

AA2012-5

**AIRCRAFT ACCIDENT  
INVESTIGATION REPORT**

**TOKYO SKYDIVING CLUB**

**J A 5 5 D Z**

**June 29, 2012**



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.

Norihiro Goto  
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

**OPERATING AGENCY : TOKYO SKYDIVING CLUB**

**AIRCRAFT TYPE : CESSNA 208B**

**AIRCRAFT REGISTRATION : JA55DZ**

**ACCIDENT CATEGORY : SKYDIVER CONTACTED WITH AIRCRAFT**

**OCCURRENCE TIME : AT ABOUT 16:55 JST, JULY 10, 2011**

**OCCURRENCE POINT : IN THE AIR, ABOUT 11,000 FEET ABOVE HONDA AIRPORT**

May 25, 2012

Adopted by the Japan Transport Safety Board

Chairman	Norihiro Goto
Member	Shinsuke Endoh
Member	Toshiyuki Ishikawa
Member	Sadao Tamura
Member	Yuki Shuto
Member	Toshiaki Shinagawa

## SYNOPSIS

### 〈Summary of the accident〉

On July 10 (Sunday), 2011, at about 16:28 Japan Standard Time (JST: unless otherwise stated all times are indicated in JST), a Cessna 208B, registered JA55DZ, operated by the Tokyo Skydiving Club, took off from Honda Airport for a skydiving flight with 20 people on board, including the Captain, a passenger and 18 skydivers. The skydivers exited from the aircraft into the airspace over the airport, and the aircraft landed at Honda Airport at around 17:10. After landing, the Captain inspected the aircraft and found the leading edge of the left horizontal stabilizer to be damaged, and one skydiver was slightly injured in both legs.

### 〈Probable causes〉

In this accident, it is highly probable that when Jumper A started his dive from the Aircraft, he failed to follow the basic established procedure, and this resulted in both his legs making contact with the left horizontal stabilizer of the Aircraft and consequently damaging the airframe.

With regard to Jumper A having made contact with the left horizontal stabilizer of the Aircraft, it is possible that the contributing factors are a higher than usual airspeed of the Aircraft climbing at full engine power, a strong air flow around the horizontal stabilizers due to the slipstream from the propeller rotating under full power of the engine, and the ram-air pressure Jumper A received, which was higher than usual due to the failure to take the proper action required when diving in a wingsuit.

## ACRONYMS

USPA	United States Parachute Association
FAR	Federal Aviation Regulations
VFR	Visual Flight Rules

## CONVERSION TABLE

1 ft	: 0.3048 m
1 kt	: 1.852 km/h (0.5144 m/s)
1 lb	: 0.4536 kg
1 in	: 25.4 mm
1 nm	: 1.852km

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

## **1.1 Summary of the Accident**

On July 10 (Sunday), 2011, at about 16:28 Japan Standard Time (JST: unless otherwise stated all times are indicated in JST), a Cessna 208B, registered JA55DZ, operated by the Tokyo Skydiving Club, took off from Honda Airport for a skydiving flight with 20 people on board, including the Captain, a passenger and 18 skydivers. The skydivers exited from the aircraft into the airspace over the airport, and the aircraft landed at Honda Airport at around 17:10. After landing, the Captain inspected the aircraft and found it to be damaged.

The aircraft sustained substantial damage and one skydiver was injured.

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

### **1.2.1 Investigation Organization**

On July 12, 2011, the Japan Transport Safety Board designated an investigator-in-charge and another investigator to investigate this accident.

### **1.2.2 Representatives from Foreign Authorities**

An accredited representative of the United States of America (USA), as the State of Design and Manufacture of the aircraft involved in this accident, participated in the investigation.

### **1.2.3 Implementation of the Investigation**

July 13, 2011            Interviews and aircraft examination

August 12, 2011       Interviews and aircraft examination

### **1.2.4 Comments from the Parties Relevant to the Cause of the Accident**

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

### **1.2.5 Comments from the Relevant State**

Comments were invited from the relevant State.

## 2. FACTUAL INFORMATION

### 2.1 History of the Flight

On July 10, 2011 at about 16:28, a Cessna 208B, registered JA55DZ (hereinafter referred to as “the Aircraft”), operated by the Tokyo Skydiving Club (hereinafter referred to as “the Club”), took off from Honda Airport (hereinafter referred to as “the Airport”) for a skydiving (hereinafter referred to as “diving”) flight with 20 people on board: the Captain, a passenger and 18 skydivers (hereinafter referred to as “jumpers”).

The diving started after the aircraft had climbed to an altitude of 13,000 ft while turning in an area within 5 nm from the Airport.

The flight plan of the Aircraft was outlined below:

Flight rules:	Visual Flight Rules (VFR)
Departure aerodrome:	Honda Airport
Estimated off-block time:	16:30
Cruising speed:	100 kt
Cruising altitude:	VFR
Destination aerodrome:	Honda Airport
Total estimated elapsed time:	30 minutes
Fuel load expressed in endurance:	3 hours 00 minute

The history of the flight up to the time of the accident is outlined below, according to the statements of the Captain and a jumper.

#### (1) Captain

After arriving at work at around 8:20 in the morning, the Captain checked the diving schedule for the day and the flight order sheet, and completed an exterior inspection of the aircraft and other relevant tasks in time for the scheduled takeoff time at 9:00. The time allotted for each flight was about 30 minutes from the start of taxiing to the landing, and the accident occurred during the eighth flight.

The Captain took off from Runway 14 due to the southerly winds on that day. After the takeoff, he climbed to about 13,000 ft while making turns. Upon receiving a message from the jumpmaster\*<sup>1</sup> for that flight saying that the diving would be started at a point one dot (about 0.2 nm) offset westward from the centerline of the Airport and about 45 seconds before reaching above the center of the Airport, the Captain initiated an approach after checking the start point on the GPS receiver.

After flying on the jump run\*<sup>2</sup> (about 3 nm), the straight leg leading to the diving start point, the Captain set the flaps to 10° one minute prior to the ‘power cut’ (reducing the engine power to idle) and, while decelerating and maintaining the altitude, retarded the

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\*<sup>1</sup> The “jumpmaster” is a person who is educated in the safe operation of the aircraft, has the skills and knowledge necessary for diving, and is authorized, under instructions from the Captain, to supervise and give directions on the exit order of other jumpers.

\*<sup>2</sup> The “jump run” refers to the course segment on which the aircraft makes a final approach with the nose heading in the direction of the diving start point in order that the jumpers exit from the aircraft.

engine throttle to idle on a “power cut” call from the jumpmaster. The diving was then started. The Captain had recently allowed for some power when retarding the engine throttle rather than setting the power to idle as was his previous habit, because setting the power to idle results in too great a loss of altitude; consequently, too short a time in the air for the jumpers. However, even with this power control, the altitude decreases at a slow rate (about 250 ft/min), so that at the time when the 5th group of jumpers finished diving, the aircraft was at about 12,500 ft.

The first 16 jumpers (1st to 5th groups) finished diving in about two minutes. When the remaining two jumpers (6th group) told the Captain that they wanted to allow additional time between themselves and the preceding group, he turned the Aircraft and flew the same course in reverse. The two jumpers also told the Captain that they did not mind a lower altitude, and so he retarded the engine throttle to descend the Aircraft. At about 11,000 ft above the runway, one of the two jumpers took his dive. The other jumper (hereinafter referred to as “Jumper A”) was to dive in succession. However, at his request to make another turn, the Captain tried to fly the original course by making a left turn. While flying at about 10,000 ft, Jumper A made another request for an increased altitude. So the Captain increased the engine power for a climb.

At about 11,000 ft, during a climb with the heading toward the Airport, the Captain heard a small ‘hitting’ sound and turned his head to look back, finding that Jumper A had already exited the Aircraft. The Aircraft at that time was configured with the flaps extended and the pitch angle at about 8° and was climbing at a rate of about 700 ft/min without banking while the engine was at full power. The normal airspeed for diving flight is between 70 and 80 kt, however the Aircraft was then flying at about 100 kt. It is standard practice for jumpers to loudly call “power cut” prior to diving to obtain permission from the Captain. The hitting sound was small, suggesting that something like a piece of metal made contact with the airframe skin, and the Captain felt no shaking in the Aircraft.

At the exterior inspection of the Aircraft after landing, the Captain found large dents on the leading edge of the left horizontal stabilizer as well as deformation of its top surface. The extent of the dents implied to the Captain that if Jumper A had made contact with the airframe, he would have sustained a serious injury, but the actual injury to Jumper A was identifiable only by the slightly red marks on his legs. On the day of the accident, the visibility was more than 10 km, there were scattered clouds between 5,000 and 6,000 ft, and the wind was weak up in the air. There were no problems for the flight.

(2) Jumper A

Jumper A wore a wingsuit (described in Section 2.9) on the day of the accident and was scheduled to dive as a member of the last of the six groups. All the jumpers in the 1st to 5th groups dived in the south-to-north direction as usual.

After that, while the Aircraft was flying from north to south after making a U-turn, the first of the two jumpers in the 6th group took his dive. Jumper A was scheduled to dive just following the preceding jumper. However, the Aircraft was losing altitude while flying toward the south and the preceding jumper’s parachute was already deployed at a

point not so different in altitude from the Aircraft. Jumper A thought that an attempt to join the preceding jumper would not be successful in this situation, and so he requested the Captain to make a U-turn by turning left for another approach to the Airport from a point in the southeast and to increase the altitude as well. Jumper A assumed that his falling speed in a wingsuit would be greater than that of the preceding jumper who was wearing a regular suit and had his parachute deployed, and he thought, therefore, that a greater difference in altitude between the two would be preferable for successful joining.

Subsequently, while the Aircraft was making turns and climbing, Jumper A lost sight of the preceding jumper's parachute. In addition, he was worried about being unable to keep to the runway time limit when he was now at a point quite a distance from the Airport, so that Jumper A rushed to exit. The Airport was in view from where he made the exit. Jumper A used to call "power cut" to have the pilot reduce the engine power, but he did not do this on the day of the accident.

Jumper A remembered that he had felt a sudden pain in both legs just after jumping out and then he was spinning. However he does not recollect where and how his body hit the Aircraft. He first thought that he had hit somewhere on the door edge. It is standard practice for the jumper to exit directly abeam of the Aircraft with his head toward the Aircraft's nose and deployment of the wings limited to the minimum possible and then open the wings after leaving the Aircraft. In standard diving without using a wingsuit, the time before deployment of the parachute is about 60 seconds. When diving in a wingsuit, it is possible to nearly double the time as the wingsuit allows gliding and thus reduces the rate of fall. Jumper A thought that he exited in the same way as usual on that day, but he later thought that, when jumping out, he might have opened his legs a little earlier.

Jumper A was able to stop spinning and subsequently regained his balance, but gave up trying to join the preceding jumper. He deployed his parachute at an altitude between 2,500 and 3,000 ft, and landed at the target point in a normal attitude. He had cross-running abrasions on both legs, with the more extensive and painful wound being on his left leg. However, he did not feel that the injury was serious enough to go to the hospital.

Jumper A had about 12 years of diving experience and had dived about 5,000 times, but he had never experienced such an occurrence. The weather was fine with no clouds or noticeable wind on that day.

This accident occurred about 11,000 ft above the Airport (Latitude 35°58'29"N, Longitude 139°31'31"E) at around 16:55 on July 10, 2011.

(See Figure 1 – Estimated Flight Path; Photo 1 – Accident Aircraft; and Photo 2 – Jump Door.)

## **2.2 Injuries to Persons**

One jumper sustained a minor injury (bruises and abrasions to both legs).

## 2.3 Damage to the Aircraft

### 2.3.1 Extent of Damage

The Aircraft sustained substantial damage.

### 2.3.2 Damage to the Aircraft Components

Horizontal stabilizers      The damage to the leading edge of the left horizontal stabilizer consisted of a 35-cm-wide dent with a maximum depth of 10 mm and a 5-cm-wide dent with a maximum depth of 2 mm (with a distance of 50 cm between the two dents) and the rivets were missing.

The top surface of the left horizontal stabilizer was deformed (creases).

(See Photo 3 – Damage to Horizontal Stabilizer.)

## 2.4 Other Damage

There was no other damage.

## 2.5 Personnel Information

(1) Captain: Male, Age 39

Commercial Pilot Certificate (Airplane)	March 21, 2000
Type rating for single engine (Land)	April 9, 1998
Class 1 Aviation Medical Certificate	
Validity:	December 30, 2011
Total flight time	4,597 h 27 min
Flight time in the last 30 days:	20 h 4 min
Total flight time on the type of aircraft	828 h 56 min
Flight time in the last 30 days:	0 h 0 min
Experience in diving flights on the type of aircraft:	About 1,600 flights
	(as reported by the Captain)

The Captain is a pilot dispatched from Honda Airways Co., Ltd. (hereinafter referred to as “the Company”), which is a competent air carrier/aerial work operator. Although the Company’s operations manual does not apply to the private operation of the Aircraft, the Company has an in-house operations manual established for the diving flights of the Aircraft.

(2) Jumper A: Male, Age 37

The United States Parachute Association\*3 (hereinafter referred to as “USPA”)

D License\*4

Validity:

March 31, 2012

Total times diving:

About 5,000 times

(as reported by Jumper A)

## 2.6 Aircraft Information

### 2.6.1 Aircraft

Type:	Cessna 208B
Serial number:	208B-0530
Date of manufacture:	April 2, 1996
Certificate of airworthiness:	DaiTo-22-630
Validity:	March 22, 2012
Category of airworthiness:	Airplane Normal N or Special Aircraft X
Total flight time:	6,510 h 58 min
Flight time since last periodical check (C check conducted on March 23, 2011)	95 h 39 min

(See Figure 2 – Three Angle Views of Cessna 208B.)

### 2.6.2 Weight and Balance

When the accident occurred, the Aircraft’s weight is estimated to have been 5,697 lb and its center of gravity is estimated to have been 188.3 in aft of the reference line, both of which are estimated to have been within the allowable range (maximum takeoff weight of 8,750 lb and center of gravity range of 180.5 – 193.37 in corresponding to the weight of the Aircraft at the time of the accident).

## 2.7 Meteorological Information

The weather observations at the Saitama Regional Meteorological Observatory Station, located about 12 km south-southeast of the accident site, around the time of the accident were as follows:

17:00	Wind direction	South;	Wind velocity	3.0 m/s (average)		
	Wind direction	South;	Wind velocity	5.8 m/s (maximum instantaneous)		
	Temperature	33.5°C;	Precipitation	0 mm;	Duration of sunshine	60 min

The observation data from the wind profiler at Kumagaya, located about 23 km north-northwest of the accident site, was as follows:

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\*3 The United States Parachute Association is a representative organization of the USA for diving operations.

\*4 The D License is the highest level (instructor level) of license of the A, B, C and D Licenses issued by the USPA. It requires the completion of 500 jumps including at least three hours of freefall time during which the jumper controls his own position.

16:50      Altitude    3,380 m (11,089 ft)  
                 Wind direction    195°;    Wind velocity    3.0 m/s;    Vertical velocity    - 0.1 m/s

The weather observations at the Airport had not been recorded and thus were not available. However, according to the Captain's statement, the wind direction and velocity announced by the Okegawa Advisory at the time of the takeoff were 160° and 7 kt, respectively.

## **2.8    Accident Site Information**

### **2.8.1    Information of the Airport and Related Facilities**

The Airport is situated in the dry riverbed field on the right bank side of the Arakawa River, located about 12 km north-northwest of Saitama City at an elevation of 39 ft. It has Runway 14/32, 600 m long and 25 m wide. The weather and takeoff/landing information for the Airport is provided by the Okegawa Flight Advisory Service Station.

The airspace 2,000 ft and more above the Airport is Yokota VFR Advisory Area. All aircraft flying under VFR are required to make radio contact with Yokota Airport. Aircraft conducting diving flights must notify at the time when the jumpers start diving and also when they finish diving.

### **2.8.2    Operational Restriction of the Airport**

The Civil Aviation Bureau of the Ministry of Land, Infrastructure, Transport and Tourism issues Aeronautical Information (NOTAM) on diving flights to call for the attention of all aircraft flying in the area. In addition, takeoff and landing are restricted by the Okegawa Advisory while diving is being conducted. The Club is required by the Company, the entity administering the Airport, to limit the time from the start to the end of diving within six to eight minutes, although this is not a written requirement.

## 2.9 Wingsuit

The special diving suit worn by Jumper A on the day of the accident is called a wingsuit, with wing-like parts under the wearer's arms and between the legs. Wingsuits were introduced approximately 10 years ago, not only help to reduce the vertical fall speed as they increase the air resistance, but also serve to create lift. According to information materials provided by the USPA, a generally used diving suit (hereinafter referred to "the jumpsuit") has the vertical fall speed of about 190 km/h. A wingsuit has the vertical fall speed of about 105 km/h, and it is also possible to glide at about 65 to 145 km/h. The Club requires that wingsuit users must have completed at least 200 jumps after acquiring their diving license.



## 2.10 Diving Experience of Jumper A

About two months before the day of the accident, Jumper A had performed solo diving in the same wingsuit. However, it was more than one year earlier that he had performed a special form of diving in which he joined another jumper who wore a jumpsuit and had his parachute deployed; also, the wings under the arms and between the legs of the wingsuit he had worn at that time were smaller than those of the wingsuit he was wearing on the day of the accident.

## 2.11 Additional Information

### 2.11.1 Permission for Diving

The Club had obtained permission for diving from the Tokyo Regional Civil Aviation Bureau in compliance with Article 90 of Civil Aeronautics Act.

### 2.11.2 Diving Procedure

According to the chief instructor and other relevant persons of the Club, the standard diving procedure is as outlined below:

To meet the required altitude of 12,500 ft or higher specified by the Club as the basic diving start altitude, the aircraft first climbs to 13,000 ft and then starts an approach (jump run) toward the diving start point determined by the jumpmaster, considering the wind on the ground and in the airspace above it (the diving start point is specified by the number of dots by which the point is offset from the runway centerline in parallel with the line and also by how much time (in seconds) the point is away from the runway center marking). The captain reports the aircraft position to the

jumpmaster and other relevant persons at 5 minutes, 3 minutes and 1 minute prior to the start of diving. At the point 1 minute prior to the start of diving, the captain sets the flap to 10° and decelerates the speed to about 80 kt, and the jumpmaster requests a ‘power cut’ after checking the conditions on the ground. The captain retards the engine power near to idle, and then the jumpers start diving. Those are the basic procedure. The phraseology and signs used to give instructions to the pilot are based on past experience.

Jumper A has an instructor’s license, although he did not serve as the jumpmaster on the flight involved in this accident. However, he was the veteran who had abundant experience in the Club.

On the day of the accident, the jumper serving as the jumpmaster belonged to the group just previous to Jumper A’s group, so that there was no jumpmaster in the Aircraft when Jumper A started diving.

### **2.11.3 Rules Relating to Diving**

The Club does not have its own rules on diving operation but carries out the operation in accordance with the USPA’s rules (the Skydiver’s Information Manual). The USPA has established the rules and guidelines on diving operations based on Part 105 – Parachute Operations of Federal Aviation Regulations (FAR) and Advisory Circular 105-2D – Sport Parachuting. Although the USPA’s manual is not officially approved by the Federal Aviation Administration (FAA), diving operations are basically conducted in accordance with this manual in the USA.

Section 6-9: “Wingsuit recommendations” in the Skydiver’s Information Manual describes the training syllabus, including a description on the danger of collision with the tail of the aircraft and the precautions(e.g. opening the arms and legs with a two-second delay after exit) to avoid this danger.

### **2.11.4 Flight Manual Supplement for the Aircraft**

The Aircraft has a Flight Manual Supplement based on the abovementioned Skydiver’s Information Manual. The Flight Manual Supplement approved by the Civil Aviation Bureau of the Ministry of Land, Infrastructure, Transport and Tourism, provides as follows concerning operation of the Aircraft for diving purposes:

#### ***Chapter 4 Normal Operation***

##### ***4-3 Briefing***

*The captain should adequately brief the jumpers on board about the NOTAM, weather, limitations and emergency operations. The captain should also ensure that the jumpers are informed of, and adequately understand, the danger and unfavorable conditions of not sitting in their seats.*

*The jumpmaster should give instructions and guidance to the divers concerning the following items and the captain should make sure that the instructions and guidance are properly followed.*

- 1. Checking of the onboard position and exit order of each jumper based on the weight and balance calculation sheet.*

(Skipped)

#### **4-7 Diving**

1. *Each diver should start diving after obtaining permission from the captain.*
2. *The jumpmaster should instruct and supervise the jumpers to ensure that they dive in the order determined in the briefing prescribed in 4-3.*

(Skipped)

#### **2.11.5 In-House Manual for Diving**

The Company has established an in-house manual on skydiving operation by C208 in order that all pilots in charge use the same procedure for operating the aircraft. The manual describes the start of diving as follows (partial excerpt):

##### *5. Before diving*

- *The captain should stabilize the speed and altitude after reaching the target altitude and give the jumpmaster permission to unfasten the seatbelt and make preparations for diving.*
- (1) *The proper timing for intercepting the jump run should be a point about three minutes before the scheduled dive time, depending on the jumpmaster and the direction/velocity of wind.*
  - (2) *The speed should be at about 1000 LBS\*<sup>5</sup> for 100 KT up to one minute before the dive time, and thereafter 700 LBS for about 75 to 80 KT should be maintained.*
  - (3) *The use of 10° flaps is advisable.*
  - (4) *The expected exit time should be reported at 5 minutes, 3 minutes and 1 minute prior to the expected point.*

(Skipped)

##### *6. Diving*

- *Diving should be started after obtaining permission from the captain.*
  - *The jumpmaster should instruct and supervise the jumpers to ensure that they dive in the order determined in the briefing.*
  - *Aircraft specifications*
- (1) *The time of the ‘power cut’ should, as a general rule, depend on the jumpmaster’s instruction except when the drop zone is poorly visible. However, if a “cut XX seconds before diving” instruction has been given in the briefing before takeoff, the instruction should be followed.*
  - (2) *Unless otherwise instructed, engine power of 250 to 350 LBS should be allowed for after the ‘power cut’ instruction in order to keep the aircraft’s descent rate to the minimum possible.*

(Skipped)

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\*<sup>5</sup> “LBS” is the unit of the engine torque reading on the torque meter. It is the generally used, shortened form of the correct representation “LBS-FT”. The notated part of the sentence means that the output should be set to 1,000 LBS-FT for flying at 100 kt.

### **3. ANALYSIS**

#### **3.1 Crew Qualifications**

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

#### **3.2 Airworthiness Certificate**

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

#### **3.3 Meteorological Conditions**

It is highly probable that the meteorological conditions at the time of the accident had no relevance to the occurrence of the accident.

#### **3.4 Conducting of the Diving Operation**

##### **3.4.1 Approach to the Diving Course**

According to the statements described in 2.1 (1), the Aircraft climbed to an altitude of about 13,000 ft in accordance with the diving operation procedure provided in the Flight Manual Supplement, and the first 16 jumpers in the 1st to 5th groups had taken their dives. Then the Aircraft reversed the heading of the aircraft by making a turn at the north of the Airport. After that the first jumper in the 6th group took his dive. As to separating the diving into two, it is highly probable that conducting the diving in this sequence had been agreed on between the Captain and the jumpers at pre-flight briefing described in the Flight Manual Supplement 2.11.4, as is suggested by the Captain's statement in 2.1 (1) that the remaining two jumpers wanted to allow for additional time between themselves and the preceding group.

##### **3.4.2 Changes in Diving Course**

According to the statements described in 2.1 (2), Jumper A asked the Captain to climb higher because the Aircraft had lost too much altitude after the first jumper of the 6th group had taken his dive and the difference in altitude from the jumper just before him had decreased. However, this is clearly inconsistent with the procedure briefed at the preflight briefing, as suggested by the Captain's statement in 2.1 (1): "...one of the two jumpers took his dive. The other jumper was to dive in succession..."

The manuals described in 2.11.4 and 2.11.5 do not provide any procedure in case that the application of a briefed method becomes impractical due to a change in conditions. Continuation of diving should be avoided under any situation where communication between the captain and the jumpers is incomplete, and in this particular case, cancellation of the scheduled special form of diving should have been considered.

### 3.4.3 Diving Procedure

According to the statements described in 2.1 (1) and (2), it is possible that the following factors contributed to Jumper A diving without requesting a 'power cut' from the Captain while the Aircraft made a turn to reverse the heading and return to the Airport during climbing at the south of the Airport.

- (a) As described in the statement of Jumper A in 2.1 (2), when he lost sight of the jumper's parachute while the Aircraft was climbing, he started to hurry lest he miss a chance to join with the preceding jumper.
- (b) As described in 2.8.2, the operational restriction is applied during the diving operation conducted at the Airport. This caused Jumper A to become restless at the thought of having to leave the airspace as early as possible.
- (c) As described in 2.11.2, Jumper A has an instructor's license and is an experienced jumper among the members of the Club, which possibly led him to believe that it would not cause a problem to deviate from the standard procedure.

### 3.4.4 Contact with Airframe

As described in 2.1 (2), Jumper A did not have a clear memory of his contact with the airframe and thus the detailed situation of collision is vague. However, from the reasons described below, it is highly probable that both legs of Jumper A made contact with the left horizontal stabilizer immediately after he began diving, which caused damage to the airframe and light injury to his legs.

- (1) Reasons why the damage to the airframe is considered attributable to contact with Jumper A
  - (a) As described in the Captain's statement in 2.1 (1), no abnormalities were found on the aircraft during the pre-flight inspection. However, damage to the horizontal stabilizer was found during the exterior inspection after landing. In addition, the Captain found that Jumper A had disappeared when he looked back in reaction to a small hitting sound while flying toward the Airport at an altitude of about 11,000 ft.
  - (b) As described in 2.2, Jumper A sustained an injury to both legs.
  - (c) As described in 2.3.2, the distance between the dents on the horizontal stabilizer of the Aircraft was 50 cm, which is almost the same as the distance between the slightly opened legs of Jumper A.
- (2) Reasons why Jumper A is assumed to have made contact with the horizontal stabilizer
  - (a) It can be assumed from the statement in 2.1 (1) that the Aircraft's speed of about 100 kt caused Jumper A to receive a greater ram-air pressure than at a standard airspeed of about 70 kt after the exit, and this in turn caused Jumper A to move more quickly toward the horizontal stabilizer due to an increase in relative speed.
  - (b) The propeller of the Aircraft rotates clockwise as viewed from the cockpit, and the slipstream from the propeller spirals rearward around the airframe, forming an upward air flow at around the left horizontal stabilizer. In addition, since the Aircraft was then climbing at full engine power with the aircraft's nose pitch up, the propeller slipstream would have been quite strong.

- (c) As described in 2.9, Jumper A was wearing a wingsuit that was of a shape much more responsive to the ram-air pressure than an ordinary jumpsuit, and as such, he should have paid special attention to several points such as opening the arms and legs after reaching sufficient distance away from the airframe after his exit. However, Jumper A was not specifically aware of this precaution, which resulted in unusually great ram-air pressure acting on his body.

## **3.5 Prevention of Similar Accidents**

### **3.5.1 Clarification of Standard Practices**

- (1) In-house manual for diving operation

The in-house manual established by the Company for its diving operation described in 2.11.5 does not clearly define the procedure on altering or discontinuing the diving operation in case that the prebriefed diving is unable to be accomplished due to a change in conditions. Also the manual assumes no situations where the jumpmaster is absent. In addition, as the method for conveying instructions to the pilot depends only on past experience rather than concretely specified methods (concerning the phraseology, hand signals, etc.). It is probable that there are situations where the jumpers' instructions are not accurately conveyed to the pilot.

For this reason, it is necessary for the Company and the Club to make clear provisions in their manuals to reflect the points mentioned above, keeping in mind that the Captain has authority for command and supervision throughout a flight such as permission for the start of diving, so that all the pilots and Club's members share clearly defined procedure.

- (2) Training

As described in 2.11.3, the Skydiver's Information Manual has the training syllabus for diving in a wingsuit. Therefore, it is necessary for the Club to provide its members with adequate training based on this manual prior to diving in a wingsuit.

### **3.5.2 Compliance with the Established Procedure**

As described in 2.11.2, the basic procedure for the start of diving requires that a 'power cut' request be made first and then diving be started after the engine power has been reduced. Jumper A has plenty of diving experience and holds an instructor's license. However, he failed to follow this basic procedure and eventually took actions with little regard for safety.

To prevent the occurrence of similar accidents, it is necessary for the Club to ensure strict adherence to the basic procedure by all of its members.

### **3.5.3 Precautions to Take When Diving in a Wingsuit**

According to the statement of Jumper A in 2.1 (2) and his experience described in 2.10, it is probable that Jumper A has some knowledge about the wingsuit in question, but it was more than one year earlier that he had performed a special form of diving in which he joined another jumper who was in a jumpsuit with the parachute deployed, and the wingsuit he had worn at that time was different from the one he was wearing this time. The first wingsuit had smaller wings under the

arms and between the legs. It is highly probable that Jumper A thought it possible to perform diving without any problem based on his earlier experience. However the amount of ram-air pressure working on the wingsuit is considered to vary largely with the shape of the wings. As such, wingsuit diving should be carried out only after each diver concerned is adequately acquainted with the performance and other characteristics of each particular wingsuit by means of, for example, training by an expert instructor.

#### **4. PROBABLE CAUSES**

In this accident, it is highly probable that the Jumper A failed to follow the basic established procedure when he started his dive from the Aircraft, which is resulted in both his legs making contact with the left horizontal stabilizer of the Aircraft and consequently damaging the airframe.

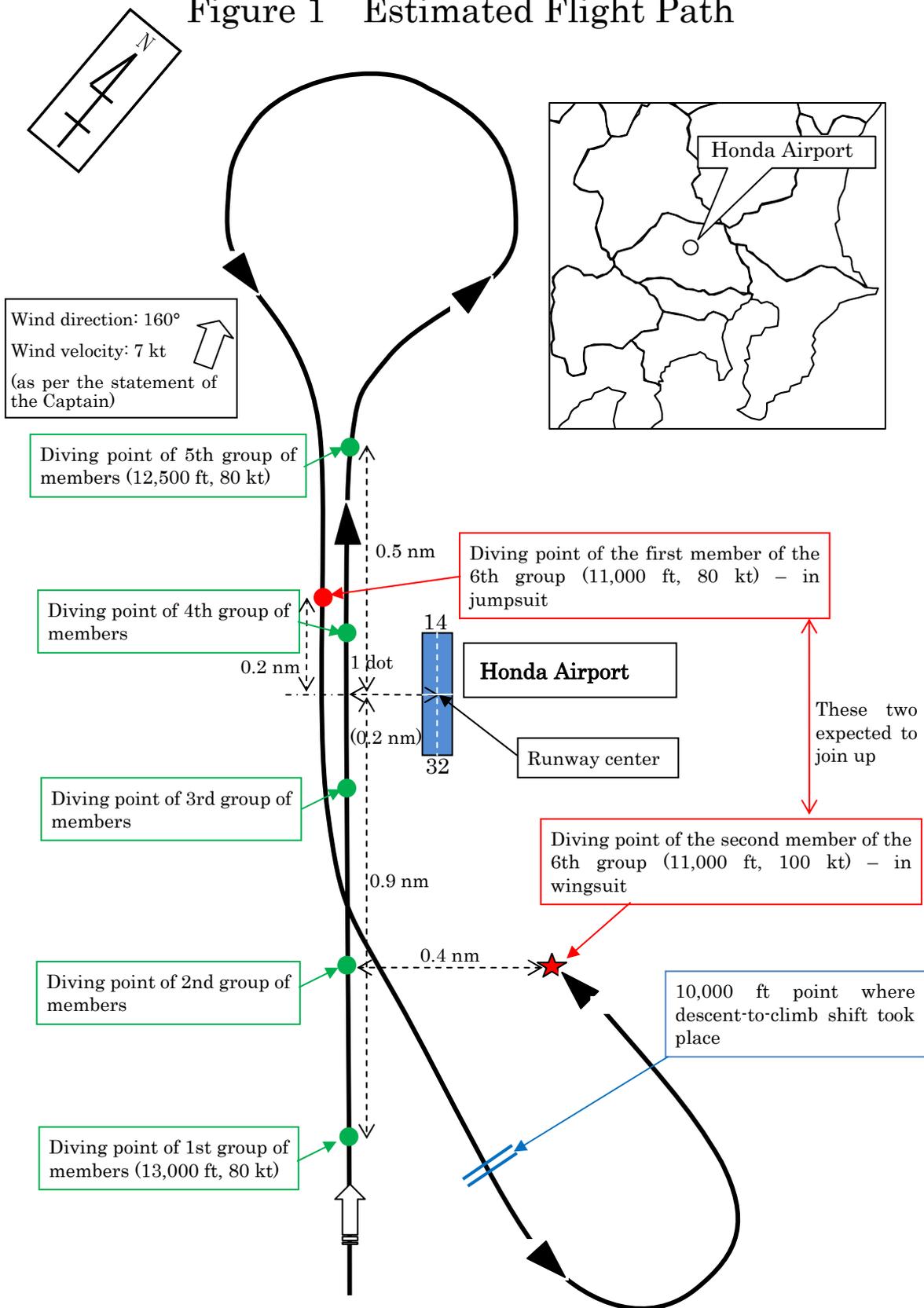
With regard to Jumper A having made contact with the left horizontal stabilizer of the Aircraft, it is possible that the contributing factors are; an usually higher airspeed of the Aircraft climbing at full engine power, a strong air flow around the horizontal stabilizers due to the slipstream from the propeller rotating at full engine power, and the ram-air pressure Jumper A received, which was higher than usual due to the failure to take the proper action required when diving in a wingsuit.

## 5. ACTIONS TAKEN

The Company took the following action to prevent the occurrence of similar accidents:

- (1) Complete revision of the in-house manual on skydiving operation by C208 referring to the Company's Operations Manual, and issuance of a directive that all jumpmasters of the Club be fully informed of the contents of the revised manual.
- (2) Implementation of regularly scheduled meetings with the participation of the chief and second instructors of the Club, the captains of the Cessna 208, and the management of the Company.

Figure 1 Estimated Flight Path



\* Positions and other information are according to the Captain's statements.

Figure 2 Three Angle Views of Cessna 208B

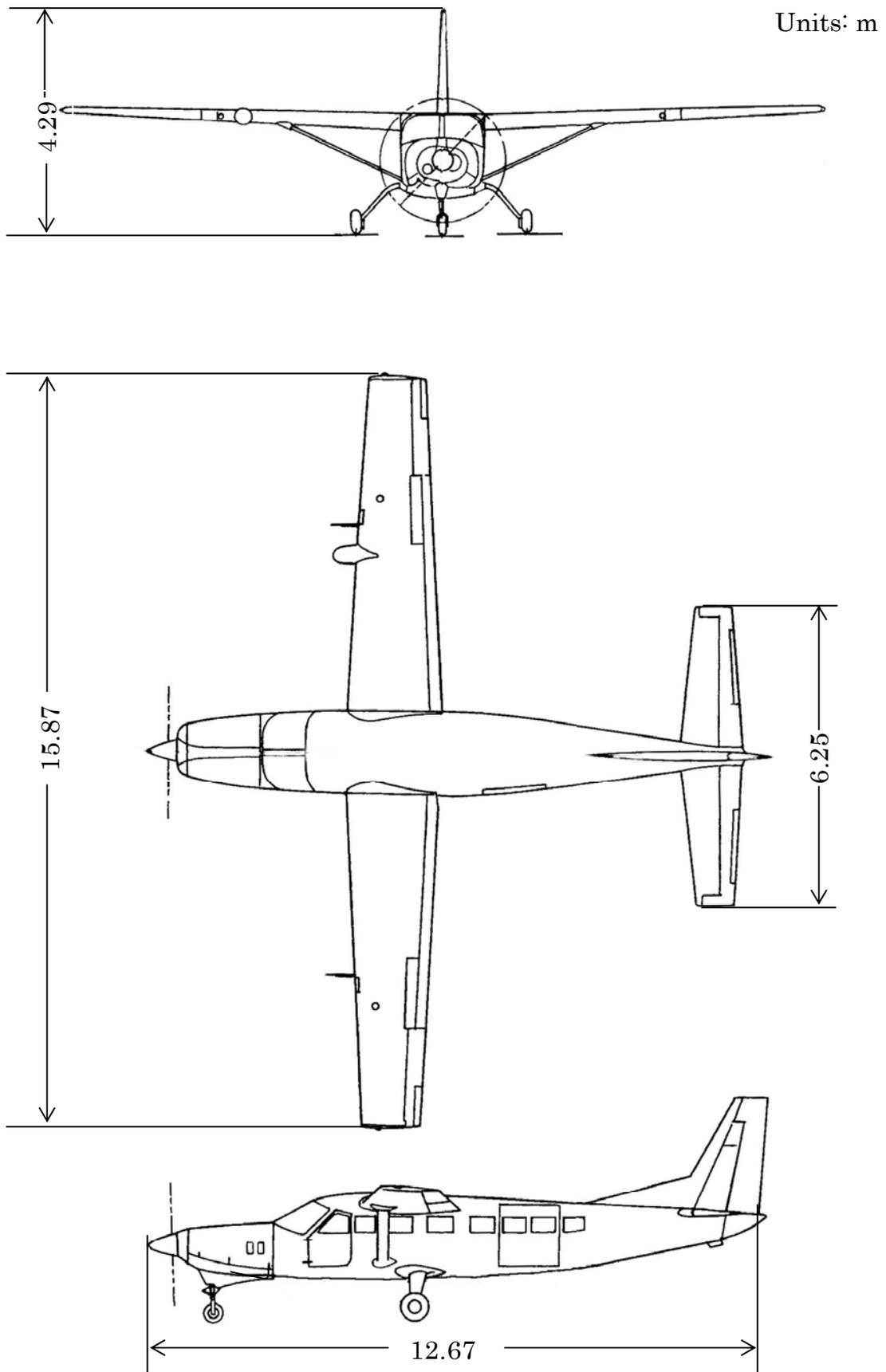


Photo 1 Accident Aircraft

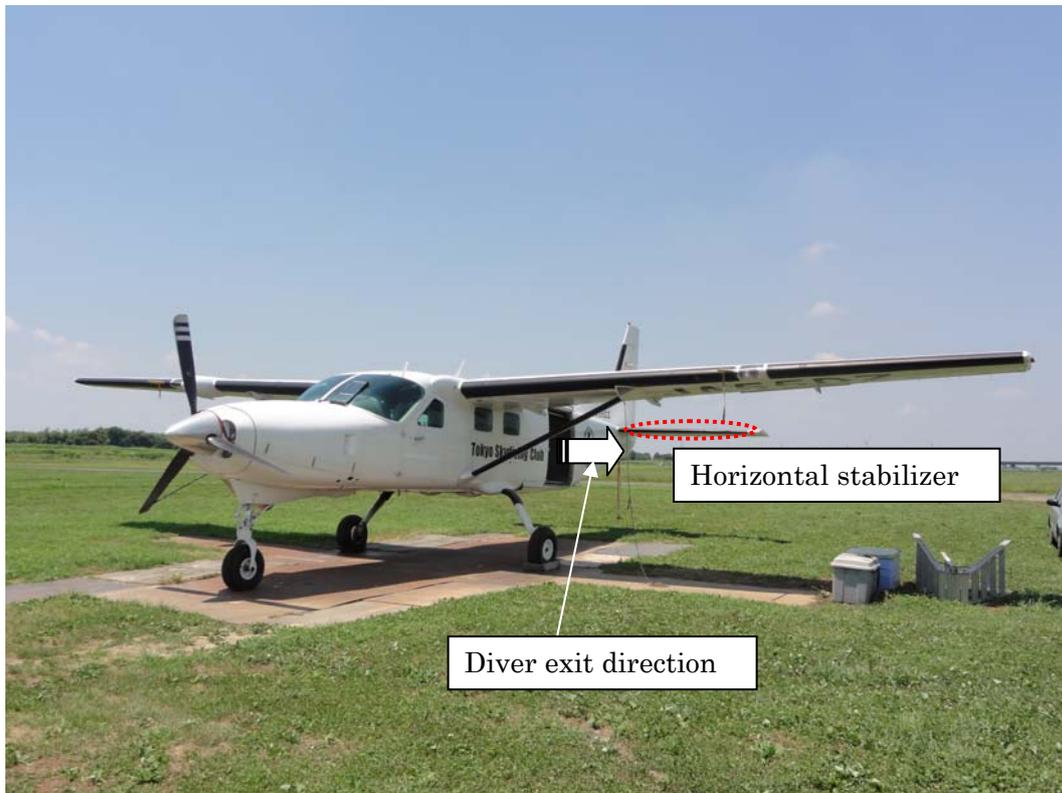


Photo 2 Jump Door

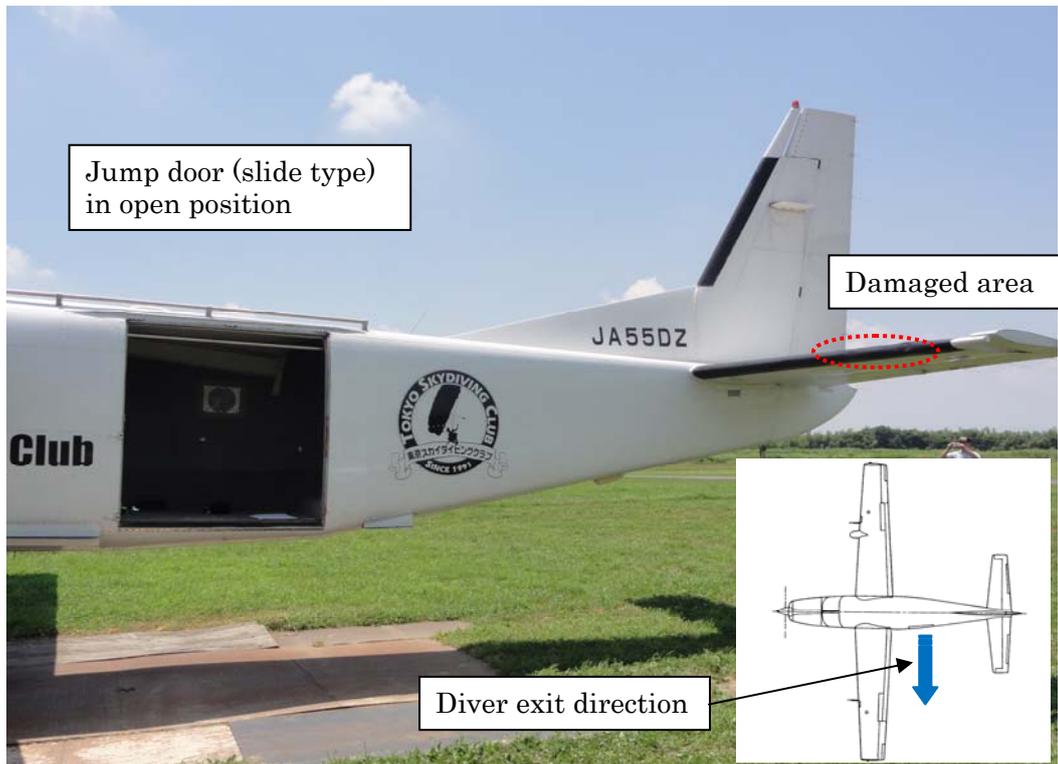


Photo 3 Damage to Horizontal Stabilizer

