AA2023-1

AIRCRAFT ACCIDENT
INVESTIGATION REPORT

Iwate Prefectural Disaster Prevention Aviation Corps
J A 1 0 T E

February 16, 2023

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
Chairperson
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.

《Reference》

The terms used to describe the results of the analysis in "3. ANALYSIS" of this report are as follows.

i) In case of being able to determine, the term "certain" or "certainly" is used.
ii) In case of being unable to determine but being almost certain, the term "highly probable" or "most likely" is used.
iii) In case of higher possibility, the term "probable" or "more likely" is used.
iv) In a case that there is a possibility, the term "likely" or "possible" is used.

AIRCRAFT ACCIDENT INVESTIGATION REPORT

FIREFIGHTER INJURY DUE TO WATER SPRINKLED FROM AIRCRAFT DURING FIREFIGHTING OPERATIONS IWATE PREFECTURAL DISASTER PREVENTION AVIATION CORPS (ENTRUSTED OPERATION TO TOHO AIR SERVICE CO., LTD.) AGUSTA MODEL AW139 (ROTORCRAFT), JA10TE IWAIZUMI TOWN, SHIMOHEI DISTRICT, IWATE PREFECTURE, AT ABOUT 15:31, APRIL 3, 2022

January 13, 2023

Adopted by the Japan Transport Safety Board

Chairperson TAKEDA Nobuo
Member SHIMAMURA Atsushi
Member SODA Hisako
Member MARUI Yuichi
Member NAKANISHI Miwa
Member TSUDA Hiroka

1. PROCESS AND PROGRESS OF THE AIRCARFT ACCIDENT INVESTIGATION

1.1 Summary of the Accident	On Sunday, April 3, 2022, an Agusta Model AW139, JA10TE, belonging to the Iwate Prefectural Disaster Prevention Aviation Corps, was performing forest firefighting operations in Iwaizumi Town, Shimohei District, Iwate Prefecture, and sprinkling water from the sky, but the sprinkled water directly hit to a volunteer firefighter on the ground, injuring him seriously.
1.2 Outline of the Accident Investigation	On April 5, 2022, the Japan Transport Safety Board (JTSB) received the report of the accident, and designated an investigator-in-charge and an investigator to investigate this accident. An accredited representative and an adviser of the Republic of Italy, as the State of Design of the helicopter involved in the accident, an accredited representative of the United States of America, as the State of Manufacture of the helicopter involved in the accident, and an accredited representative of Canada, as the State of Design and Manufacture of the engine of the helicopter involved in the accident, participated in the investigation. Comments on the draft Final Report were invited from the parties relevant to the cause of the accident and the Relevant States.

2. FACTUAL INFORMATION

2.1 History of the Flight	According to the statements of the Captain, the Co-pilot, the Operation

Commander*1, the Hoist Operator*2, the injured person, the witness, and the Commander of the Ground Firefighting Operations Party*3 as well as records of the Multi-Purpose Flight Recorder (hereinafter referred to as "MPFR") installed on the helicopter, the history of the flight is summarized as follows:

At 12:38 JST (JST: UTC+9 hours; unless otherwise noted, all times are indicated in JST in this report on a 24-hour clock) on April 3, 2022, an Agusta Model AW139, JA10TE, belonging to the Iwate Prefectural Disaster Prevention Aviation Corps, took off from Hanamaki Airport for conducting firefighting operations of a forest fire that broke out at about 12:00 on April 3, 2022, in Iwaizumi Town, Iwate Prefecture. In the cockpit of the helicopter, the Captain sat in the right seat as the PF*4 and the Co-pilot sat in the left seat as the PM*4. And in the cabin, there were five persons in total, consisting of an Operation Commander, a Hoist Operator and three ground support personnel.

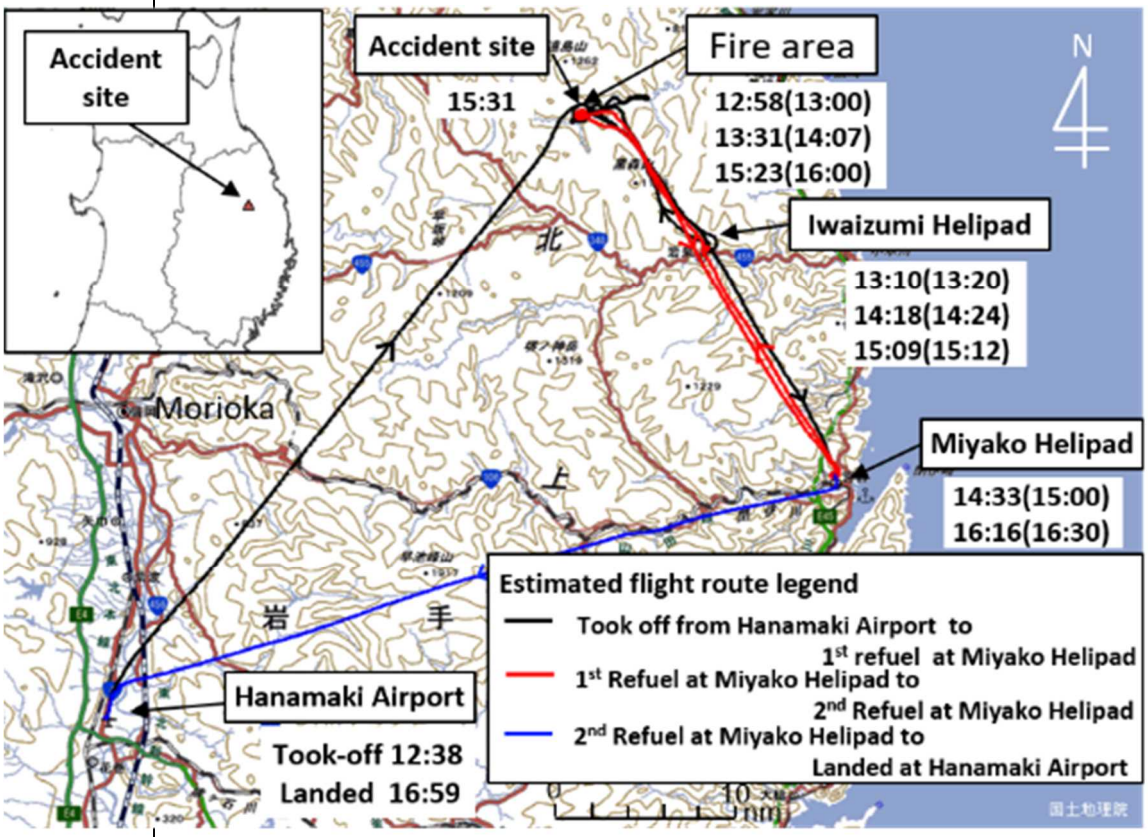

Figure 1: Estimated flight route of the rotorcraft

*1 The "Operation Commander" is a person who shall direct and supervise those persons on board the aircraft in order to properly carry out the purpose of flight operations, except for duties to be performed by the captain pursuant to the provisions of Article 73 of the Civil Aeronautics Act.

*2 "Hoist Operator" refers to a Disaster Prevention Aviation Corps Officer who performs aircraft guidance and operates fire bucket-related equipment, hoist equipment and others under the direction of the Operation Commander during firefighting and disaster prevention operations.

*3 The "Ground Firefighting Operations Party" refers to the entire unit consisting of the headquarters and the Ground Firefighting Operations Unit that conducts firefighting operations directly at the fire area.

*4 "PF" and "PM" are terms used to identify pilots by their different roles in aircraft operated by two persons. The PF abbreviates Pilot Flying and is mainly responsible for maneuvering the aircraft. The PM abbreviates Pilot Monitoring and mainly monitors the flight status of the aircraft, cross checks operations of the PF, and undertakes other non-operational duties.

	(1) Outline of the history of the flight (See Figure 1) 12:38 The helicopter took off from Hanamaki Airport. 12:58 When the fire area was checked from the sky, a weak easterly wind was blowing, and the fire area was spreading to the mountain slope. 13:10 After supplying the firefighting bucket (see 2.8 (2)) with water from the fire engine at the Iwaizumi Junior High School Temporary Helipad (hereinafter referred to as "Iwaizumi Helipad"), which was the water supplying site, the helicopter headed for the fire area. 13:31 The first water sprinkle (500 liters) started. 13:40 In order to shorten the time, the water supplying method was changed to self-watering*5 from the Akka River. 13:43 to 14:05 From the second to the sixth water sprinkle (about 200 liters/time) was conducted. 14:07 In order to prepare for changing the water supplying method and to refuel, the helicopter headed for the Miyako Fire Station Training Area Temporary Helipad (hereinafter referred to as "Miyako Helipad") via Iwaizumi Helipad. 14:18 to 14:24 The helicopter went through Iwaizumi Helipad in order to prepare for moving equipment. 14:33 to 15:00 The helicopter refueled at Miyako Helipad and headed for Iwaizumi Helipad. 15:09 to 15:12 After picking up the ground support personnel and loading the equipment at Iwaizumi Helipad, the helicopter headed for the Akka River located close to the fire area. 15:23 When the fire area was rechecked from the sky, the fire was almost brought under control and no fire was visible. 15:31 A portable pump was used to supply the fire bucket with 700 liters of water from the Akka River in an idle field next to the river. At about 15:31:40 When the seventh water sprinkle was performed, the sprinkled water directly hit a volunteer firefighter on the ground, injuring him. The circumstances of the injuries were not reported to the helicopter. The injured volunteer firefighter was transported to the hospital by ambulance after descending the mountain together with the witness to the vicinity of the Otaira Small Water Supply Facility Purification Plant. 15:36 to 15:50 Afterward, the water sprinkle was performed four times, eventually totaling 11 times. 16:59 After refueling at Miyako Helipad, the helicopter landed at Hanamaki Airport. After landing, the helicopter received a report about the injured person from Miyako Fire Department Headquarters. The injured person was diagnosed with fractures of the thoracic and lumbar, which were serious injuries. (1) Statements of the Captian, the Co-pilot, Operation Commander, Hoist

*5 "Self-watering" refers to a method of supplying an underslung external fire bucket with water by submerging the bucket in a river, lake and others and lifting it.

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Operator, the injured volunteer firefighter, volunteer firefighter (witness), and the Commander of Ground Firefighting Operations Party

(a) Captain

At the start of the firefighting operations, the water supplying point was at Iwaizumi Helipad where we unloaded necessary equipment, supplied the bucket with water, and then headed for the fire area. As it takes time to fly round trip between the fire area and Iwaizumi Helipad, we switched to self-watering from the Akka River after the second water supplying, supplying approximately 200 liters of water each time, and performed the water sprinkle five times in total. However, as sufficient water was not obtained with the self-watering method, the portable pump was used to supply the fire buckets with water from the Akka River in an idle field near the accident site, and the two fire buckets were alternately used for firefighting. We left the fire area once for preparation and refueling, loaded equipment at Iwaizumi Helipad, refueled at Miyako Helipad, and returned to the fire area.

After arriving on the site, getting the fire crews off the helicopter and unloading the equipment, we restarted the water sprinkle, setting at 700 liters as the maximum load capability because of the maximum take-off weight limitation. When the water sprinkle restarted, there were three locations where thick white smoke rose within the range covered by the helicopter. Targeting one of those locations as a water sprinkle aiming point, the helicopter started to approach. As the fire outbreak point was small in the location where white smoke was rising, the speed of the helicopter was slowed to a lower speed of about 10 kt so that the Hoist Operator could easily guide the helicopter and the fire could be effectively extinguished. As the target point would not be seen directly from the pilot's seat when sprinkling water, we performed the water sprinkle from approximately 50 m ahead of the target point, following the guidance of the Hoist Operator. After finishing the water sprinkle, we received a report from the Hoist Operator that the sprinkled water hit a volunteer firefighter on the ground. However, assuming that he would not be injured, we continued the aerial firefighting operation thereafter.

(b) Co-pilot

When sprinkling water during flight, I focused on monitoring the outside in order to avoid contact with ground obstacles. Before descending to a low altitude at the point of self-watering from the Akka River, we broadcast twice to alert the local residents through an external loudspeaker, saying "Please be careful of strong winds caused by the helicopter," but we did not do it in the location we sprinkled water.

When arriving at the fire area again after refueling, we found the fire was almost brought under control and no fire was visible. As for the Ground Firefighting Operations Unit which had been deployed on the mountain slope at the time of the accident, they were hidden in the mountain forest and could not be seen from the pilot's seat at all.

(c) Operation Commander

As the Operation Commander, I was in charge of overall operations and liaison with the Ground Firefighting Operations Party. When the water was

	sprinkled, I was checking the water sprinkle conditions while opening the left door. After refueling, we revised the plan of water supplying method and conducted the operations using two firefighting buckets alternately and the idle field near the fire area as a water supplying site. After revising the plan, firstly we started to sprinkle 700 liters of water, and in the second half of the water sprinkle operations, I saw the water hit a volunteer firefighter. Every time when sprinkling water, I used to check the situation in the vicinity of the water sprinkle area, but at that time, I did not see anyone in the forest. (d) Hoist Operator As a Hoist Operator, I sat with the right door open and operated the fire bucket while guiding the helicopter to the fire extinguishing point during the firefighting operations. In normal water sprinkle operations, I would guide the helicopter from approximately 50 m ahead of the center of the fire and call via in-flight communication by saying, "Start sprinkling water, sprinkling water, sprinkling water, sprinkling water, finish sprinkling water," after confirming whether it was safe below. When the water hit the volunteer firefighter, I was guiding the helicopter to the center of the fire emitting smoke. And at around the time of my third calling of "Sprinkling water" during the water sprinkle, I saw a figure right below and the water hitting it. (e) Volunteer firefighter (the injured person) During the firefighting operations, I wore an orange raincoat over a navy-blue happi coat. At first, I was extinguishing a fire in the valley extending from the vicinity of Otaira Small Water Supply Facility Purification Plant on the west side, therefore, I did not see the area where the helicopter was sprinkling water at all. I moved and changed the fire extinguishing site as the fire spread to the mountain top. To get to the site where I was injured, taking a roundabout path, I moved through the road made for transporting logged trees in the upper part of the mountain. When I was injured, the fire was almost brought under control and the fallen trees were still smoldering, so I was going to extinguish the fire from close range, descending the slope while further extending the fire hose, and there was no calling for attention for the water sprinkle operations by the helicopter, but suddenly the helicopter loomed over in the sky. No sooner had I thought the helicopter's nose turned toward me than the sprinkled water hit me directly. I did not remember how to avoid it. The altitude of the helicopter was very low at about 20 to 30 m. After being directly hit by the water, I was unable to speak in pain. And I descended the mountain accompanied by a nearby volunteer firefighter and was transported to the hospital. (f) Volunteer Firefighter (Witness) I was engaged in the firefighting operations together with the injured person. The fire department personnel had transceivers, but the volunteer firefighters did not have it, so I was getting information from the nearby fire department personnel. I knew the helicopter was flying, but sometimes it only passes by, so I was not sure if the helicopter would sprinkle water when the accident occurred. The location where the helicopter sprinkled water could hardly be seen from the

	valley on the west side. When the injured person was going to extinguish the fallen trees' fire that was almost brought under control but still smoldering. And when he was extending the fire hose not filled with water, and trying to attach the tip of the fire hose, the water sprinkled from the helicopter directly hit him. When the water hit the injured person, as he was stuck in a place where he could not move, he curled up his body and tried to avoid it. The helicopter was flying at an altitude of about 20 to 30 m, which is lower than usual. In case of flying over a mountain forest where the trees are higher, the helicopter would have flown at a higher altitude, but this time, the mountain was young and shrubby, therefore it might have flown low. (g) Commander of Ground Firefighting Operations Party When the helicopter started the aerial firefighting operations, the Ground Firefighting Operations Unit was responsible for the lower part of the mountain, and the helicopter was in charge of firefighting for the upper part. Approximately 70 people entered the mountain area, and the fire hoses were deployed mainly from three directions. When the accident occurred, the injured person was going to extend the fire hose while descending the slope of the mountain, but the details about how he was holding the fire hose were unknown. I obtained the information from fire department personnel via transceiver that the water had directly hit the injured person. As I heard the injured person was able to walk by himself, I instructed him to descend the mountain and rest. He was then transported to the hospital. During helicopter firefighting operations, the Commander of the Ground Fire Operations Section provides the information about general movement, but does not provide an alert every time water sprinkle operations are performed. In addition, as a general recognition, we believe that water sprinkling from a medium-sized rotorcraft will have little impact on the ground. Regarding the water sprinkling from the Chinook, a large rotorcraft of the Japan Self Defense Force, we do not allow it to go into mountain areas because of its large volume of water. This accident occurred in a mountain forest in the vicinity of Akka in Iwaizumi Town, Shimohei District, Iwate Prefecture (39°58"26 N, 141°39"54 E), at about 15:31 on April 3, 2022.
2.2 Injuries to Persons	One volunteer firefighter: Seriously injured
2.3 Damage to the Aircraft	Extent of damage: None
2.4 Personnel Information	Captain age 51 Commercial pilot competence (rotorcraft) July 7, 1992 Specific pilot competence Expiration date of piloting capable period June 1, 2023 Type rating for multi-engine turbine (land) July 25, 2000 Agusta AB139 June 1, 2016 Instrument flight certificate November 12, 2008 Class 1 aviation medical certificate validity September 22, 2022

	Total flight time 5,648 hours 47 minutes Total flight time in the last 30 days 11 hours 55 minutes Flight time on the type of rotorcraft 202 hours 41 minutes Total flight time in the last 30 days 11 hours 55 minutes
2.5 Aircraft Information	(1) Type: Agusta Model AW139 Serial Number: 41506, Date of Manufacture: September 9, 2015 Airworthiness Certificate: No. Tou-2021-439, Validity: February 2, 2023 (2) When the accident occurred, the weight of the helicopter was estimated to have been 6,384 kg, and that the position of center of gravity (CG) was estimated to have been at 537 cm. It is, therefore, highly probable that both the weight and the center of gravity were estimated to have been within the allowable range (the maximum take-off weight: 6,800 kg; the CG range that corresponds to the weight at the time of the accident: 508 to 553 cm).
2.6 Meteorological Information	(1) Observation at Regional Weather Station During the time period relevant to the accident, the observation values at Iwaizumi Regional Weather Station, which is located about 19 km southeast of the accident site, were as follows: 15:00 Wind direction East, Wind velocity 2.8 m/s, Temperature 12.2 ℃ Sunshine duration 1.0 hour, Precipitation 0.0 mm (2) Observation by the fire department personnel at the fire area According to the Commander of the Ground Firefighting Operations Party in the vicinity of the fire area, weather conditions around the accident site were as follows: Weather: Fine, Wind direction: East to southerly (turning into the slope), Wind velocity: Weak, Visibility Good From the conditions of the smoke, it was determined that the wind was weak.
2.7 Accident Site	(1) Fire occurrence location and firefighting operations status near the accident site Figure 2 shows the approximate range covered by the helicopter's water sprinkle operations, the estimated location where the volunteer firefighter was injured, and the locations where the Ground Firefighting Operations Party deployed the main fire hoses for the area where the fire spread. The fire started from about 200 m south-west of the location where the volunteer firefighter was injured, and spread northeastward on the mountain slope. The Ground Firefighting Operations Party extended the hoses from three major locations and performed firefighting operations while deploying firefighters in order to prevent the fire from spreading. On the other hand, the helicopter performed water sprinkling 11 times in the vicinity of the location where the volunteer firefighter was injured.

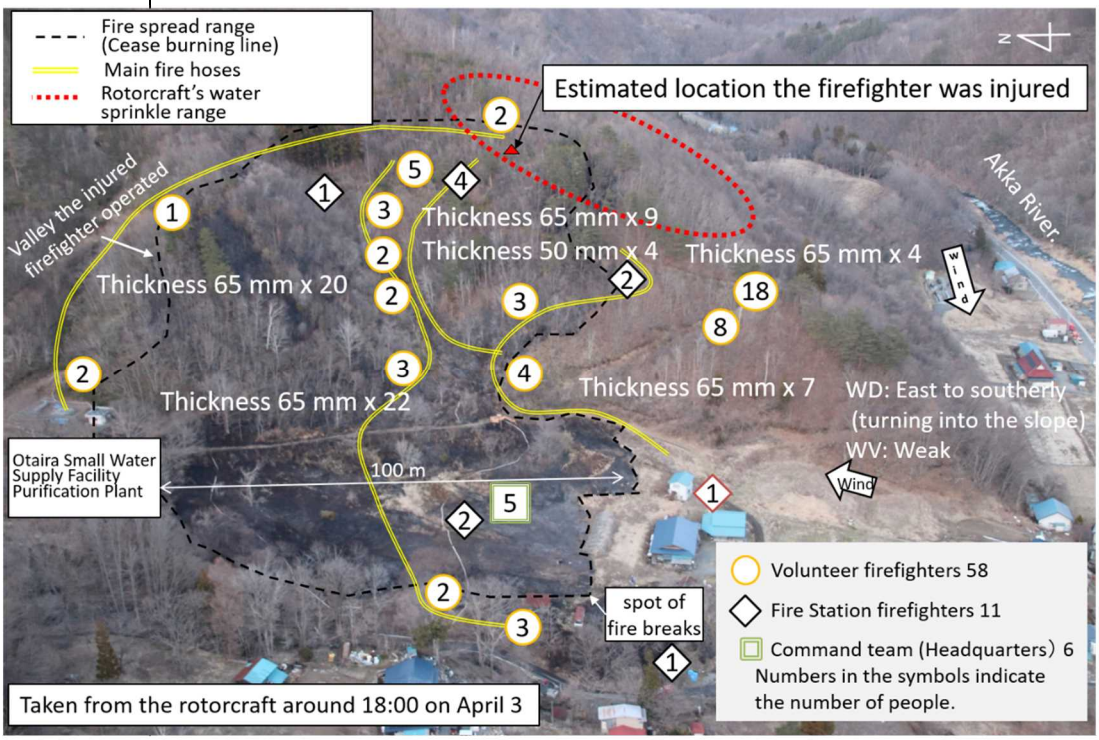

Figure 2: Fire spread range, deployment of the Ground Firefighting Operations Party and the rotorcraft's water sprinkle range

(2) The accident site

As shown in Figure 3, the area around the accident site was a slope covered with shrubby, young trees, and with thick trees here and there, and there were traces of burnt leaves and fallen trees on the ground. Besides, in a heavily wooded area in the forest, it was difficult to spot someone from the side.

Figure 3: Trees around the accident site

2.8 Additional Information

(1) Information on flight recorder

The helicopter was equipped with a Multi-Purpose Flight Recorder (MPFR) that functions both as a digital flight data recorder and a cockpit voice recorder, made by Curtiss-Wright Corporation of the United Kingdom, which recorded the flight data but did not retain any voice record information at the time of the accident, as it was overwritten.

The following are the records during the seventh water sprinkle when the accident occurred.

The flight specifications at the time of the accident (about 15:31:40) are as follows:

Pressure altitude: 1,725 ft, Radio altitude: 35 ft
(Influenced by the fire bucket, a lower altitude than the actual one was temporarily indicated.)
Ground speed: 4 kt, Airspeed: 0 kt (Unable to be indicated due to low speed)
Estimated ground clearance about 100 ft
(Difference between pressure altitude and elevation)

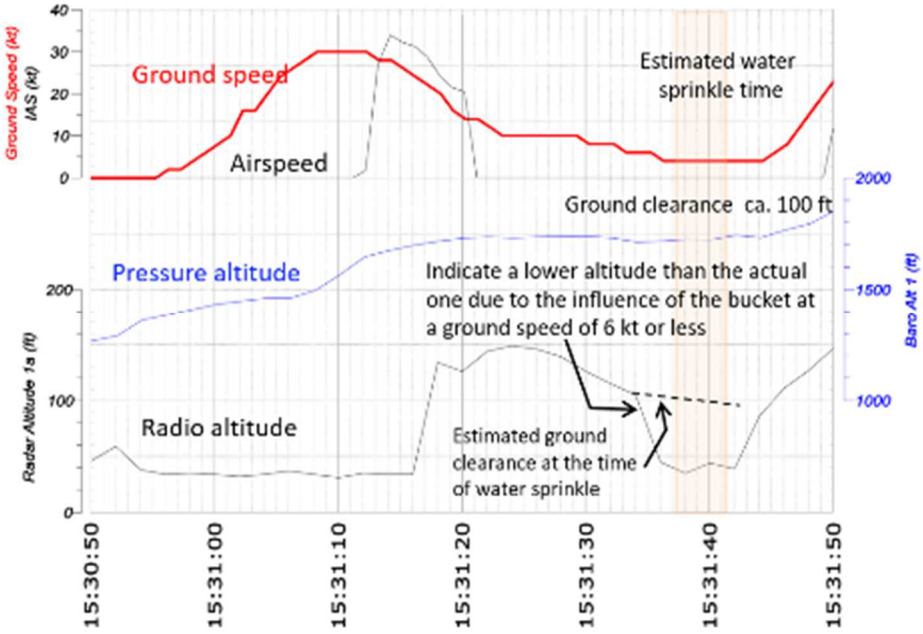

Figure 4: Flight records at the time of the accident

(2) Externally suspended firefighting bucket

The externally suspended firefighting bucket is a device, which is attached by a cargo hook to the helicopter, that can carry up to 1,200 liters of water and fire-extinguishing agent for aerial firefighting operations where water is sprinkled through its bottom on the fire area. The collapsible bucket can be carried aboard the helicopter, and at the time of sprinkling water, the onboard crew pulls the operation rope manually and water is sprinkled by opening and closing its bottom door.

There were no anomalies found in the helicopter and the externally suspended firefighting bucket.

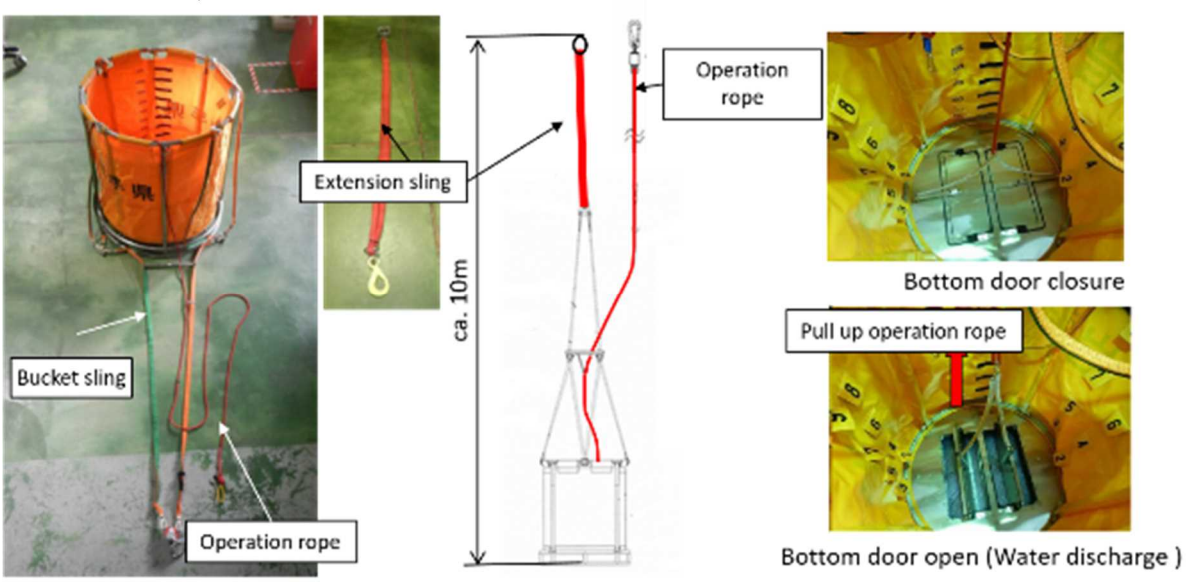

Figure 5: Externally suspended firefighting bucket

(3) Recommended flight speed and altitude at the time of sprinkling water

The firefighting operations manual of the Aviation Corps stipulates the following.

When the firefighting bucket is slung, the reference speed shall be about 60 kt or less, and it shall be about 30 kt or less at the time of discharging water. And when the bucket is empty, flying with the bottom door open can make the bucket stable.

In accordance with each forest physiognomy and fire state, it is necessary for effective water sprinkle to adjust flight altitude and speed depending on the fire extinguishing equipment to be used.

According to the "The Research Expert Committee Report on Helicopter Firefighting for Forest Fires" issued in 1996, it is required to conduct the operations while maintaining an altitude of about 100 to 200 ft and a speed of about 20 to 40 kt during aerial forest firefighting operations.

(4) Results of confirming water sprinkle conditions at different flight speeds and altitudes

At the time of the Aviation Unit's water sprinkle training using the fire bucket, the spread of water sprinkle under different flight conditions was confirmed, as shown in Figure 6.

Average wind direction and velocity at the time of confirmation:

300° 5 kt (Sprinkle course 300°)

Volume of water sprinkled: 700 liters

Confirmation result

The faster the flight speed was, the wider the sprinkled water spread. At a ground speed of 10 kt or less, the spread range became narrower, particularly, at a ground speed of about 5 kt. The influence from the flight altitude to the spread range was small, and water was sprinkled within an extremely narrow range.

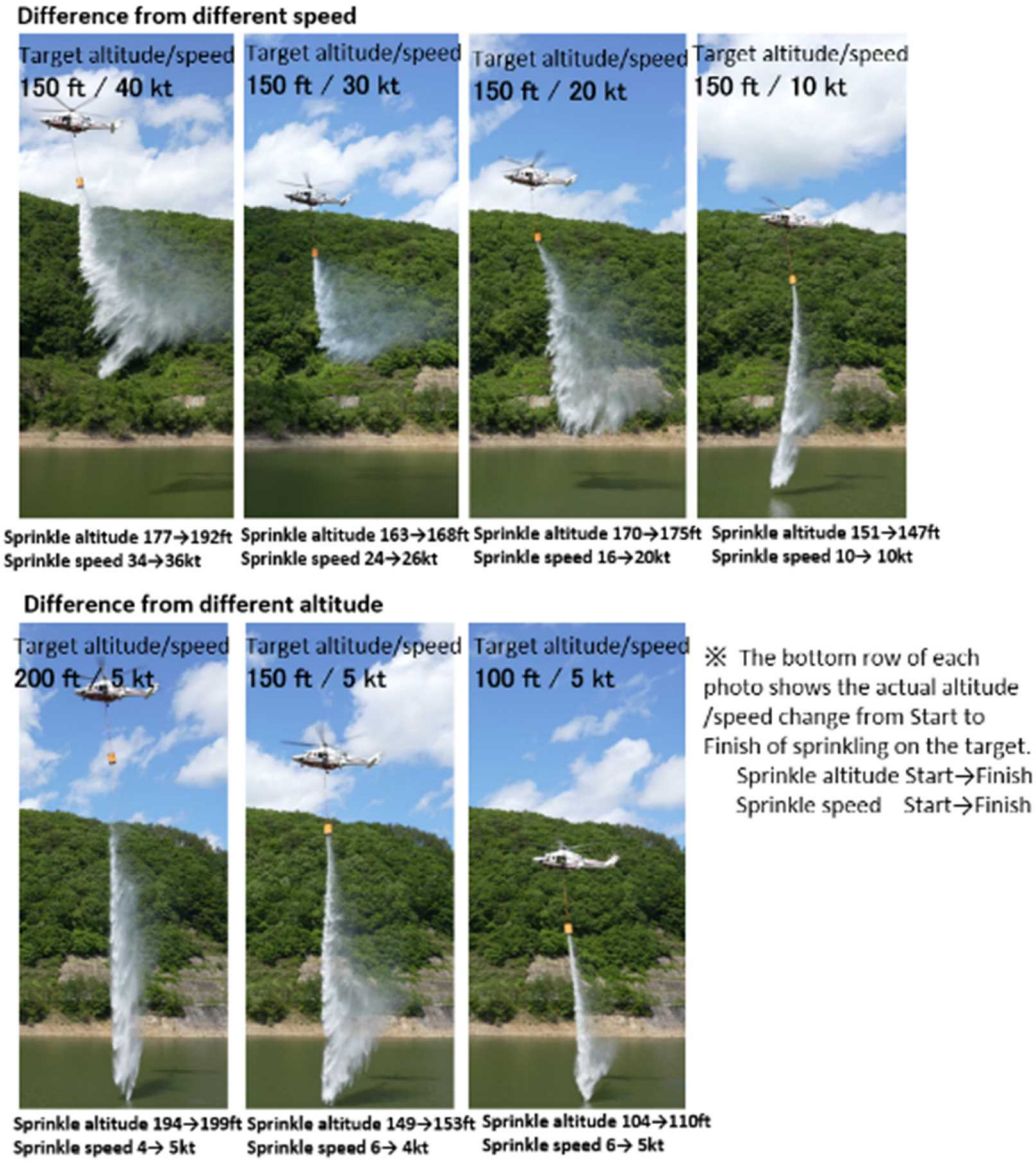

Figure 6: The spread of water sprinkle under different flight conditions

(5) Coordination between the Aviation Firefighting Team and the municipal Fire Service Agencies

The coordination with the municipal Fire Service Agencies when helicopters are dispatched to support is stipulated under the provisions of the Fire Defense Organization Act (Act No. 226 of 1947) as follows: (Excerpt)

(Coordination when an Aviation Firefighting Team is dispatched to support)

Article 48 When a prefectural Aviation Firefighting Team is dispatched to support the Fire Service Agencies of a municipality, the Aviation Firefighting Team shall act in close coordination with the municipal Fire Service Agencies that receive the support.

(6) Division of the roles and safety management at the fire area

Regarding effective helicopter forest firefighting operations, in the Research Expert Committee Report on Helicopter Firefighting for Forest Fires, etc.*6, issued

*6 "The Research Expert Committee Report on Helicopter Firefighting for Forest Fires, etc." by the National Council of

	by the National Council of Aerial Fire and Disaster Prevention in March 1998, the division of the roles between Air (helicopters) and Ground Units*7 and safety management are described as follows: *When helicopters are engaged in firefighting as its main operations, the responsibilities are divided as follows:* *Priority areas where the Air Unit (helicopters) shall respond to* ・ *Deep mountains where it takes time for the Ground Unit to enter* ・ *Steep slopes (at 30 degrees or more) that make it difficult for the Ground Unit to engage in the operations* ・ *Stony slopes near cliffs where hazards likely occur during ground operations* ・ *Dangerous locations for operations where it is difficult to secure an escape route on the ground* ・ *Areas where there are a lot of combustible materials on the ground, and there is concern that the fire may spread rapidly as it dries out* ・ *Locations where the fires spread three-dimensionally as stand fire, crown fire and others occur* ・ *Flying sparks that occurred in areas away from where the main fire spread* *Areas where the Ground Unit shall mainly respond to* ・ *Around the roads where vehicles can run through* ・ *Around the places where water supply can be secured on the ground* ・ *Gentle slopes easy to engage in the operations* ・ *Areas where the accumulation layer of combustible materials is thin and fire extinguishing methods such as fire tapping may be effective* ・ *Locations where surface fires are mainly occurring* *Areas where both shall jointly respond to* ・ *Around locations where firebreaks are set (Air Unit (helicopters): response to flying sparks, stand fire*8 *and others; Ground Unit: prevention of surface fires from spreading)* ・ *Areas where the fire is strong and the Ground Unit cannot easily approach (Air Unit (helicopters): temporary suppression of the fire, the Ground Unit: suppression and extinguishment after the fire has weakened)* ・ *Locations where the fires spread three-dimensionally (Air Unit (helicopters): suppressing crown fire*9 *and others, Ground Unit: suppressing and extinguishing surface fire)* *Safety management at the fire area* *1 Precautions for the Ground Unit* *When helicopters are engaged in firefighting operations, the Ground Unit should pay attention to the following points in and around the areas covered by the aerial operations*

Aerial Fire and Disaster Prevention (issued in March 1998 (P 36 to 37, 51))

*7 The "Ground Unit" is a generic term for the units operating on the ground including the Ground Firefighting Operations Party, logistical support, and rescue operations and others.

*8 "Stand fire" refers to a forest fire that ignites the trunks of trees.

*9 "Crown fire" refers to a forest fire that burns the branches and leaves of trees.

	・Always be aware of approaching helicopters during the firefighting operations. *・Take precautionary measures such as temporary evacuation and others, as the fires may intensify suddenly due to the downwash caused by the helicopter passing.* *・In principle, do not enter the water sprinkle area during the aerial firefighting operations.* *・When firefighting buckets are used as firefighting equipment in the aerial operations, pay attention to the helicopter's flight course, keeping in mind the risk of falling.* *・Do not carelessly give signals from the ground in order to ensure the safety of helicopter operations.* *2 Precautions for the Air Unit (helicopters)* *When helicopters are engaged in firefighting operations, the Air Unit should pay attention to the following points in relation to the Ground Unit.* *・When using firefighting buckets, avoid flying over private houses, roads, and Ground Firefighting Operations Units as much as possible by taking into consideration emergency situations such as falling equipment.* *・In principle, firefighting water shall be sprinkled in the area where there are no active Ground Firefighting Operations Units.* *・When sprinkling water in the area where the Ground Firefighting Operations Units are engaged in the operations, be sure to coordinate closely with them in advance.* *・Coordinate closely with the Ground Units in advance even when using fire extinguishing agent.*

3. ANALYSIS

3.1 Involvement of Weather	None
3.2 Involvement of Pilot	None
3.3 Involvement of Aircraft	None
3.4 Analysis of Findings	(1) Coordination between helicopters and the Ground Firefighting Operations Party Regarding the coordination between helicopters and the Ground Firefighting Operations Party, Article 48 of the Fire Defense Organization Act stipulates that "they shall act in close coordination with each other." As described in 2.8 (6), in the Research Expert Committee Report on Helicopter Firefighting for Forest Fires, etc., the division of the roles between helicopters and the Ground Firefighting Operations Party, and safety management are described, and the main responsible locations are distinguished and prioritized for each helicopter and the Ground Firefighting Operations Party. In principle, the Ground

Firefighting Operations Party shall not enter the water sprinkle area during the aerial firefighting operations, the air asset (helicopters) shall sprinkle water in areas where there are no active Ground Firefighting Operations Units, and they shall be sure to coordinate with the Ground Asset in advance when sprinkling water in the area where the Ground Firefighting Operations Unit is engaged in the operations. However, the JTSB concludes that at the time of the accident, both Air and Ground Assets did not operate in accordance with this principle.

(2) Firefighting locational overlap between the helicopter's operations and the injured volunteer firefighter at the time of the accident

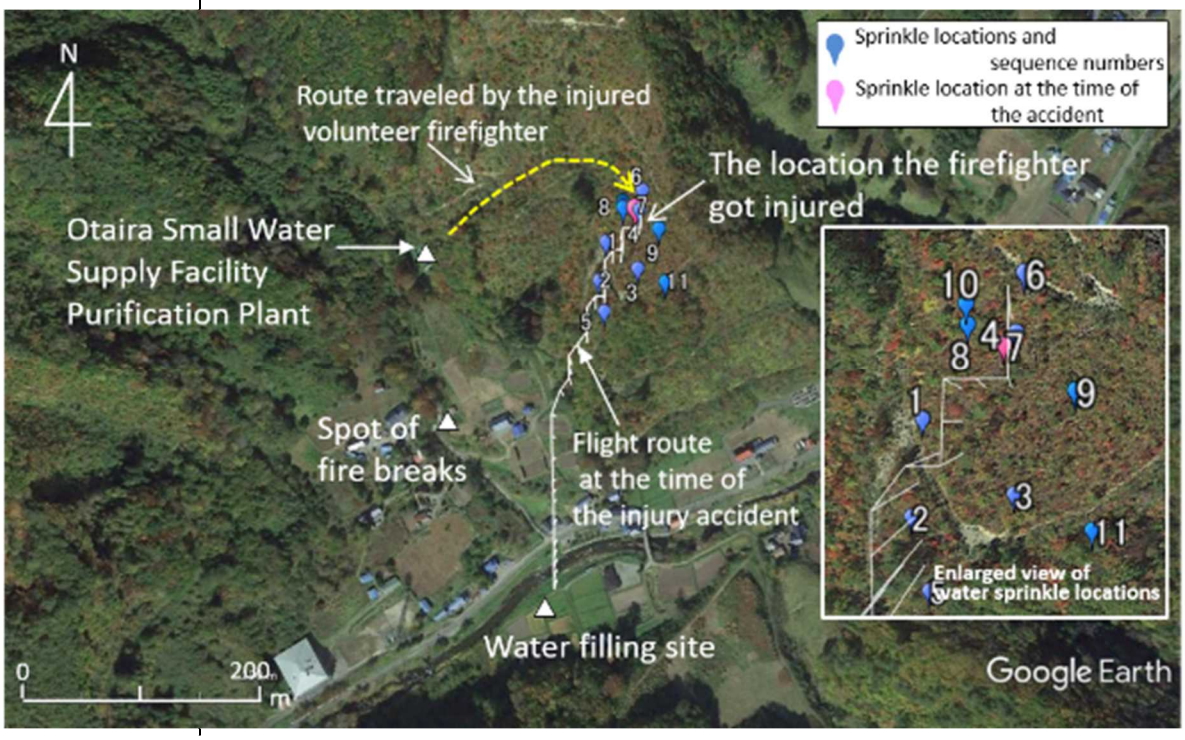

Figure 7: Route traveled by the injured person and the rotorcraft's water sprinkle locations

As the deployment of the Ground Firefighting Operations Unit and the range of the helicopter's water sprinkle operations were overlapped as shown in Figure 2, regarding the helicopter's flight history and the scene of the accident, we made a comparison between the travel direction of the injured volunteer firefighter and the helicopter's water sprinkle location as shown in Figure 7. During the first half of the firefighting operations, the injured volunteer firefighter was extinguishing the fire in the valley located on the upper side of Otaira Small Water Supply Facility Purification Plant on the west side. Besides, the helicopter was sprinkling water along the ridge of the location where the volunteer firefighter was injured. The JTSB concludes that as the helicopter was away from the vicinity of the accident site to refuel from 14:07 to 15:23, it is probable that the volunteer firefighter moved along the yellow route shown in Figure 7 and was extinguishing the smoldering fallen tree while the helicopter was not flying over the site. As the Co-pilot stated that the fire was almost brought under control and no fire was visible at 15:23 when the helicopter was flying over the fire area, the fire was more likely close to being extinguished and the fire spread range became narrower. After that, the helicopter supplied the bucket

with 700 liters of water and sprinkled water in the guided location where the smoke was coming from at about 15:31:40. However, it was probable that the insufficient coordination between the helicopter and the Ground Firefighting Operations Party resulted in the target location overlap between the helicopter and the injured volunteer firefighter, and they were extinguishing the same location where fallen trees were smoldering.

(3) Influence of the flight altitude and speed of the helicopter

At the time of the accident (at about 15:31:40), the helicopter was flying at a ground speed of 4 kt and an estimated ground altitude of about 100 ft. During the water sprinkle operations, the helicopter was sprinkling water at a lower speed than that which was recommended, because a flight altitude of 100 to 200 ft and a flight speed of 20 to 40 kt were recommended as described in 2.8 (3).

As described in 2.8 (4), when water is sprinkled at a low ground speed of 5 kt, the influence from the flight altitude is small, and water is sprinkled within an extremely narrow range. The JTSB concludes that at the time of the accident, as the fire was almost under control, the range of the fire area became narrower, therefore, the Captain more likely performed water sprinkle operations at a low speed so that the Hoist Operator could easily guide the helicopter and efficient firefighting operations could be conducted. It is possible that as the helicopter sprinkled water at a low speed of 4 kt, a large volume of water was sprinkled without spreading, which might increase the impact on the volunteer firefighter who was hit directly by the sprinkled water.

(4) Visibility and evacuation when water is sprinkled

The JTSB concludes that as described in 2.7 (2), due to the heavily wooded area around the accident site, it was more likely difficult to spot someone from the side, therefore, when the helicopter was guided to the fire area at the time of the accident, the helicopter crews would have to visually confirm the injured volunteer firefighter on the ground diagonally from above, and it was difficult for the helicopter crews to find the volunteer firefighter in an early stage. In addition, as the injured volunteer firefighter found the helicopter in the midst of being in a heavily wooded area just before the accident, it was more likely difficult for him to evacuate to a safe place after visually confirming the helicopter.

(5) Preventive measures for similar accidents

(a) Coordination between helicopters and the Ground Firefighting Operations Party

The JTSB concludes that as in the Research Expert Committee Report on Helicopter Firefighting for Forest Fires described in 2.8 (6), helicopters and the Ground Firefighting Operations Party more likely need to act in close coordination with each other. And especially, in a situation where the fire is almost extinguished, the fire spread range becomes narrower, which increases the probability of the firefighting locational overlap between helicopters and the Ground Firefighting Operations Party. It is difficult for the Ground Asset to evacuate quickly from the water sprinkle location as a helicopter flies in. Therefore, it is desirable to further consider how to closely exchange information about the helicopters' action plan and the water spray locations and ensure to

	convey the obtained information in order to avoid firefighting locational overlap. (b) Selection of appropriate flight speed The JTSB concludes that as in 2.8 (4), the spread of water sprinkle is greatly affected by flight speed, therefore, when extremely low-speed flight is required, it is necessary to sprinkle water after fully grasping the firefighting locations, taking into consideration the impact on the Ground Firefighting Operations Unit.

4. PROBABLE CAUSES

The JTSB concludes that the probable cause of this accident was that the volunteer firefighter was most likely injured because the firefighting water sprinkled from the sky directly hit the volunteer firefighter when the helicopter was performing aerial firefighting operations using an externally suspended firefighting bucket.

It is probable that the water sprinkled from the sky directly hit the volunteer firefighter because the fire was nearly extinguished, and when their firefighting locations were overlapped, the coordination between the helicopter and the Ground Firefighting Operations Unit was not sufficient.

5. SAFETY ACTIONS

The Iwate Prefectural Disaster Aviation Corps took the following measures after this accident.

In addition to reconfirming and reemphasizing the safety measures in each manual, including the firefighting manual, regarding the strengthening of coordination during disaster prevention helicopter firefighting operations, they requested each Chief of the Firefighting headquarters in Iwate Prefecture to make the following information known, and the information was provided to the Fire Disaster Prevention Aviation Unit chiefs throughout the country.

Matters for coordinating and sharing information at the time of starting aerial firefighting operations (including when resuming operations after suspension)

1 Locations and start time of water sprinkle operations by disaster prevention helicopters

2 Operation status of the Ground Firefighting Operations Party (operation locations, etc.)

3 Other matters necessary for firefighting operations