AA2018-9

AIRCRAFT ACCIDENT
INVESTIGATION REPORT

SETOUCHI SEAPLANES INC.
J A 0 2 T G

November 29, 2018

JTSB 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.

Kazuhiro Nakahashi
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

AIRCRAFT DAMAGE DURING WATER LANDING AT THE SEA SURFACE ABOUT 1.2 KM OFF SAKAIGAHAMA URASAKI TOWN, ONOMICHI CITY, HIROSHIMA PREFECTURE, JAPAN AT AROUND 11:13 JST, APRIL 15, 2018

SETOUCHI SEAPLANES INC. QUEST KODIAK 100 (AMPHIBIAN), JA02TG

November 9, 2018
Adopted by the Japan Transport Safety Board
Chairman Kazuhiro Nakahashi
Member Toru Miyashita
Member Toshiyuki Ishikawa
Member Yuichi Marui
Member Keiji Tanaka
Member Miwa Nakanishi

1. PROCESS AND PROGRESS OF THE INVESTIGATION

1.1 Summary of the Accident	On Sunday, April 15, 2018, a Quest Kodiak 100, registered JA02TG, operated by Setouchi SEAPLANES Inc. repeated bounce during the water landing and suffered damage to the aircraft.
1.2 Outline of the Accident Investigation	On April 16, 2018, the Japan Transport Safety Board (JTSB) designated an investigator-in-charge and an investigator to investigate this accident. An accredited representative of the United States of America, as the State of Design and Manufacture of the aircraft involved in the accident, participated in the investigation. Comments were invited from parties relevant to the cause of the accident and the Relevant State.

2. FACTUAL INFORMATION

2.1 History of the Flight	According to the statements of the pilot (hereinafter referred to as "the Pilot") and the Advisor*1 as well as the recordings of the flight data in the Integrated Instrument System (hereinafter referred to as "the Flight Record"), the history of the flight up to the accident is summarized below. On Sunday, April 15, 2018, at around 10:02 Japan Standard Time (JST; UTC + 9 hrs), a Quest Kodiak 100, registered JA02TG, operated by Setouchi

*1 "Advisor" refers to a pilot, who is designated by the Company to give advice to the Pilot as a captain on what he noticed about the aircraft control and others, has the Company's flight instructor qualification and took the right pilot's seat on the cockpit during the familiarization flight for the Pilot on the day.

	SEAPLANES Inc. (hereinafter referred to as "the Company"), took off from the water area about 1 km southwest of the Company's pier at Sakaigahama, Urasaki Town, Onomichi City, toward northwest in order to make an familiarization flight for the Pilot, with the Pilot as a captain in the left seat and the Advisor in the right seat in the cockpit, after they confirmed no abnormalities during the pre-flight checks. According to the statement of the Pilot, at that time it was fine weather with a good visibility; the wave height was about 20 cm; and the wind velocity was at about 10 kt from the north at the observation of the vane anemometer installed at the Company's pier. The Pilot made take-offs and touchdowns eight times repeatedly in the procedure, in which after taking off and flying traffic pattern, the Aircraft touches down directly into the wind or in the light crosswind from the right front with the normal procedure setting Flaps 35° to turn its nose from north to northwest; and every time the Aircraft taxies on the water to the start position of take-off roll to take off. The Advisor was giving appropriate advice on what he noticed about the take-off and touchdown techniques of the Pilot while reading out the wind direction and velocity indicated on the Integrated Instrument System. The Pilot decided to try to make the last (the ninth) crosswind landing from the left side. Judging from the conditions of the sea surface during the previous take-offs and touchdowns, he assumed that the crosswind component from the left would be at around 5 kt; and he maintained the heading to the east and made a touchdown with the wing low*2 by lowering the upwind left wing. After touchdown, the Pilot reduced the power as usual; but right after that, during decreasing speed he felt as if the nose of the Aircraft had weathervaned irregularly to the left, thus he increased the use of right rudder to maintain its heading. As there seemed no room for the right rudder to be used any more, the Pilot decided to make a go-around and restart to make a touchdown from the beginning. Before calling out for a go-around, the Pilot gradually increased the power that had been reduced, while considering the effects of the right rudder. The Advisor regarded the touchdown techniques of the Pilot as appropriate and thought that the Pilot would make a normal deceleration. But the Pilot began to gradually increase the power without saying anything, therefore, the Advisor confirmed saying "Why are you increasing the power?" Hearing those words, the Pilot thought that it might be better not to make a go-around but to reject it, and reduced the power again. But at this time, as the Aircraft had already become airborne, the Pilot increased the power a little so that the impact at touchdown could be reduced. Immediately afterwards, the Aircraft touched down, and then commenced to bounce.

*2 "The approach by wing low" means a process to approach the extended centerline of the runway and others by cross control using the rudder, while increasing aileron to hold the upwind wing down, in order to counter the drift of a crosswind and not to turn to the upwind side. (See 2.8 (1) III, for the crosswind landing approach with the wing low.)

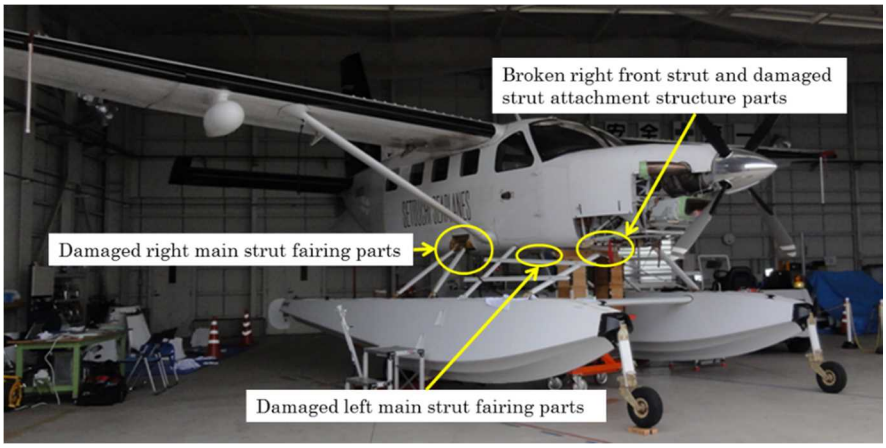
	Therefore, after reducing the power again, the Pilot increased the power in order to prevent the impact at the next touchdown, however, the Aircraft touched down on the water with its nose down. At this time, as the Pilot heard a large impact sound as if something had been broken and the Aircraft continued bouncing, he commenced a go-around. The Advisor felt it was dangerous because the intention of the Pilot, who repeated reducing and increasing the power without saying anything, was not clear and the cape that had been seen at their left side was then looming in front of them, thus, instantly he called out "I have" (I have: it means taking over an aircraft control), took the control of the Aircraft, maximized the power, and executed a go-around. The Pilot entrusted the Advisor with the Aircraft control so that the go-around procedures would not be overlapped. After that, the Aircraft flew in the vicinity of the pier for confirmation of the Aircraft condition; and as the damage on its float struts were confirmed visually by a mechanic on the ground, the Pilot decided to divert to Kounan Airport and make an emergency landing. The Pilot took the control of the Aircraft on the way and arrived over Kounan Airport. And then after the visual confirmation by a mechanic on the ground, the Pilot made an emergency landing. The Pilot confirmed the damage to the Aircraft during post-flight inspection. This accident occurred at around 11:13 on April 15, 2018, at the sea surface off Sakaigahama, Urasaki Town, Onomichi City, Hiroshima Prefecture (34° 23' 20" N, 133° 16' 08" E). (See Figure 1: Accident Site, Figure 2: Area Map of the Accident Site and Table: The Flight Record.)
2.2 Injuries to Persons	None
2.3 Damage to Aircraft	Extent of damage: Substantial damage 1. Right front strut; Broken 2. Right front strut attachment structure parts; Damaged 3. Fairings of left and right main struts; Damaged  Photo 1: Damaged parts of the Aircraft

Photo 2: Damaged right front strut attachment structure parts

2.4 Personnel Information

(1) Pilot Male, Age 59

Commercial pilot certificate (Airplane)	June 2, 1981
Pilot competence assessment Expiry of practicable period for flight	October 2, 2019
Type of rating for Single engine turbine sea	June 12, 2017
Class 1 aviation medical certificate	Validity: November 4, 2018
Total flight time	10,125 hours 05 minutes
Flight time on the same type of aircraft	155 hours 19 minutes
Flight time in the last 30 days	10 hours 26 minutes

(2) Advisor Male, Age 68

Airline transport pilot certificate (Airplane)	March 7, 1991
Pilot competence assessment Expiry of practicable period for flight	June 13, 2019
Type of rating for Single engine turbine sea	December 12, 2016
Class 1 aviation medical certificate	Validity: July 1, 2018
Total flight time	16,398 hours 17 minutes
Flight time on the same type of aircraft	249 hours 52 minutes
Flight time in the last 30 days	27 hours 20 minutes

2.5 Aircraft Information

(1) Type: Quest Kodiak 100

Serial number: 100-0156,	Date of Manufacture: October 23, 2015
Airworthiness certificate	No. Dai-2017-445
Validity	October 25, 2018
Total flight time	452 hours 53 minutes

(2) When the accident occurred, the weight was estimated to have been 5,871 lb (the maximum landing weight: 7,200 lb) and the position of the center of the gravity was within the allowable range.

(3) When the accident occurred, the stall speed (indicated airspeed) for Flaps 35° was approximately 42 kt.

2.6 Meteorological Information

(1) The weather values of the vane anemometer installed at the Company's pier (located about 1.2 km east of the accident site) and the wave height by visual estimation were as follows:

Time	Wind direction	Wind velocity	Wave height	Swells
09:57	360°	10 kt	25 cm or less	None
11:20	360°	12 kt	25 cm or less	None
11:41	360°	15 kt	25 cm or less	None

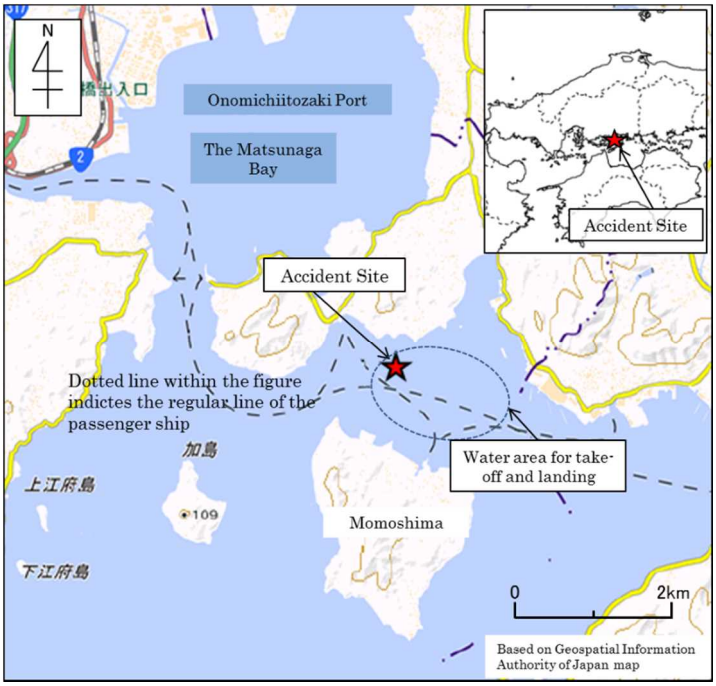
	(2) Observations according to the Fukuyama Meteorological Office located (at an elevation of 1.6 m) about 6.5 km north of the accident site were as follows (the wind velocity was converted from m/s into kt): 11:20 Wind direction: northwest; Wind velocity: 9 kt Maximum instantaneous velocity: 17 kt
2.7 Accident Site	The accident site was at the sea surface about 1.2 km westward of the Company's pier in Sakaigahama, Urasaki Town, Onomichi City, Hiroshima Prefecture; and the site was in the vicinity of central part of sea surface, which is surrounded by several lands with small hills and islands; and there is a channel (approximately 1 km width) opening from the west to the southeast in this water area, where the Company usually uses for take-offs and landings of its aircraft. As being close to every land located in the north or the south, this water area has geographical features that the winds blowing from north or south tend to change the direction and velocity due to the effects of those surrounding lands.  Figure 1: Accident Site The Flight Record and the area map of accident site including the estimated flight route based on the Flight Record are shown as follows:

Table: The Flight Record (Minimum recording interval: 1 second)

Time 11:12 (Second)	Heading (°)	Pitch angle (°)	Roll angle (°) R: right L: left	Air speed (kt)	Pressure Altitude (ft)	Power (Propeller torque) (ft・lb)	Vertical acceleration (G)1.0 Standard	Remarks
20	081	-2	R1	87	45	443		Approaching
30	081	5	L3	70	9	461	0.99	Before touchdown
35	081	7	L0.4	64	1	472	1.07	Made touchdown
38	079	6	R0.3	60	-3	197		Reduced power
41	063	8	R3	51	-4	375		Commenced go-around
44	042	5	R2	51	-2	1,471	0.86	Increased power
46	041	6	R3	53	0	917	0.85	Rejected go-around
47	040	6	R8	58	-1	875	1.05	Reduced power
48	035	6	R6	55	0	1,154	0.85	Increased power
49	033	6	R6	60	4	435	1.25	Reduced power
50	023	6	R2	57	-1	895	0.80	Increased power
51	023	-0.3	L4	60	5	524	1.46	The accident occurred
53	010	10	L3	57	-3	1,953	0.95	Commenced go-around
59	046	10	R37	68	53	1,620		Climbing

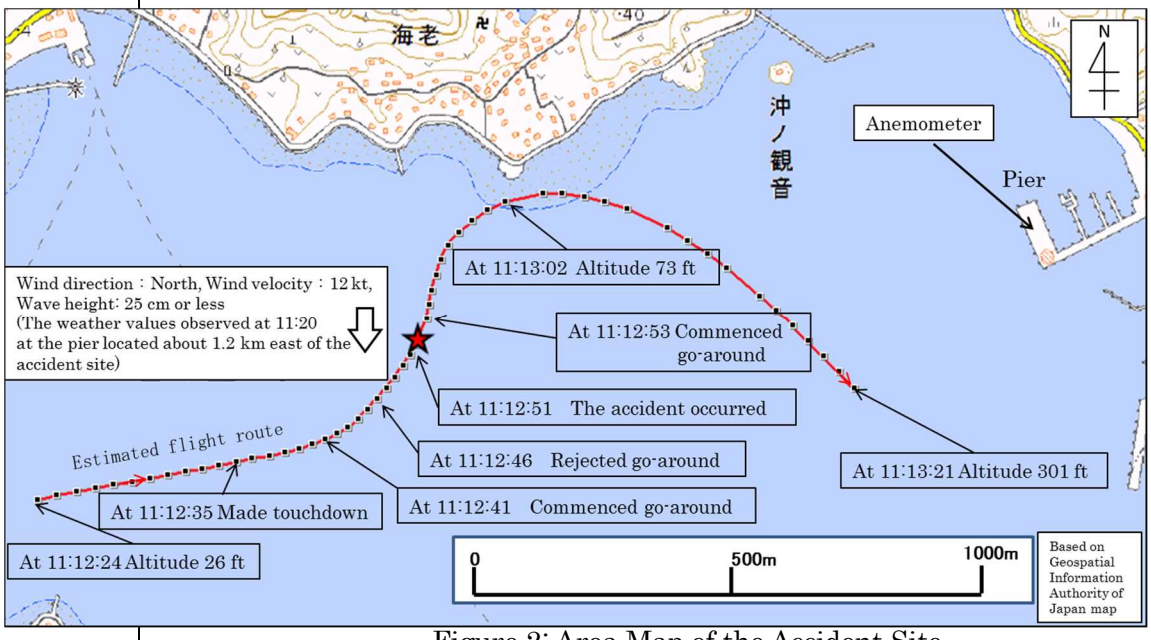


Figure 2: Area Map of the Accident Site

2.8 Additional Information

(1) Regarding the crosswind landing, the following manuals and operations handbook have descriptions as follows:

I. Flight crew operating manual of the Company

Chapter 4: Limitations of aircraft (excerpts)

Maximum crosswind component at the time of take-off and landing:

	12 kt (Minimum demonstrated crosswind velocity in the flight manual) II. Training manual of the Company 4-10-3 Crosswind landing (excerpts) a. Specifications: Flaps 35°, Approach speed 75 kt b. Note • The initial approach shall be made in the same manner as normal touchdown and by the crab approach*3. • The water landing attitude (8°±0.5°) shall be established along with the final approach with the wing low (cross control). • The approach shall be maintained with the fuselage held paralleled to the ground track, and the aircraft shall not be slipped sideways. • If rudder pressure is loosened immediately after touchdown, there may be a risk of the flip-over due to the water drag. The cross control shall be maintained until the floats settle down on the water surface while decelerating. 4-12 Go-around (excerpts) a. Note • Always be ready for an unexpected go-around, and in case of execution, go-around shall be executed without any hesitation. • When executing a go-around, "Go Around" shall be called out and reported to the ATC after that. b. Judging criteria for executing a go-around When the following conditions are recognized after establishing a final water landing attitude. • The sideslip of the aircraft cannot be stopped because the approach with the fuselage held paralleled to the ground track cannot be made due to the changes in wind. • The target angle at touchdown (8°±0.5°) cannot be maintained. • The airspeed 65 kt cannot be maintained. • The descent rate at touchdown cannot be maintained at 200 ft / m or less. • After bouncing, a sign of porpoising*4 was observed. III. U.S.DEPARTMENT OF TRANSPORTATION FEDERAL AVIATION ADMINISTRATION Flight Standard Service "SEAPLANE, SKIPLANE and FLOAT/SKI EQUIPPED HELICOPTER OPERATIONS HANDBOOK" 2004,pp.6-3.6-4 *Chapter 6 Seaplane Operations-Landings* (excerpts) *Crosswind Landing* *Lower the upwind wing and use rudder to maintain a straight path in crosswind landing approach with the wing low. This creates a slip into the wind to offset the drifting tendency.*

*3 "Crab approach" refers to an approach method of aircraft to approach the extended centerline of the runway and others by establishing the wind correction angle in the upwind side to counter the drift of a crosswind.
*4 "Porpoising " refers to a motion of aircraft to repeat the grounding and lifting of the aircraft by the bounce like a dolphin jumping on the sea surface, which is observed if the corrective action taken by a pilot is not appropriate when the aircraft touches down at a higher descent rate and with shallower nose-up attitude than usual, and then bounces.

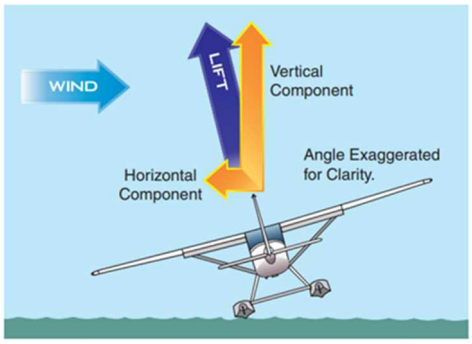


Figure 6-4. Dropping the upwind wing uses a horizontal component of lift to counter the drift of a crosswind.

As the seaplane touches down on the upwind float, the water drag will quickly slow the seaplane and the downwind float will touch down as aerodynamic lift decrease.

Close the throttle, and increase aileron to hold the upwind wing down. As the speed decreases, the rudder becomes less effective and the seaplane weathervanes into the wind due to the weathercock effect[*5].*

Many pilots make a turn to the downwind side after landing to minimize weathervaning and centrifugal force generated by the effects.

(2) Regarding the propeller effects, there are following descriptions from Page 102 to 104 in the "Aerodynamics I –Aircraft Propeller-" (published in 2010 by the Japan Aeronautical Engineer Association).

I. Effect of the propeller slipstream (excerpts)

When a single-engine aircraft with the propeller rotating clockwise is flying at high engine power and low forward speed, the high-speed rotation of an aircraft propeller gives effects on the propeller slipstream that causes the difference in lift between the left and right wing and also exerts a strong sideward force from the left on the aircraft's vertical stabilizer, thus the aircraft tends to roll to the right with its nose toward the left.

II. P-factor (excerpts)

As the AOA of each propeller blade changes in the rotating position in low air speed when an aircraft is flying with a high AOA of the main wings, the thrust on its plane of rotation becomes asymmetric. In the case of the propeller rotating clockwise, as the thrust becomes larger in its right half, the aircraft's nose tends to be yawed to the left.

3. ANALYSIS

3.1 Involvement of Weather	Yes
3.2 Involvement of Pilot	Yes
3.3 Involvement	None

*5 "Weathercock effect" refers to the characteristics of aircraft to weathervane into the wind under the influence of the vertical stabilizer.

of Aircraft	
3.4 Analysis of Findings	(1) Effect of weather The wind velocity observed at the Company's pier had been gradually increasing from 10 kt at the time of take-off to 15 kt after the accident occurred. The wind velocity observed at the Fukuyama Meteorological Office during the time period when the accident occurred was an average of 9 kt, but at the same time the maximum instantaneous wind velocity of 17 kt, nearly twice as increasing as the average, was also observed. Judging from the characteristics of the water area, it is somewhat likely that the direction and velocity of the northern wind at the accident site might have been changing due to the effects of the geographical features in the vicinity of the windward area. The Pilot stated that he felt as if the nose of the Aircraft had weathervaned irregularly to the left after touchdown. From these facts, it is somewhat likely that the maximum instantaneous wind velocity, when the accident occurred, might have exceeded 12 kt that is the crosswind component limitations of the Company; and the Aircraft had been affected by the change in crosswind's direction and velocity. (2) The touchdown at the accident It is highly probable that after making several touchdowns in a light crosswind from the right front with its nose turning from the north to the northwest, the Aircraft touched down in a crosswind from the left with its nose turning to the east. It is probable that at around 11:12:20 when the Aircraft made an approach at a pressure altitude of about 45 ft, the nose attitude was lower and the airspeed was higher than those described in the training manual; but at around 11:12:30 before touchdown, while correcting the nose attitude and airspeed, the Aircraft established the wing low to counter the crosswind component from the left. Afterwards, at about 11:12:35, it is probable that the Aircraft touched down by taking the wing low with orderly nose attitude while maintaining the same heading. It is probable that from around 11:12:41, the Aircraft power, which had been reduced once after touchdown, was increased, but at around 11:12:47, the power was reduced again. From around 11:12:48 to 11:12:51, the power was increased and reduced repeatedly. From around the time when the power was increased, the Aircraft was rolling to the right with its nose veering to the left. It is probable that the nose veered to the left because there were propeller effects, which was due to increasing the power of the Aircraft with the propeller rotating clockwise, in addition to the weathercock effect caused by the crosswind from the left. And it is also probable that the Aircraft rolled to the right because the centrifugal force generated by the nose veered to the left acted on. Based on the statements of the Pilot and the Advisor, the Flight Records of the airspeed at that time, which was higher than the stall speed by about 10 kt, during the power increasing and reducing, the three-times-changes in

	vertical acceleration (logged at around 11:12:47, 11:12:49 and 11:12:51), and these increasing changing values, it is probable that the Aircraft took bounces repeatedly with lifting after touchdown; and the bounces were gradually getting bigger. Particularly, at 11:12:51, the nose of the Aircraft fell much lower than the normal water landing attitude, and the maximum vertical acceleration during this period was recorded. Judging from these records, it is probable that while rolling to the right, the Aircraft touched down so hard from the right float and suffered damage to the Aircraft. It is highly probable that the Aircraft made a go-around in powering up and made a right climbing turn near the shore. (3) Judgment and actions taken by the Pilot and the Advisor It is probable that judging from the conditions of the sea surface during the previous take-offs and touchdowns, the Pilot assumed that it would be within crosswind component limitations and made a touchdown in a crosswind from the left with the nose to the east at about the same attitude and speed as stipulated in the training manual. Afterward, the Pilot reduced the power for deceleration, but it is probable that the changing crosswind component from the left intensified at a moment caused the weathercock effect, by which the nose commenced veering to the left. It is highly probable that the Pilot increased the power gradually, trying to make a go-around and restart to make a touchdown from the beginning, but he did not feel that it was a situation where the danger was imminent; therefore he did not call out for a go-around promptly to the Advisor; and as the Pilot did not call out for a go-around immediately, the Advisor confirmed the Pilot's intention to increase the power. And at this time, it is probable that the Pilot, instead of expressing his intention to go around, took what the Advisor said as an instruction and then rejected a go-around. As the Aircraft, however, had already been airborne, it is probable that the Pilot increased the power again and raised the nose so that the impact at touchdown could be reduced. It is also probable that the Aircraft began bouncing as the Pilot increased and reduced the power, and raised the nose. It is probable that in spite of the subsequent increasing or reducing the power and setting the nose attitude, the Pilot was not able to stabilize the Aircraft during bounce; and he still continued the same control without making a go-around, which resulted in the hard touchdown that was logged as the third in the Flight Record, leading to the damage to the Aircraft. Moreover, it is probable that from around the time of commencing a go-around, the Pilot had not been able to correct the nose veering. It is somewhat likely that the series of the Pilot's actions were taken based on his vague judgment on the go-around. It is highly probable that the Advisor felt it was dangerous because the intention of the Pilot, who was repeating the increase and reducing of the power without saying anything, was not clear; and the Pilot was not able to stabilize the Aircraft during bounce, in addition, the cape that had been seen

	at the left side was looming in front of them; therefore, the Advisor called out "I have" as an emergency evacuation, took over the Aircraft control, and executed a go-around. (4) Familiarization flight of the Company It is probable that this accident occurred when the Pilot, who had commenced a go-around during the crosswind landing in his familiarization flight, rejected a go-around hearing the confirmation of the Advisor on board. In this accident, it is somewhat likely that the reason why the touchdown was made in the maximum wind velocity that instantaneously exceeded the crosswind component limitations of the Company was because the Pilot did not grasp the crosswind conditions enough to make an appropriate judgment; and the reasons why the Pilot rejected a go-around and the Aircraft repeated the bounce were that he made a vague judgment on the go-around, as well as he had not learned enough about how to handle the bounce. In addition, it is probable that the Advisor's confirmation had an influence on the Pilot's action to reject a go-around. Based on the above-mentioned, it is necessary for the Company to consider ensuring that pilots are fully aware of matters related to crosswind landings and go-around, and to clarify the procedures for conducting familiarization flight as well as the role / responsibilities of advisers on board during the familiarization flight. (5) Prevention of similar accidents Generally, the following measures shall be considered in order to prevent accidents during crosswind landing by the seaplane equipped with floats. 1. By observing the water surface in details before touchdown and determining the condition of wind, wave, swell and others, the touchdown shall be planned so that every value will be within operation limitations. 2. If there are wind observation equipment and others in the vicinity of the touchdown area, and particularly the wind velocity close to the limitations is observed, the latest information on wind direction and velocity shall be obtained and utilized to judge wind conditions. 3. The wing low shall be established before touchdown so that an approach will be made with the fuselage held paralleled to the ground track. 4. The upwind float shall be touched down first and directional control shall be maintained so that the aircraft will be able to taxi on the water without slipping sideways. 5. A turn to the downwind side shall be made after touchdown, if necessary, in order to minimize weathervaning and the centrifugal force caused by the weathercock effect. 6. If a go-around is judged to be necessary for safety reason in such a case as aircraft bouncing after touchdown, the go-around shall be executed without hesitation.

4. PROBABLE CAUSES

It is probable that in this accident, the Aircraft touched down so hard, while repeating the bounce after the Pilot rejected the go-around, and suffered damage to the Aircraft.

It is probable that the reason why the Aircraft touched down so hard while repeating the bounce was that the Pilot was not able to stabilize the Aircraft during bounce by increasing / reducing the power and setting the nose attitude, and continued the same control without making a go-around.

5. SAFETY ACTIONS

The Company has decided to take measures and provide education on the revisions in order to prevent the recurrence of similar accidents.

(1) To summarize the points to be noted regarding the take-offs and landings during crosswinds and thoroughly make them known to pilots including:
The principle that the take-offs and landings into the wind shall be made; the method to judge the wind conditions on the water surface by a low pass before touchdown; the key points in the case of inadvertent crosswind landing (sideslip prevention, countermeasures against weathercock effect, etc.); and the measures to handle bounce (go-around) and others.

(2) To confirm regularly the knowledge and expertise of the captain by a pilot checker or a director of training division.
- 1 month, 3 months, 6 months, and 9 months after promotion to the captain
- 6 months after the one year since the promotion to the captain

(3) To add the recurrent training and prescribe the implementation procedures in the operation manual annexes.

(4) To prescribe in the operation manual annexes, the role of a pilot other than the captain who is to be on board for the recurrent training.

(5) To issue the notification by the Director of the Operation Department and to stipulate the judgment standards and the implementation procedures for the go-around when a pilot other than the captain is to be on board and the judgment standards and the implementation procedures for the take-over by a pilot who is not the Pilot Flying.