communicate with Relevant Organs)

Article 19　With regard to the implementation of aerial firefighting activities, an operating organization shall strive to develop a system to mutually and closely communicate with other administrative organs that employ aircraft for search and rescue (referred to as "relevant organs" in Article 23).

Chapter V　Aircraft Accident Control Measures

(Establishment of Search and Rescue System and Reporting in the Event of Aircraft Accident)

Article 20 (1)　If an accident involving a firefighting helicopter (limited to the accidents specified in the items of Article 76, paragraph (1) of the Civil Aeronautics Act; the same shall apply in the following Article) has occurred or its occurrence is suspected, the operating organization shall promptly establish a system for searching for the helicopter and conducting rescue activities.

(2)　In the case referred to in the preceding paragraph, the operating organization shall promptly report to the Commissioner of the Fire and Disaster Management Agency accordingly.

(Reporting on Case in Which Accident Is Likely to Occur)

Article 21　If a case emerges in which an accident involving a firefighting helicopter is likely to occur, the operating organization shall report to the Commissioner of the Fire and Disaster Management Agency accordingly.

Chapter VI　Mutual Support Agreement

(Mutual Support Agreement)

Article 22 (1)　An operating organization shall strive to conclude mutual support agreements with other local governments in the vicinity.

(2)　An operating organization shall strive to ensure that firefighting helicopters required for aerial firefighting activities in the area of the operating organization are available for operation at all times by, for example, adjusting the timing of inspection for firefighting helicopters necessary for receiving the airworthiness certification referred to in Article 10, paragraph (1) of the Civil Aeronautics Act (referred to as the "airworthiness inspection" in the following Article) among the operating organization and other local governments with which the operating organization has concluded mutual support agreements.

(Cooperation with Relevant Organs)

Article 23　In case the firefighting helicopters of an operating organization become inoperable for a reason such as undergoing an airworthiness inspection, the operating organization shall strive to conclude agreements with relevant organs for mutual cooperation in responding to disasters that require aerial firefighting activities in the event of such disasters.

Supplementary Provisions

(Effective Date)

Article 1　These Standards shall come into force from October 1, 2019; provided, however, that the provisions specified in the following items shall come into force from the respective dates specified therein:

(i) the provisions of Article 5, paragraph (1) (limited to the part concerning the operational safety manager) and paragraph (3):　April 1, 2021

(ii) the provisions of Article 4, paragraph (2), Article 6, Article 7, Article 10 (limited to the part concerning item (ii)), and the following Article:　April 1, 2022

(Transitional Measures)

Article 2 (1) From the enforcement date of the provisions specified in item (ii) of the preceding Article until the date on which three years elapse from the same enforcement date, if there are special circumstances in which an operating organization deems it difficult to have two pilots board a firefighting helicopter in light of the situation surrounding the ensuring and fostering of pilots, the operating organization may, notwithstanding the provisions of Article 6, paragraph (1), assign a person who holds a competence certification and aviation medical certification for qualification as an airline transport pilot or commercial pilot (limited to the qualification associated with rotorcraft) and who has received the developmental training for pilots based on a plan formulated by the operating organization pursuant to the provisions of Article 11, to board a firefighting helicopter as an operation assistant in place of one of the pilots under Article 6, paragraph (1). With regard to the application of the provisions of Article 6, paragraph (2) in this case, the phrase "one of the pilots referred to in the preceding paragraph as the pilot in command and the other pilot as the copilot" in the paragraph shall be read as "the pilot as the pilot in command and a person who holds the competence certification and aviation medical certification for qualification as an airline transport pilot or commercial pilot (limited to the qualification associated with rotorcraft) and who has received the developmental training for pilots based on a plan formulated by the operating organization pursuant to the provisions of Article 11, as an operation assistant."

(2) An operation assistant shall monitor the surroundings and provide the pilot in command with assistance, such as by advising on flight operations.

(3) An operating organization that has an operation assistant board a firefighting helicopter pursuant to the provisions of paragraph (1) shall prescribe the flight experience requirement and other requirements that operation assistants of its firefighting helicopters are required to meet.

(4) Operation assistants must meet the requirements prescribed by their operating organization pursuant to the provisions of the preceding paragraph.

Article 3 With regard to the application of the provisions of Article 9, paragraph (1) in relation to the firefighting helicopters that are in existence at the time of enforcement of these Standards and are not equipped with the gear, devices, materials, and equipment specified in Appended Table 1 (including new firefighting helicopters that local governments are in the process of acquiring at the time of enforcement of these Standards and that are not to be equipped with the gear, devices, materials, and equipment specified in Appended Table 1 according to their specifications decided through such acquisition process), the phrase "shall equip" in Article 9, paragraph (1) shall be read as "shall strive to equip."

Appended Table 1 (Re: Article 9, paragraph (1))

(i) Automatic flight control system

(ii) VOR (VHF Omni-directional Range) receiver and ILS (Instrument Landing System) receiver

(iii) Airborne DME (Distance Measuring Equipment)

(iv) Air traffic control automatic transponder

(v) Radar altimeter

(vi) Standby attitude indicator

(vii) GPS (Global Positioning System) navigation system

(viii) GPS (Global Positioning System) map display device

(ix) Traffic alert and collision avoidance system

(x) Flight data recorder and cockpit voice recorder

(xi) System that utilizes satellite communications for managing the behavior of firefighting helicopters

(xii) Satellite telephone equipment

Appended Table 2 (Re: Article 9, paragraph (2))

(i) Floats for emergency water landing

(ii) Snow-landing gear (skid skis and snowshoes for helicopters)

(iii) Lifeboat

(iv) External fuel tank

(v) Weather radar

(vi) RNAV (area navigation) device

(vii) Ground proximity warning system

(viii) Device to detect obstacles

(ix) Blackout curtain

(x) Hoist camera

(xi) Searchlight apparatus