

AA2006-1

**AIRCRAFT ACCIDENT  
INVESTIGATION REPORT**

**JAPAN COAST GUARD**

**J A 6 9 0 3**

**December 21, 2005**

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

The investigation for this report was conducted by Aircraft and Railway Accidents Investigation Commission (ARAIC), on the aircraft accident involving Japan Coast Guard Sikorsky S-76C in accordance with the Aircraft and Railway Accidents Investigation Commission Establishment Law and Annex 13 to the Convention of International Civil Aviation for the purpose of determining causes of the aircraft accident and prevention of recurrence, not for the purpose of blaming responsibility of the accident.

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Junzo Sato  
Chairman,  
Aircraft and Railway Accident Investigation  
Commission

# **AIRCRAFT ACCIDENT INVESTIGATION REPORT**

**JAPAN COAST GUARD**

**SIKORSKY S-76C (rotorcraft), JA6903**

**ABOUT 9km SE OFF KONOSEHANA, SADO ISLAND,**

**NIIGATA PREFECTURE**

**Around 13:12, January 10, 2005**

**December 21, 2005**

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

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

### **1.1 Summary of the accident**

On Monday January 10, 2005, a Sikorsky S-76C of Japan Coast Guard, registration JA6903 was in rescue hoist training with Japan Coast Guard ship “Yahiko” about 9km SE off Konosehana, Sado island (13nm SE from Sado airport (RJSD), Niigata prefecture. During the training the aircraft’s No.1 engine failed and it ditched followed by capsizing and sinking.

Of the six crew members on board, one sustained serious injuries and another sustained minor injuries.

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

#### **1.2.1 The investigative organization**

On January 10, the Aircraft and Railway Accidents Investigation Commission (ARAIC) received a Serious Incident Notice and assigned an investigator-in-charge and one investigator. On January 13, the notice was renewed to an Accident Notice.

#### **1.2.2 Accredited representative and adviser by foreign authorities**

Accredited representative from the United States, the state of design and manufacture of the aircraft, participated in the investigation.

#### **1.2.3 The implementation of the investigation**

The investigation proceeded as follows.

January 12	Investigation, recovered debris
January 13	Interview, the crew and the witnesses
	Investigation, the identical aircraft and crew equipment, Japan Coast Guard ship “Yahiko”

#### **1.2.4 Comments from persons relevant to the cause of the accident**

The comments were submitted from the pilots and the Japan Coast Guard.

#### **1.2.5 Comments from the participating state**

The comments on the draft report were invited from the United States.

## **2 FACTUAL INFORMATION**

### **2.1 History of flight**

Japan Coast Guard (JCG) Sikorsky S-76C, registration JA6903 was to fly with two pilots, two mechanics and a radio operator on board to conduct a rescue hoist training with JCG ship “Yahiko”.

Maintenance log states that the preflight check was done by the captain and the mechanic and no anomalies were found.

The outline of the flight plan filed to Tokyo Airport Office was as follows.

FLIGHT RULES: VFR, DEPARTURE AERODROME: Niigata Airport, EOBT: 11:45,  
CRUISING SPEED: 120kt, CRUISING ALTITUDE: VFR, ROUTE OF FLIGHT: Higashi  
port – Kakuta – Kariha – Akadomari – Higashi port, DESTINATION AERODROME:  
Niigata Airport, ENDURANCE: 3 hours 30 minutes, PERSONS ON BOARD: 5

The aircraft took off from Niigata Airport at 11:59 and reached over JCG ship Yahiko which was about 9km SE off Konosuhana, Sado island. The aircraft did an out of ground effect (OGE) hovering check and confirmed engine condition was good. The aircraft started rescue training in which the trainees are hoisted up to the aircraft from the ship's bow deck whose heading was 180°. About 10 minutes into the training one hoisted rescuer (a diver) was on board the aircraft. The progress of the event up to the ditching was stated by the captain, copilot, two mechanics, radio operator, diver and the Yahiko administrator<sup>(note 1)</sup>.

Note 1: The administrator is the second in command of the ship and assumes the responsibilities of all the administrative matters of the ship.

#### (1) Statement of captain

I took the right seat and I was PF. About 10 minutes into the training, we were hovering above Yahiko's bow deck hoisting down a cable to the deck. Our heading was about 270° against wind of 250° 15kt. Our hovering altitude was 75 to 85ft above the sea surface.

I noticed something was wrong when I heard a warning tone. Wondering why, I checked the instrument panel and found a warning light illuminating, with No.1 engine parameter indication almost zero and No.2 engine parameter indication almost maximum. I judged the No.1 engine failed and I wanted to fly the aircraft away from the ship. The hoist cable was not yet severed. But very soon I heard the "Cable severed!" on the intercom. I started fly-away actions from the ship. I lost altitude during that period. Judging from the altitude at that time I had no option but to ditch. It was impossible to nosedive and gain airspeed for flyaway. Next thing that came into my mind was a level attitude landing. I felt it was very long before the mechanic severed the cable, however, I felt time elapsed very quickly since then followed by ditching, capsizing and sinking. Landing gears were not downed. I didn't deploy emergency floats. Float systems were armed but I couldn't shift my right thumb from the "FORCE TRIM REL SW" to the "FLOAT SW" in order to control the aircraft. The copilot could have pressed the "FLOAT SW", however, I didn't have time to order him to do so. Our operations manual states it is captain's job to deploy the floats. The aircraft flew diagonally right away from the ship and landed with almost level attitude. Upon ditching the aircraft banked right and water rushed into the cabin. I was submerged and sitting in almost upside-down. I calmed myself down and unbuckled my harnesses. My copilot had already evacuated and the copilot door was left open. I evacuated through the door.

During the course of the training I experienced no aircraft vibrations deriving from main rotor/flight control icing.

## (2) Statement of copilot

When we did an OGE power check, I found no anomalies. When No.1 engine failed, I was looking out of the cockpit. I noticed something was wrong when I heard the “Engine Out” tone. It was not preceded by any engine-out indications.

By checking the caution lights I confirmed No.1 engine failed, then checked the instrument panel vertical engine parameters. The parameters showed that the left bar was near zero and the right bar was high and yellow circular symbol indicative of 30 second power was illuminating. With all those indications I judged No.1 engine failed. While I struggle to activate the hoist cable severance switch on the lower center console, I heard the “Cable severed” intercom announcement from the aft cabin. It was the mechanic who severed the cable. The elapsed time until the ditching was well less than a minute. We made a level attitude landing. When water came in up to my ankle, the aircraft banked right and I felt it would capsize very soon. I tried to open the left cockpit door by pulling lock pin button to open the door, but it wouldn’t open. The door finally opened when water level rose up to my chin. I evacuated through the door.

Things went so rapidly there was no time to deploy the emergency floats.

OAT was somewhere between 0° to 1°C and it was snowing mixed with rain. Engine Anti-Ice switch was “On”.

## (3) Statement of mechanic A

I was a hoist operator and I was in right aft cabin. About ten minutes into the training, we were hovering, with the hoist cable lowering to the deck to pick up another diver. When the diver on the deck tugged the guide rope and was about to secure himself to the downed hook, I heard the warning tone. At first I didn’t recognize what it meant. I first thought of radar altitude warning and looked down to the deck, but the altitude was OK. Judging from the conversations between the pilots, I thought of engine failure. I said “Cable severed!” over the intercom, severed the cable without delay and said “Clear to fly away”. And the captain started an evasive maneuver. During the maneuver, I felt a shock. Maybe it was caused by the aircraft hitting the ship. Then we landed on water. The landing was smooth and the attitude was level. Just after the ditching the aircraft began to roll right and water rushed in from the open door. The aircraft rolled 90° and my body got floated. Then my hand touched left door emergency release lever. I pulled it and an emergency exit was made. The aircraft rolled another 90° to an upside-down position. Water rushed in and its level rose up to my chin. I was at a loss for a very short time whether to use an emergency oxygen bottle called “SPARE AIR®” or not. I decided not to because it takes time to take it out from my life vest. I evacuated through the exit with my safety tether anchored to the aircraft. After surfacing I tried to unbuckle the safety tether. I managed to unbuckle it after fishing and unplugging the buckle safety pin with my hand with slippery leather glove on.

(4) Statement of mechanic B

I was supporting the Mechanic A sitting next to his left. When I heard a warning tone I saw a red warning light illuminating over the captain's shoulder and he said "Engine Out". When I looked down to the ship, I noticed we're losing altitude. Then I heard a bang in the rear and felt a shock. Very soon I heard a splashing noise. The shock was smaller.

Upon landing water rushed in and water level rose to my breast level very rapidly. I noticed that the aircraft was rolling. I remember the mechanic A said he would open the left emergency exit. Then we're capsized and the cabin floor was above my head. We could breathe trapped air. I had a hard time to get myself freed from the safety tether. I don't remember how I did. As the air pocket became small, I decided to use the SPARE AIR®. After struggling to remove the bottle from my life vest, I was able to breathe. I think I removed my helmet then. I think during the egress I was hurt. I have bruises on the back of my head and my neck still hurts. I don't remember which side of door I used to exit.

Because I had a ditching training, I didn't feel scared when the water rushed in after landing. I knew the difficulty of removing the oxygen bottle from the life vest.

(5) Radio operator

I was in the aft cabin and sitting next to the left door. I remember the copilot said "No.1 --- (not audible) caution" and the captain acknowledged by uttering "Uum". The mechanic A said "Hoist cable severed". I don't have a memory until ditching. I felt a minor shock when we landed on water. Upon landing the aircraft rolled right and water rushed in through the open door. I tried to move to the open door but I was washed back. I don't remember through which door I escaped. I didn't use the SPARE AIR®. I escaped the aircraft as the last person. I remember I had a deep breath in the cabin. I escaped with the safety tether anchored and had my shoulder straps cut on the surface and I was released from it.

(6) Statement of rescuer (diver)

I was sitting on the aft seat. The engine noise waned and I thought the helicopter was losing its power. Upon landing water rushed in. I don't know which way the aircraft rolled and capsized. One of the crew opened an emergency exit. I thought that's the way out. When I submerged myself I found someone there. I pushed him out. I surfaced myself again in the cabin and breathed trapped air for a while. When I tried to escape again I realized that I was still tethered. I released the tether and evacuated the cabin. When I surfaced on the sea, I found four crew members were already afloat.

I'm not equipped with a SPARE AIR®.

(7) Statement of Yahiko's administrator

I was in the bridge observing the training. About ten minutes into the training, the helicopter came in and lowered the hoist cable hovering above the bow. Then something white streamed to rearwards from the fuselage. My first thought was snow, but I think it was smoke

generated by engines. It was pure white smoke. Just after one or two seconds when I wondered what it was, the helicopter began unstable and it was losing altitude. I didn't notice the change in engine noise. I believe the captain was trying to fly the helicopter away from the ship. It appeared the helicopter changed its heading to the left after it became unstable. It didn't elapse more than one minute, it may be as long as 30 seconds until landing after I saw the white smoke.

The helicopter came down unstably, latter half of its tail boom bumped into the bulwark and slid outboard. I saw a part flung off from the tail section. I think it was a tail rotor blade. The helicopter moved diagonally away from the ship and ditched some 30m away from the ship. I saw main rotors flung away upon touching the sea surface. I think the ditching occurred within one or two seconds after the bump into the bulwark.

Then I shifted my attention away from the helicopter, so I didn't see it roll over. When I saw it next time, the aircraft was capsized and the crew members were evacuating from it. The aircraft ditched around 13:12. It was snowing but the wind was not strong or gusty. Abrupt weather change didn't exist. There were no birds flying around us.

The last thing I wanted was the helicopter landing on the bow deck.

The accident occurred about 9km SE off Konosuhana, Sado island, Niigata prefecture, around 13:12, January 10, 2005.

(See Figure1, Picture 1, 2 and 3)

## **2.2 Injuries to persons**

The radio operator had severe injuries and the mechanic B had minor injuries.

## **2.3 Damage to the aircraft**

### **2.3.1 Degree of damage**

It is unknown because the aircraft was not recovered.

### **2.3.2 Aircraft damage by part**

- |                       |         |
|-----------------------|---------|
| (1) Main rotor blades | Severed |
| (2) Tail rotor blade  | Severed |
| (3) Left elevator     | Severed |

(See Picture 3 )

## **2.4 Damage to the properties**

Slight damage to the bulwark of the ship

## **2.5 Personnel information**



(1) Captain: Male, age 39

Commercial Rotorcraft License

Date of issue	October 4, 1990
Type Ratings	Land, Multi Turbine engine Sikorsky S-76

Class 1 airman Medical Certificate

Period of validity	October 1, 2005
Total flight hours	2,284 hours 12 minutes
Flight hours, last 30 days	12 hours 55 minutes
Total flight hours on S-76	173 hours 45 minutes
Flight hours, last 30 days	11 hours 25 minutes

(2) Copilot

Commercial Rotorcraft License

Date of Issue	November 7, 2000
Type Ratings	Land, Multi Turbine engine Sikorsky S-76

Class 1 airman Medical Certificate

Period of validity	May 7, 2005
Total flight hours	997 hours 45 minutes
Flight hours, last 30 days	8 hours 25 minutes
Total flight hours on S-76	495 hours 20 minutes
Flight hours, last 30 days	6 hours 55 minutes

## 2.6 Aircraft Information

### 2.6.1 Aircraft

Type	Sikorsky S-76C
Serial number	760483
Date of manufacture	April 25, 1998
Certificate of airworthiness	Tou-16-073
Period of validity	April 25, 2005
Categories	TA/TB or Special X
Total flight hours	3,629 hours 45 minutes
Flight hours since scheduled 100 hours maintenance check	44 hours 45 minutes

(See Figure 2)

### 2.6.2 Engines

Type: Turbomeca Ariel 2S1

Serial No.	Date of manufacture	Total time in service
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No.1	20076	February 28, 2001	1,941 hours 05 minutes
No.2	20503TEC	September 29, 1997	1,469 hours 35 minutes

### 2.6.3 Weight and Center of Gravity

The weight of the aircraft at the time of the accident is estimated to be approximately 11,148lb, with the center of gravity at 200.2in, both being within the allowable limits (maximum weight 11,700lb, with an allowable center of gravity range between 197.5in and 205.6in)

### 2.6.4 Anti-ice equipment

The aircraft was equipped with an engine anti-ice system and snow protection kit.

### 2.6.5 Fuel and lubricating oil

The fuel on board was JET A-1, with antifreeze PRIST (product of PPG Co., Specification: MIL-L-85470(A)/ASTM STANDARD D4171) added. Oil on board was Jet Oil .

## 2.7 Meteorological Information

(1) Meteorological observations by Yahiko during the period relating to the accident were as follows:

- 13:00 Wind direction WSW, Wind speed 5.5 to 8.0m/s, Visibility 6km, Cloud amount 10/10, Cloud type Nimbostratus, Temperature 1° C, Humidity 86%, Atmospheric Pressure 1,012hPa.
- 14:00 Wind direction W, Wind speed 5.5 to 8.0m/s, Visibility 7km, Cloud amount 9/10, Cloud type Nimbostratus, Temperature 2.2°C, Humidity 83%, Atmospheric Pressure 1,011hPa.

(2) Weather conditions obtained from both pilots at the time of accident were as follows:

Wind about 250°15kt, snow with rain, OAT 0° to 1°C

(See Picture 2)

## 2.8 Information on radio transmission

No anomalies were found in the radio transmissions made by the aircraft to Niigata Airport Air Traffic Control Tower and to Yahiko.

## 2.9 Information on the accident site and the debris

### 2.9.1 Accident site

According to the marine navigational chart, the accident site was the sea about 9km SE off Konosehana, Sado island, Niigata prefecture. Some debris were afloat. The aircraft capsized and sank. The marine navigational chart reads the depth of the accident site to be about 500m.

### 2.9.2 Detailed information of the aircraft damage

The exact damage of the aircraft is unknown because the aircraft was not recovered. Debris recovered on the bow deck and from the sea surface were as follows.

(1) Three severed main rotor blades (MRBs) and an elevator were recovered from the sea surface. It was obvious that three MRBs were severed by the impact into the sea upon landing. The MRB measured span-wise about 2.3m, 2.5m and 3.5m respectively. They were all severed about one meter away from each main rotor hub.

Left elevator was severed at the root and it had a big span-wise crack.

(2) One tail rotor blade was recovered on the bow deck of the ship. It was obvious it was severed due to the aircraft's contact with the bow of the ship. The outer blade end was rounded and the paint was scratched off.

(See Picture 4)

### **2.9.3 Ship's Damage**

(1) The ship's flag post in the bow was bent to port at the attachment point to the handrail on the bulwark.

(2) The vertical handrail beside the ladder under the flag post was bent to starboard at its base with three scratches at its top and two scratches at the height of bulwark.

(3) Part of paint on the handrail was scratched off and it was dented to the depth of about 5mm. The shape of the dent formed an arc, and it was estimated to be dented by a high velocity rotating object.

(See Picture 5)

### **2.10 Medical Information**

Those who were injured received treatments at Hospital in Niigata city. One was hospitalized due to pneumonia caused by inhalation of sea water and the other sustained minor head injuries.

### **2.11 Rescue operations**

Following the ditching of the aircraft, at 13:14 the ship lowered a rescue boat to the surface and started rescue activities with four personnel on board. At 13:15 all on board the aircraft was confirmed to have evacuated from the capsized aircraft. All evacuees were rescued at 13:21.

### **2.12 Tests and research to find facts**

#### **2.12.1 Rate of descent from an OGE hovering with one engine inoperable (OEI)**

To obtain rate of descent from an OGE hovering with OEI, ARAIC requested the manufacturer of S-76C to compute the rate of descent. The conditions of computation and the result were as follows.

(1) Conditions

- a. Gross weight: 11,148lb
- b. Engine: Turbomeca Ariel 2S1
- c. Power in use: 30 second power
- d. NR: 100%
- e. OAT: 1°C
- f. Hovering altitude: 80ft
- g. Relative wind: Left 20°, 14kt

(2) Result

Rate of descent is 550fpm, however, this value varies depending on pilot input.

**2.12.2 The cause of No.1 engine failure**

Inquiries were made to the engine manufacturer what is meant by white smoke from the exhaust pipe. The manufacturer's reply was;

Judging from the temperature, humidity and the existence of moisture, it is highly provable that the engine flame out occurred and atomized fuel went through the exhaust pipe.

**2.13 Other necessary information**

**2.13.1 No.1 engine maintenance record**

The engine was manufactured on February 28, 2001. The maintenance works applied to the engine were those designated by AD/SB and periodical maintenance. No module exchanges were done. No anomalies were found as for the maintenance record.

**2.13.2 Engine's anti-freezing capability**

- (1) The engine manufacturer states that instantaneous snow, ice or water of 40g will not cause engine mechanical failure and flame-out.
  
- (2) The aircraft manufacturer states that S-76C/C+ engine inlet design (configuration) is certified by Authorities to operate under snowfall and blizzard condition.

**2.13.3 Operational limitations of the aircraft**

The S-76C Rotorcraft Flight Manual states its operational limitations as follows (excerpts).

*2.9 Operational limitations (Icing related parts only)*

- a. Flight in known icing condition is prohibited.*
- b. Flight in falling or blowing snow is prohibited unless aircraft is fitted with snow protection kit (P/N 76076-30008-013) and a satisfactory functional check has been performed.*
- c. Activate the engine anti-ice systems when OAT is below 2 deg. C and visible water is observed.*

## 2.13.4 Emergency procedures

The S-76C Rotorcraft Flight Manual states OEI and ditching procedures as follows.

### 3.3 SINGLE ENGINE POWER FAILURE

*Symptoms:*

*Initial:*

*Large torque split*

*No.1 or No.2 ENG OUT warning light and alternating tone*

*Confirming:*

*Nr remains 107% Nr or droops depending upon collective position.*

*Torque decreases to zero*

*N1 decreases below ground idle*

*N2 decreasing.*

*T5 decreasing*

(Unnecessary portions omitted)

#### 3.3.2 SINGLE-ENGINE FAILURE – HOVER (5 to 10 FEET)

- a. Maintain collective pitch setting or lower collective slightly to establish descent.*
- b. Increase collective to cushion landing as touchdown becomes imminent.*
- c. After touchdown, neutralize cyclic and simultaneously reduce collective to minimum.*

(Unnecessary portions omitted)

#### 3.24 DITCHING (FLOATATION SYSTEM)

*The optional emergency floatation system is designed for emergency landing on water. This system may be expected to keep the helicopter upright long enough to permit passengers and crew to exit the life rafts or rescue boats<sup>(note 2)</sup>. A subsequent takeoff or long term towing should be attempted.*

Note 2: Emergency floats are activated by electricity and have enough buoyancy to keep the aircraft afloat.

(Unnecessary portions omitted)

##### 3.24.1 DITCHING PROCEDURES

- 1. Floatation system test switch – Check NORM*
- 2. Landing gear - DN*

#### NOTE

*If the landing gear cannot be extended for any reason, the floats can be deployed with*

*the gear retracted.*

**CAUTION**

*Operation of the landing gear during or after float inflation may result in damage to the floats and partial loss of floatation capability.*

*3. Float arming switch - ARMED*

*4. Press the cyclic stick float inflation switch. Allow sufficient time for full inflation prior to water contact.*

**NOTE**

*Float inflation time is 10 seconds. (JA6903's float inflation time is 5 seconds because its expansion agent is Helium gas.)*

*5. Notify all occupants to prepare for emergency water landing.*

**2.13.5 Emergency ditching procedure**

Aircraft Operations Manual (Internal safety directive) states emergency ditching procedure as follows.

*9.1.2 Emergency ditching/evacuation and crew task*

*4. Task*

*(1) At the onset of an emergency*

*a. Captain: Start emergency procedure*

*b. Copilot: Support the captain, monitor instruments and take care of radio transmission.*

*c. Mechanic: Monitor engine instruments and advise the captain.*

*(Unnecessary portions omitted)*

*(2) When the conditions never improves;*

*a. Captain: Decision to ditch (to where and how)*

*b. Copilot: Send distress information (location, altitude, heading, nature of emergency, estimated point of ditching)*

*c. Mechanic: Check aft-cabin preparedness and be in support of the captain.*

*(Unnecessary portions omitted)*

*(3) On final approach*

*a. Captain: Control the aircraft*

*b. Copilot: Prepare for the ditching, be in support of the captain*

*c. Mechanic: Assume emergency landing posture*

*(Unnecessary portions omitted)*

*(4) Landing on water*

*a. Captain: Shut down the engines*

*b. Copilot: Be In support of the captain*

*c. Mechanic: Assume emergency landing posture*

(Unnecessary portions omitted)

### **2.13.6 Emergency training and safety equipment**

#### (1) Ditching training

All crewmembers except mechanic A received ditching training either at the Maritime Self Defense Force training facility or at the JCG training facility during the time period between March 2001 and February 2003. Mechanic A had experienced actual ditching before.

#### (2) Diving training

The rescuer (a diver) finished his two month diving training in November 2004.

#### (3) SPARE AIR®

SPARE AIR® is stored on the left lower front portion of the life vest with a nylon strap and Velcro® tape.

Among three personnel with SPARE AIR® on board in the cabin, only one of them used it. The rest considered its use, however, they didn't use it because it takes time to remove it from the life vest.

#### (4) Safety tether

A safety tether is a body restraint gear with belt, shoulder harnesses and a tether. Unbuckling the belt enables a crew to be released from the gear. A belt and shoulder harnesses are adjustable. The length of a tether is about 3m and it can be anchored to the aircraft fitting. Because 3m is long enough for activities in the cabin, tethers are adjusted to the length <sup>(note 3)</sup> which enables crews to stay inside of the cabin to cope with unexpected attitude change.

In order to unbuckle one has to pull out a safety pin and pull the release lever. The pin has a hole for a safety cord. The other end of the pin is bent to keep itself in position while being inserted.

One of the aft-cabin occupants unleashed himself from the safety tether and evacuated the aircraft, however, remaining two evacuated with the tether anchored. Of the two, one managed to unleash himself after surfacing, the other had his shoulder harnesses cut by someone else and unleashed himself.

Note 3: The average length of adjusted tethers which were found in the identical type aircraft at Niigata air base was 1.7m.

(See Picture 6 and 7)

### **2.13.7 Consistency to the Aeronautics Law**

In accordance with the proviso of article 81, Aeronautics Law, the permission to fly below minimum safety altitude was obtained.

### 2.13.8 Hoist operations

(1) The hoist cable can be severed by activating hoist shear switches in the cockpit or right aft cabin.

(2) It was not stated in the Aircraft Operations Manual who should activate the switch in case of emergency during hoist operations. The captain's pre-flight mission briefing didn't cover the emergency hoist cable severance.

However, the tacit understanding existed among personnel at Niigata air base that the one operating the hoist activates the "sever" switch, if this is not appropriate a copilot does the job.

(3) The Rotorcraft Flight Manual states that the height-velocity diagram does not constitute a limitation when conducting hoist operations.

(See Figure 3)

### 2.13.9 Rescue hoist training

In JCG 9<sup>th</sup> Region, most of rescue hoist trainings are conducted using JCG ship Yahiko and aircraft dispatched from Niigata air base.

Trainings are classified as joint training. In the training the ship and the aircraft act on equal basis. Judgment on flight is aircraft captain's responsibility. The judgment to continue the training or not is coordinated between the aircraft and ship captains. The ship-side and the aircraft-side have safety rules respectively.

### 2.13.10 Necessary time for evasive action after visual recognition

"Flight and Psychology"<sup>(note 4)</sup> describes the necessary time for target recognition/judgment as follows.

*Recognizing an object requires 1.045 seconds, which is divided into 0.1 seconds for catching an object image on the retina, 0.295 seconds for shifting one's gaze to it, 0.65 seconds for recognition. In addition 2 seconds for decision, 0.4 seconds for pilot input, about 2 seconds for aircraft response are necessary for the onset of evasive action, in other words about 5.5 seconds of latitude is necessary for evasive action. When a pilot's attention is outside of the cockpit, checking the instrument, seeing the outside and focusing the faraway target requires additional 2.32 seconds.*

Note 4: Dr. Isao Kuroda, "Flight and Psychology" p23. Published by Obunshorin in 1977

### 2.13.11 Icing

(1) "New Aeronautic Weather"<sup>(note 5)</sup> describes general condition necessary for icing as follows.

*Icing needs two conditions.*

*1. An aircraft is required to fly in the rain or droplets in the clouds.*

*2. The temperature of water droplets encountering an aircraft needs to be 0°C (32°F) or below.*



*In clear atmosphere likeliness of icing is small, however, in the area with temperature of near 0°C and high relative humidity, icing occurs due to moisture freezing caused by air expansion when the air travels over propellers and/or wing surface.*

(Unnecessary portions omitted)

*Severe icing occurs between temperature range of -10°C and 0°C (15°F and 32°F).*

(Unnecessary portions omitted)

*Air expansion and associated temperature decrease have possibility of reducing wing surface temperature by 1° to 2°C.*

Note 5: Umeji Hashimoto and Yoshio Suzuki, "New Aeronautic Weather" p176, published by Japan Weather Association on April 25, 1998

(2) Intensities of icing accumulation are defined as follows in the U.S.<sup>(note 5)</sup>

*TRACE: Ice becomes perceptible. Deicing equipment is not utilized unless encountered for over 1 hour.*

*LIGHT: If the deicing equipment is used occasionally, it is able to remove the icing.*

*MODERATE: The rate of accumulation is such that even short encounters become potentially hazardous and use of deicing equipment or flight diversion is necessary.*

*SEVERE: The rate of accumulation is such that deicing equipment fails to reduce or control the hazard. Immediate flight diversion is necessary.*

Note 5: AIMJ P.8-36, Edited by Civil Aviation Bureau, Ministry of Land, Infrastructure and Transport

### **3. ANALYSIS**

#### **3.1 Aircrew certificates and medical certificates**

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

#### **3.2 Certificate of airworthiness**

The aircraft had a valid certificate of airworthiness and was maintained in accordance with applicable regulations.

#### **3.3 Relations with the weather conditions**

At the time of the accident it was snowing with rain and the temperature was 1°C and humidity was 86% (equivalent to dew point -1°C). It was 1° away from freezing point, and as the picture 2 shows moisture existed in the air. Given the trigger of reduced temperature it is considered that the icing might occurred.

#### **3.4 Aircraft operations**

(1) Aircraft operations under icing conditions

As described in 2.13.3 it is prohibited to operate the aircraft under the known icing conditions. These conditions are interpreted that OAT is below 0°C and water droplets exist in the air. The aircraft encountered snow and rain with snow protection kit and engine anti-ice system respectively.

The rotorcraft flight manual does not specify to what extent of icing flights are allowed, however, judging from the onboard anti-icing capabilities, it is estimated that “Light” intensity of accumulation is the upper limit.

Relationship between icing and No.1 engine failure is described in paragraph 3.8, however, it is considered that icing on main rotors did not occur because pilots did not comment on the vibrations before the engine failure.

## (2) Hoist operations

As described in 2.13.8 the height-velocity diagram does not constitute a limitation. However, hoist operations take place in the hatched area of the height-velocity diagram, where it is preferred not to fly, in the case of OEI it is difficult to land safely and the aircraft has to resort to emergency landing/ditching.

Therefore, when conducting hoist operations, pilots should observe engine instrument closely to detect engine malfunction, and under the weather condition of near 0°C temperature, rain and snow, which is considered to have higher probability of icing and that leads to OEI, training requiring long duration of hovering in the hatched area of height/velocity diagram should not be done. For OEI, the captain should be well prepared for the procedures to reduce the harm to the occupants/outside people and damage to surrounding properties.

## **3.5 Actions taken from the engine failure to the water landing**

### (1) Duration from the engine failure to the water landing

With manufacturer’s descent rate computation of 550fpm and assumed hovering height of 80ft, about 9 seconds is the result of the calculation for the duration between the engine failure and the water landing. Given the pilot input and ground effect it is considered that this figure might have changed.

### (2) Actions taken until water landing

Referring to the description in 2.13.10 estimation was made how many seconds does a pilot need to react in the above mentioned situation.

2 to 3 seconds to check the instrument panel after hearing a warning tone, see outside and focus his gaze on some objects; about 2 seconds for decision making; 2 to 3 seconds for pilot input and aircraft response, all add up to 6 to 8 seconds. Given pilot action under high psychological tension it is considered about 9 second was barely enough time for him to do all the necessary things by himself by the time he lands the aircraft on water.

### (3) Aircraft maneuver

The aircraft, trying to fly away from the ship, bumped into ship's bulwark with its tail section, and landed on water. During the course of descent left elevator and one tail rotor blade were detached from the aircraft leaving dents and scratches on handrail and flag pole. Main rotor blades were severed by hitting the surface of the sea.

(4) Possibilities of gaining speed and altitude after becoming OEI

Taking into consideration the hovering altitude at which the OEI occurred on height-velocity diagram, it is doubtful that the aircraft picks up speed and lift and flies away with OEI before it lands on water.

### 3.6 Survival factors

(1) Emergency floats

Given the on-board floats' buoyancy it is considered the pilot should have tried to activate the system to inflate them even after ditching, although it is not clear whether they could have been electrically activated underwater. Inflated floats should have helped crew members evacuate by keeping the aircraft afloat, providing rescuers with certain amount of time even if occupants were trapped inside.

(2) Evacuation training

Because all personnel on board had ditching/diving training or experience of actual evacuation, they probably evacuated with some amount of psychological leeway.

One occupant suffered pneumonia after inhaling water, however, it is considered that this has no connection with the evacuation training he had earlier.

(3) SPARE AIR®

Judging from how the SPARE AIR® was attached to the life vest and its use, it is considered difficult to use it under emergency situation.

It is suggested that JCG should make some improvement for quick removal of the SPARE AIR® from the life vest.

(4) Safety tether

In order to be released from the aircraft, cabin occupants have to undo the harnesses or do something to the tether. For the former, (a) the occupant has to unbuckle the belt or (b) loosen shoulder harnesses and belt and undo the harness. For the latter, the occupants have to (c) cut the tether with a knife or something or (d) unlock the anchor from the cabin fitting.

Option (a) requires quick and sure release of the safety pin. Option (b) requires loosening of three points and undoing the harness. Option (c) raises an issue of safe utilization of sharp knives under confusion by all occupants at the same time. Option (d) raises question of quick locating one's anchor to the cabin fitting and a released tether may be trapped by some aircraft components during evacuation.

Feasible option (a)'s present status is that it is considered difficult to withdraw the safety pin out of the buckle with gloved hands under confusion of ditching because the pin head is not shaped suitable for a gloved finger.

Therefore improvement should be made onto the safety tether to make it possible for a wearer to release himself with gloved hands under emergency situations.

### **3.7 Crew duties**

The mechanic knew the situation on the ship deck best and he severed the hoist cable without letting an opportunity slip away. Aircraft Operations Manual does not state specifically who should sever the hoist cable in the event of emergency, JCG should clarify who should do this.

As stated in 2.13.5, duties of captain and copilot are "aircraft control" and "in support of the captain" respectively. The captain's understanding was that it's his duty to inflate floats. It is considered that some discrepancy existed between his understanding and his duty in the Aircraft Operations Manual. Even if he was occupied to control the aircraft, copilot must have had a chance to push the FLOAT SW. Consequently these lead to the insufficient emergency counteraction. Upon revision of the Aircraft Operations Manual, procedures should be realistic and situation oriented.

### **3.8 Reasons for No.1 engine failure**

Provable causes for engine failure are FOD, fuel system malfunction and internal mechanical failure.

(1) As stated in 2.1(7) there were no sea birds flying in the vicinity of the ship, possibility of FOD suction is negated.

The weather condition was such that it didn't deny the possibilities of icing. It is probable that the icing developed in the engine inlet area and detached ice chunks were sucked into the engine and this lead to flame-out. However, discrepancies exist to support this theory. They are:

- a. The aircraft was equipped with engine anti-ice system and it was functioning.
- b. The aircraft was equipped with snow protection kit and it was functioning.
- c. The engine manufacturer guarantees the engine's capability against snowfall and icing.
- d. The aircraft manufacturer guarantees that the engine inlet is designed to be operational under snowfall and blizzard condition.
- e. No.2 engine, operating under the identical condition of No.1 engine, did not fail.

(2) If No.1 engine failed due to fuel system malfunction, fuel system cautions should have lit and pilots should have noticed, however, they only noticed "Engine out warning" tone. Thus it is considered that no fuel system malfunction occurred.

(3) If No.1 engine failed due to mechanical failure in the engine, engine related cautions should have lit and pilots should have noticed, however, they only noticed "Engine out warning" tone.

Thus it is considered that no mechanical failure occurred.

(4) In above mentioned (1) and (3), signs of destruction are supposed to be left on compressor blades and turbine blades, however, no confirmation was made because the engine of the aircraft was not recovered.

Whatever the reason for the engine failure, atomized fuel was expelled through the exhaust pipe and was witnessed by the ship administrator. The reason for No.1 engine failure, among above mentioned reasons, (1) is considered to have higher probability.

### **3.9 Captain's situation awareness toward hoist operations**

It is estimated that the captain had his situation awareness that he was flying the aircraft under the weather conditions with small margin of icing, however, with no icing oriented vibrations, with engine anti-icing system and snow protection kit, his estimation for icing was low.

The aircraft can reach airfield safely if OEI occurs during cruise flight, however, in this case the OEI occurred during hoist operations, sole option for the captain was to land on water.

The captain, not being overconfident with the aircraft and engine performance, should have been more cautious to weather conditions, and made decisions with larger margin of safety.

## **4. PROBABLE CAUSE**

In the accident, while conducting the rescue hoist training, in which the aircraft was hoisting up a personnel from the ship deck, the aircraft's No.1 engine failed, followed by ditching and capsizing, and occupants of the aircraft sustained serious injuries.

It is considered possible that ice chunks were sucked into the engine leading to an engine failure, however, the cause of the failure was not determined because the engine of the aircraft was not recovered.

## **5. ACTIONS TAKEN BY JCG**

JCG has taken the corrective actions after the accident. They are as follows.

### **(1) Revision of JCG Aircraft Operations Manual**

- a. Additional procedures to counter inadvertent engine failure were added to the hoist operations.
- b. Float deployment procedures for ditching were made more specific.

### **(2) Modification of life vests**

Modifications for quick removal of the SPARE AIR® were made to life vests and they were distributed to each air base.

Figure 1 Accident site layout

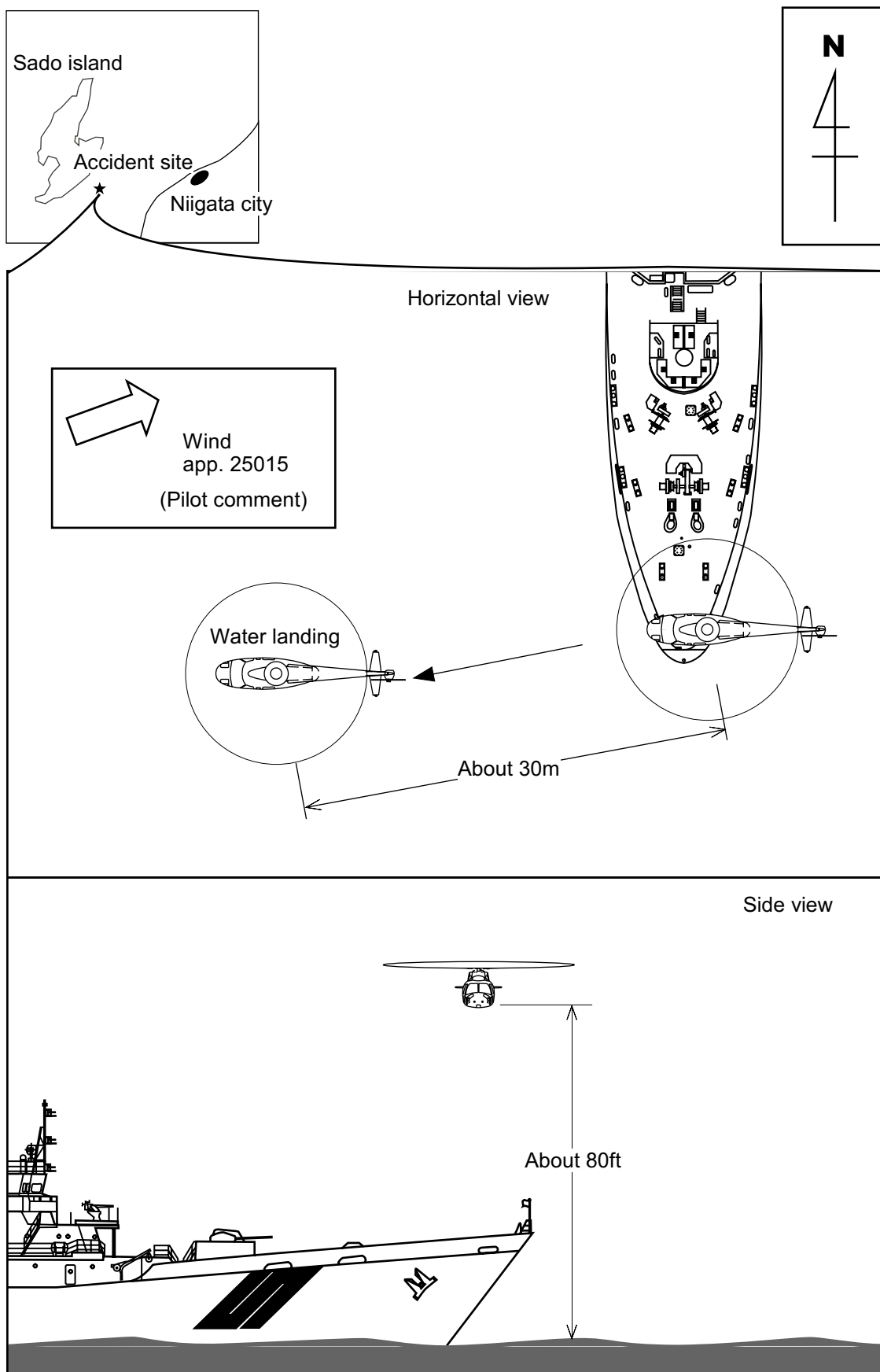


Figure 2 Three-angle-view of Sikorsky S-76C

Unit : m

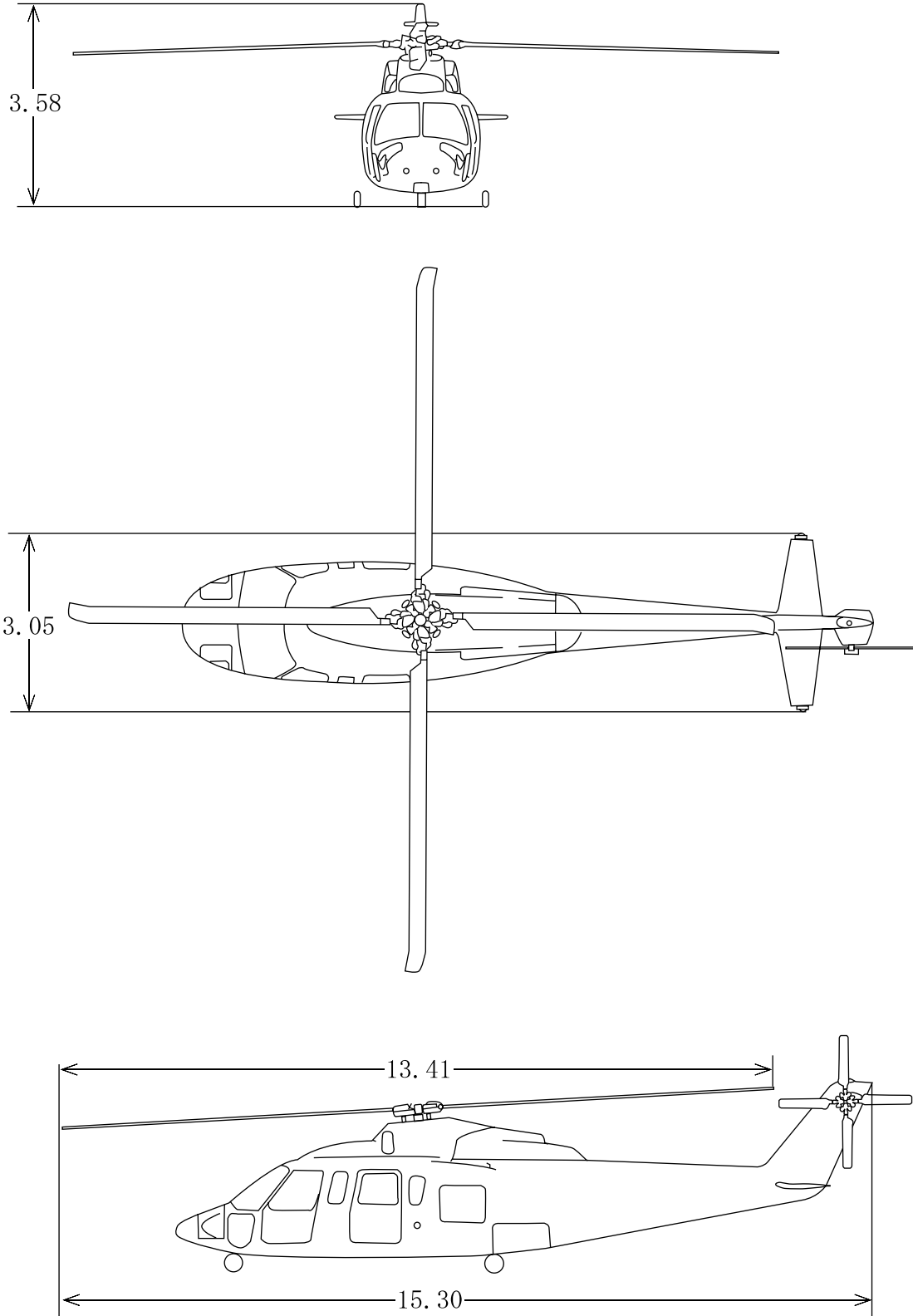


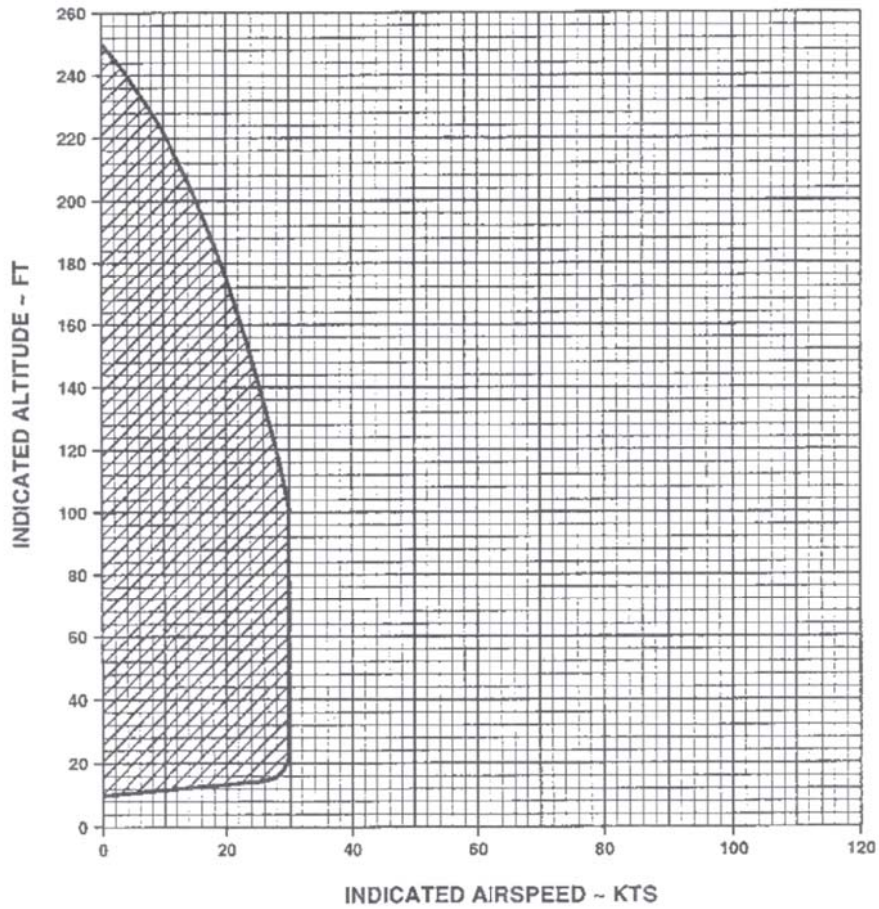
Figure 3 Height/Velocity diagram

**LIMITING HEIGHTS AND CORRESPONDING  
SPEEDS FOR SAFE LANDING AFTER AN  
ENGINE SUDDENLY BECOMES INOPERATIVE**

THESE CURVES ARE APPLICABLE TO ALTITUDES AND TEMPERATURES AT THE CORRESPONDING MAXIMUM ALLOWABLE TAKEOFF GROSS WEIGHT AS DETERMINED FOR CATEGORY A OR B. THE HIGH HOVER POINT IS BASED ON MAXIMUM OGE HOVER WEIGHT.

- INFORMATION ON TEST CONDITIONS:
1. HARD SURFACE RUNWAY
  2. WINDS 5 KTS OR LESS
  3. STRAIGHT TAKEOFF AND CLIMBOUT PATH
  4. GEAR DOWN AT ENTRY

NOTE: AVOID FLIGHT WITHIN SHADED AREA EXCEPT AFTER INITIATING FLARE FOR A NORMAL LANDING.



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SA

Figure 1-4. Height/Velocity Diagram  
FAA APPROVED JUNE 19, 1996



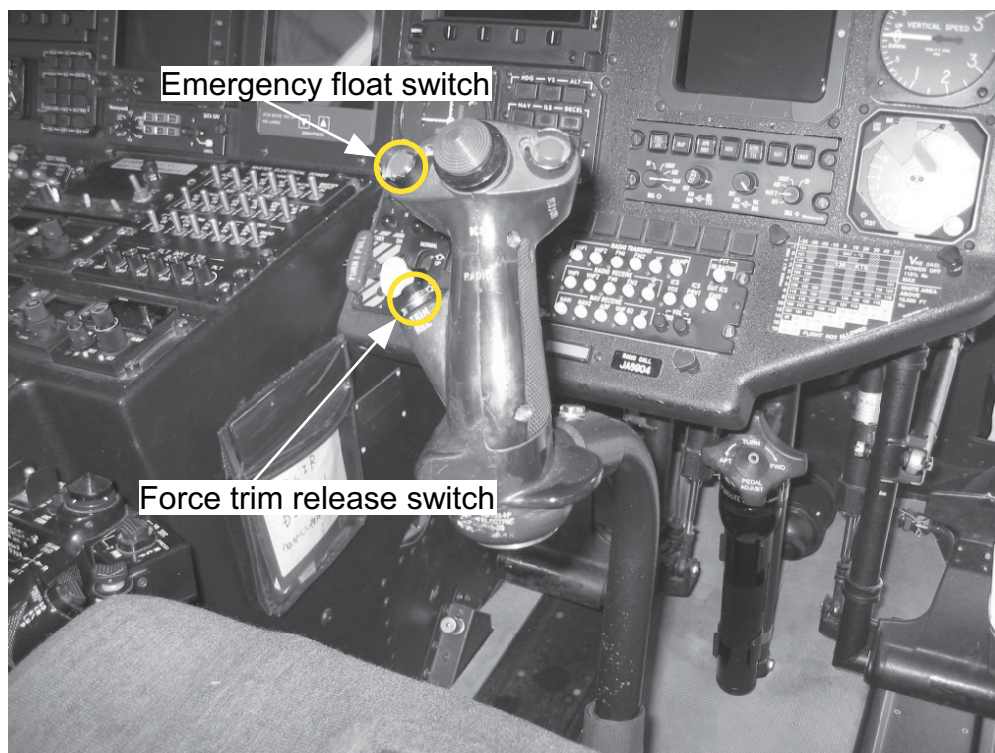
Picture 1 Accident aircraft and Rescue hoist training



Picture 2 Snowfall

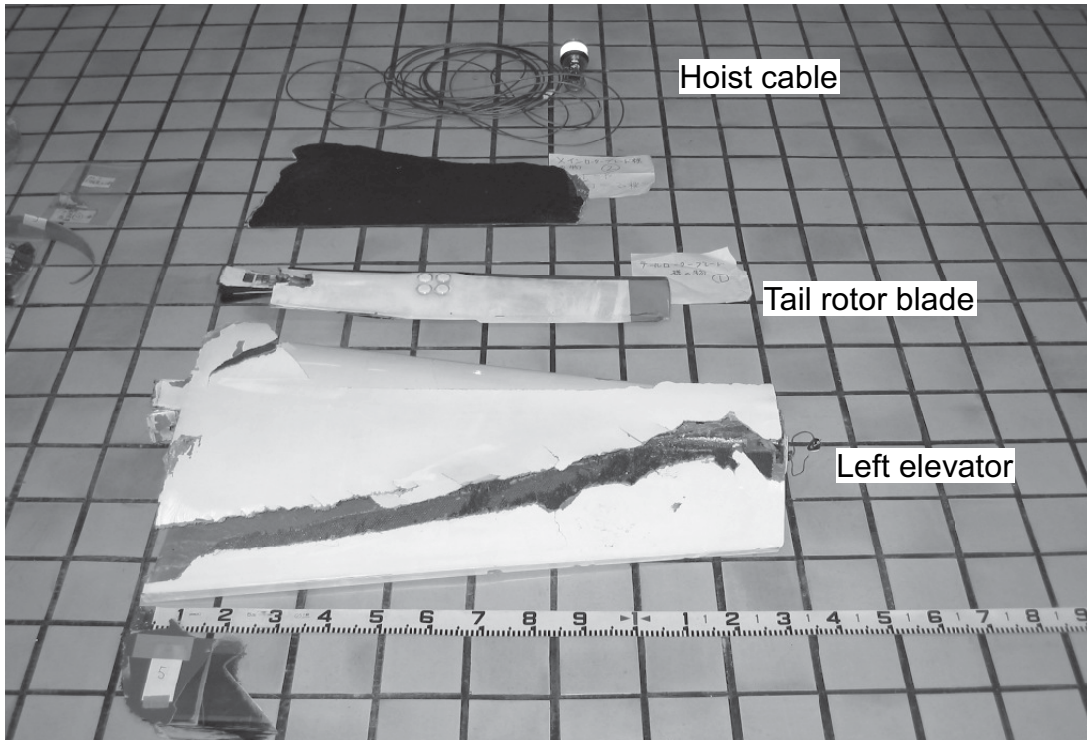
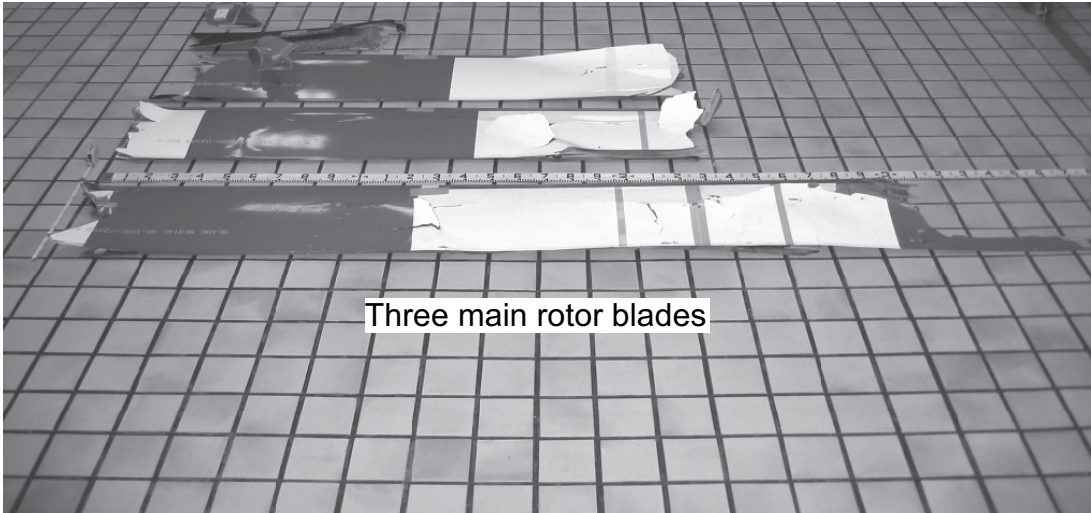


Picture 3 Cyclic stick



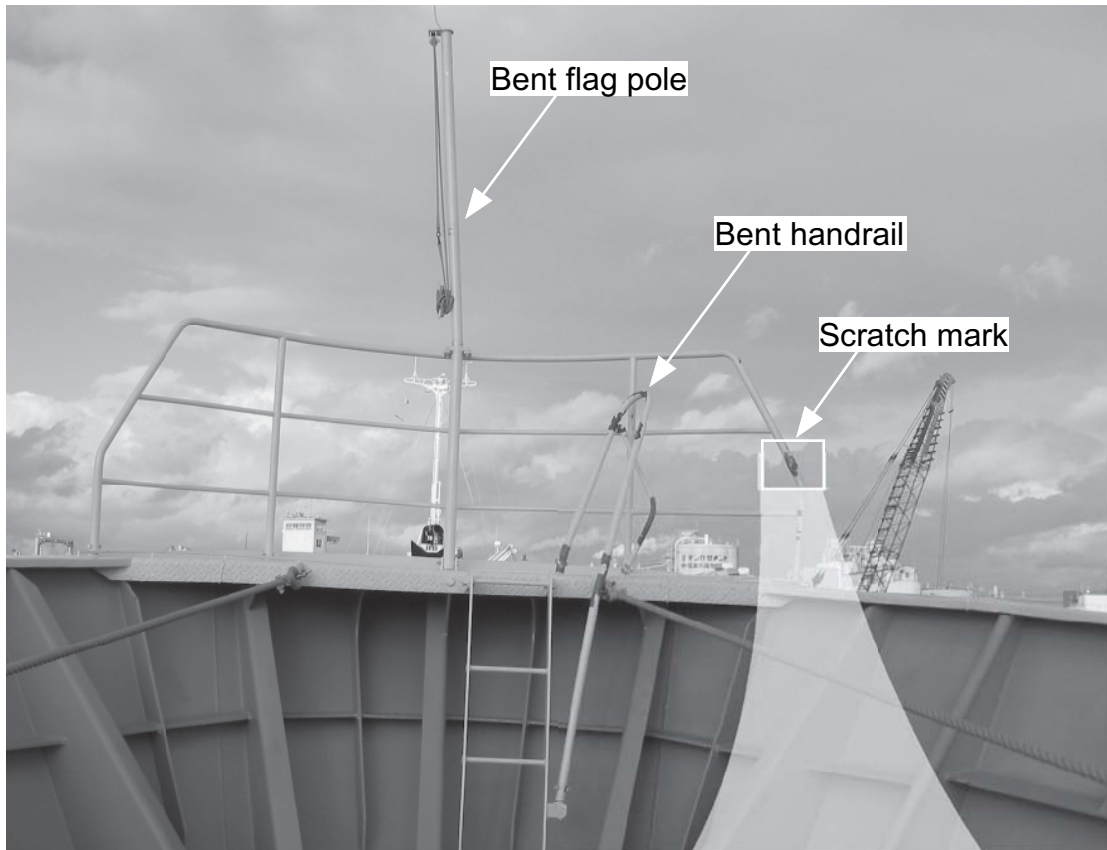
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Picture 4 Recovered debris





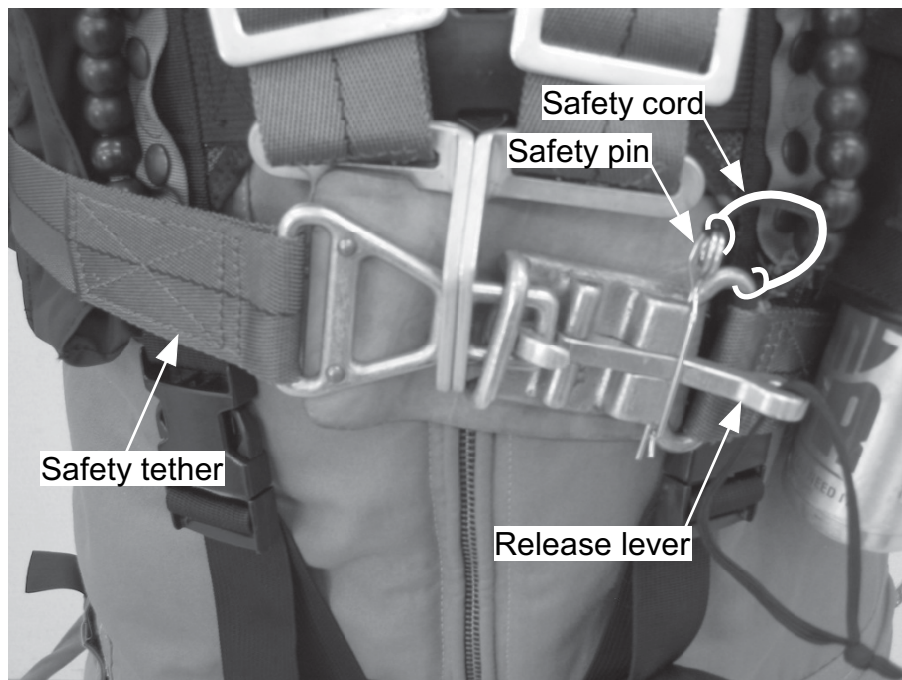
Picture 5 Damages left on the ship



Picture 6 SPARE AIR®



Picture 7 Buckle, Safety tether



Note The color of safety cord is changed for clarity.