

AVIATION OCCURRENCE REPORT

CAPSIZING AT TAKE-OFF

CESSNA U206F C-GNUG
RIVIÈRE DES PRAIRIES, QUEBEC
20 JULY 1996

REPORT NUMBER A96Q0114

The Transportation Safety Board of Canada (TSB) investigated this occurrence for the purpose of advancing transportation safety. It is not the function of the Board to assign fault or determine civil or criminal liability.

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Summary

The float-equipped Cessna U206F (serial number U20602795), with six persons on board, was to make a pleasure flight from Rivière des Prairies, Quebec, to the Gouin Reservoir. The seaplane started its take-off run on a water surface agitated by strong cross-winds from the right. The aircraft lifted out of the water at very low speed, travelled about 1,000 feet before taking off, and fell back on the water in a pronounced nose-up attitude. The pilot-owner continued with the take-off, and the aircraft lifted out of the water a second time. The left wing then struck the surface of the water; the left float dug into the water, and the aircraft capsized. The pilot told the passengers to unfasten their seat-belts as the aircraft rapidly filled with water. He then went toward the rear to try to open the two cargo doors to let the occupants out. A man who had witnessed the accident immediately proceeded to the site to assist the occupants. He opened the left front door, and the female passenger evacuated the seaplane. A child followed soon afterward. As they had no life jackets, these two persons clung to the floats until the other rescuers arrived. The first fire-fighters and police officers arrived at the site about 15 minutes after the accident. The pilot and the other three passengers drowned inside the aircraft.

Ce rapport est également disponible en français.

Other Factual Information

The pilot was qualified for the flight. He had about 1,350 flying hours, including about 1,000 hours on type.

The water surface used for the take-off was a river about 1,000 feet wide bordered by trees. At the time of the take-off in a westerly direction, the winds were from the north with gusts estimated at 20 knots. Before the take-off, witnesses had mentioned the strong cross-winds to the pilot. The exact take-off speed could not be determined.

The aircraft was certified, equipped, and maintained in accordance with existing regulations and approved procedures. There was no evidence found of any airframe failure or system malfunction on take-off. The aircraft had no known deficiencies before the flight and was being operated within its load and centre of gravity limits. Examination of the aircraft after it was removed from the water revealed that the forward leaf of the rear cargo door had been forced.

The aircraft was equipped with a Robertson short take-off and landing (STOL) kit. It was also equipped with a Flint Aero wing-tip auxiliary tank kit. These two kits increase lift and reduce the stall speed of the aircraft. Owners modify their seaplanes with these kits to be able to take off and land on water over shorter distances and to increase the maximum take-off weight of the seaplane.

The Robertson kit uses modified flaps and ailerons. When the pilot extends the flaps, the ailerons also deploy by small increments to 16 degrees, producing the equivalent of 25 degrees of flap. This increases camber over a larger part of the wing, which improves wing lift at low speed. However, the upward travel of the ailerons, which normally rise on the side of the turn, is limited to approximately the neutral position, and this reduces the roll efficiency and roll control of the aircraft. Flight manual supplements are published for the Robertson and Flint Aero kits. There was no evidence found that these flight supplements had been inserted in the aircraft flight manual as required by aviation regulations. There was no official flight test conducted to evaluate the changes in performance of the modified aircraft, and it is not required by the present regulations.

The pilot had the five passengers—one man, one woman, and three children—board via the left front main door. The pilot sat in the left front seat and had the passengers sit as follows: the man in the right front seat; the woman in the second row seat behind the pilot with her two-year-old daughter on her lap; the six-year-old child in the seat to the right of the woman, in line with the forward leaf of the right rear cargo door; and the nine-year-old child in the only seat at the right rear, in line with the aft leaf of the cargo door. There are no regulations regarding passenger distribution on this type of aircraft.

On board the aircraft, the pilot used the intercom to give the passengers a safety briefing. All were wearing headphones and a microphone. During the investigation, the woman said that she removed her headphones to tend to the children and that she did not hear the safety briefing given by the pilot. The content of the pilot's safety briefing could not be determined.

Although there were life jackets on board the aircraft, none of the occupants was wearing one at the time of the accident. Wearing a life jacket is not mandatory; however, in report SA9401 entitled *A Safety Study of Survivability in Seaplane Accidents*, the TSB recommended that Transport Canada require that all occupants of seaplanes wear a personal flotation device during the standing, taxiing, take-off, and approach and landing phases of flight (A94-07).

The pilot used 20 degrees of flap, as suggested in the flight manual for the Cessna U206F seaplane. For a take-off in strong cross-wind conditions, the Cessna U206F flight manual suggests using the minimum flap required for the take-off distance available. The flight manual does not specify any cross-wind take-off limitations because the limitation depends on pilot skill instead of aircraft capability.

For a normal take-off with an aircraft fitted with a Robertson kit, the flight manual supplement suggests 20 degrees of flap. The only reference to cross-wind take-offs in the Robertson supplement relates to the STOL take-off procedure, when the flaps should be extended to 25 degrees. The suggestion is that 5 knots be added to the take-off speed for every 10 knots of wind speed.

Several experienced bush pilots stated that they extend the flaps to 10 degrees instead of 20 degrees when taking off in strong cross-wind conditions with a Cessna U206F equipped with a Robertson kit and a Flint Aero wing-tip kit. They indicated that the seaplane attains a higher take-off speed in this configuration; also, the ailerons are more effective in cross-winds because they do not lower completely and their upward travel is less restricted.

When the flaps are extended to 20 degrees, strong winds cause the seaplane to lift out of the water and take off prematurely. The aircraft is still at low speed, close to the stall speed. If the winds are gusting, the seaplane can stall and fall back on the water when the gust subsides.

The Cessna U206F is equipped with two doors: the left front main door, next to the pilot seat, and a double cargo door in the right rear. The forward leaf of the cargo door is in line with the second row of seats, and the aft leaf is in line with the rear row of seats. All seats face forward. The Cessna U206F is certified in this configuration with its two doors in accordance with Part 3 of the Civil Air Regulations (CAR), and is consequently approved by Transport Canada.

When the flaps are extended to 20 degrees, the forward leaf of the cargo door on this type of aircraft can open only about 8 cm, and this makes it difficult to fully open the aft leaf of the cargo door. Pilots and operators of this type of aircraft are aware of the difficulty, but it is not mentioned in the aircraft owner's manual. In this accident, there was no evidence found that the two leaves were opened, despite the evidence that the forward leaf of the cargo door was forced from the inside.

The Cessna U206F Stationair owner's manual describes the operation of the cargo door in the section entitled *Cargo Door Emergency Exit* as follows:

If it is necessary to use the cargo doors as an emergency exit and the wing flaps are not extended, open the forward door and exit. If the wing flaps are extended, open the doors in accordance with the instructions shown on the red placard which is mounted on the forward cargo door.

The following instructions were on the sign on the inside of the forward leaf of the cargo door of the aircraft:

EMERGENCY EXIT OPERATION

1. *ROTATE FORWARD CARGO DOOR HANDLE FULL FORWARD THEN FULL AFT.*
2. *OPEN FORWARD CARGO DOOR AS FAR AS POSSIBLE.*
3. *ROTATE RED LEVER IN REAR CARGO DOOR FORWARD.*
4. *FORCE REAR CARGO DOOR FULL OPEN.*

This investigation included an ergonomic assessment of the double cargo door using the criteria prescribed in Part 3 of the CAR and military criteria for ergonomics . According to the criteria used in the ergonomic assessment, one emergency exit must generally be designed to be easy to use, easily accessible, free of obstructions, and easy to find and open in the dark. On this type of Cessna, the forward leaf of the cargo door must be opened to allow the aft leaf to open. The handle used to unlatch the cargo door forward leaf is accessible to passengers seated in the middle row of seats, but is harder to reach for passengers seated in the rear row. If the flaps are extended to 20 degrees, as they were in this accident, the flaps allow the forward leaf of the cargo door to open only slightly, and this impedes occupant evacuation. The handle used to unlatch the aft leaf of the cargo door, which is mounted in the upright frame member of the leaf itself and is in line with the backrest of the right-hand second row seat, is difficult to reach for the passenger occupying that seat. In addition, when the handle is lowered to the open position, it strikes the slightly open forward leaf, which prevents the aft leaf from opening. The handle must be raised in order to open the aft leaf, but here again, the latch may re-engage.

The criteria used for the ergonomic assessment state that the emergency exits must open quickly, within three seconds, and all occupants must be able to evacuate the aircraft within 60 seconds using only half the emergency exits available. Ground tests showed that even with the flaps retracted, it was not possible to open either leaf of the rear cargo door within three seconds or to evacuate six adults within 60 seconds.

Following an accident in 1984 at Salone Lake (report No. 84-Q40031), the Canadian Aviation Safety Board forwarded an Aviation Safety Advisory to Transport Canada indicating that the rear double cargo door of the Cessna 206 was hard to open. No measures were taken to have the doors modified. In March 1991, the Cessna Aircraft Company issued a service bulletin, SEB91-04, to improve the cargo door latch mechanism on the Cessna 206 and U206. This service bulletin advised adding a return spring to the aft cargo door handle and installing two new placards. One was placed on the forward cargo door, and one on the aft cargo door pointing out the handle location. The changes reduced by one the steps to be taken to open the two cargo doors but did not eliminate the jamming of the forward cargo door against the flaps when they are at 20 degrees down. The owner of the aircraft did not comply with this service bulletin. The service bulletin was not mandatory, as it did not affect the airworthiness of the aircraft.

¹ Department of Defence (1987), *Military Handbook: Human Factors Engineering Design for Army Material*, MIL-HDBK-759A;

Department of Defence (1989), *Military Standard: Human Engineering Design Criteria for Military Systems, Equipment and Facilities*, MIL-STD-1472 D.

The ergonomic assessment of the rear cargo door was conducted during the day in favourable light conditions. In the accident, the seaplane was inverted in the water and remained totally submerged. The female passenger reported that the water was murky and that it was hard to see anything under water.

A study relating to escape and survival from aircraft ditching states that the rotation of the body underwater and loss of gravitational reference makes disorientation inevitable for survivors prior to escape from an inverted aircraft. In addition, the darkness produced by water flooding into the aircraft aggravates the disorientation. Survivors who were questioned in this study reported experiencing confusion, panic, and disorientation in the occurrences. The study concludes that only those who have experienced disorientation in an underwater trainer understand the problem and know how to deal with it to get out and survive. Early in the summer preceding the accident, the *Association des pilotes de brousse du Québec* held a training session on exiting an aircraft under water. At the training session, pilots (belted in the seat of an aircraft) were dropped in a pool and had to try to evacuate the aircraft. The pilot of the accident Cessna was unable to attend this annual training session.

The deaths of the pilot and three passengers were attributed to drowning. There was no evidence that incapacitation or physiological or psychological factors affected the pilot's performance.

Analysis

The investigation revealed that the seaplane was maintained in accordance with existing regulations and approved procedures. There was no evidence found of any airframe failure or system malfunction on take-off.

The pilot was experienced on this type of aircraft. By all indications, before embarking on the flight, the pilot assigned the passengers seats in the aircraft in an arrangement that he considered most effective and most agreeable for them. However, children were seated near the exit door, and there is a strong possibility that having an adult near the emergency exit would have facilitated evacuation.

The pilot gave the passengers a safety briefing, but some passengers were distracted and did not hear it clearly. The emergency exit instructions were on the sign on the cargo door, but the pilot did not demonstrate how to operate the two leaves of the cargo door to ensure that the passengers knew how they operated and to facilitate opening the door in an emergency; however, such a demonstration is not mandatory under the regulations. The pilot did not ask the passengers to wear life jackets for take-off, nor is this mandatory under the aviation regulations.

There are no limitations for take-offs in cross-wind conditions because they depend on pilot skill. The pilot took off in strong cross-wind conditions and used 20 degrees of flap, as indicated in the Cessna U206F manual and the Robertson kit supplement. However, the pilot could have used 10 degrees of flap like some pilots with experience on this type of aircraft. The effectiveness of the ailerons, which was diminished by the Robertson

² Brooks, C.J., North Atlantic Treaty Organization, Advisory Group for Aerospace Research and Development, Aerospace Medical Panel, *The Human Factors Relating to Escape and Survival from Helicopters Ditching in Water*, Neuilly-sur-Seine, France: AGARD, 1989. ISBN 92-835-0522-0.

kit installed on the seaplane and the use of 20 degrees of flap, did not allow the pilot to maintain roll control during the take-off; the strong right cross-winds lifted the right wing of the aircraft, which then rolled to the left.

While the aircraft was overturned in the water, the pilot went to open the rear cargo door. By all indications, the pilot and the other occupants became disoriented in the murky water, and no one was able to find the handle of the cargo door forward leaf to open it. The damage observed on the cargo door forward leaf suggests that one of the adults tried to force it open.

The system for opening the two leaves of the rear cargo door is complex and difficult to operate under normal conditions, but opening the leaves is even more difficult if the flaps are extended for a take-off or landing. This makes the rear cargo door practically unusable, and as a result, the left front main door is the only usable emergency exit for all occupants.

Findings

1. The aircraft was certified, equipped, and maintained in accordance with existing regulations and approved procedures.
2. The weight and centre of gravity of the aircraft were within the prescribed limits.
3. The pilot was certified and qualified for the flight in accordance with existing regulations.
4. The pre-flight briefing given by the pilot was not heard by all passengers.
5. The content of the pilot's briefing could not be determined.
6. The passenger distribution was such that it was not easy for the occupant seated in line with the cargo door to open the door in an evacuation.
7. Opening the leaves of the rear cargo door of a Cessna U206F is complex and difficult if the flaps are extended to 20 degrees; it is even more difficult when the seaplane is submerged and overturned.
8. The damage to the forward leaf of the cargo door suggests that one of the adults tried to force it open.
9. The pilot did not ask the passengers to wear their life jackets during taxiing and take-off, nor is it mandatory to do so under the aviation regulations.
10. The Robertson and Flint Aero flight supplements do not mention the position of the flaps on the Cessna U206F seaplane for a take-off from water in strong cross-wind conditions.
11. The pilot used 20 degrees of flap to take off from water in cross-wind conditions.
12. The pilot was unable to maintain roll control of the seaplane during a take-off from water in strong cross-wind conditions.
13. The pilot was unable to attend the annual optional training on evacuating a submerged aircraft.

Service Bulletin SEB91-04, to improve the cargo door latch mechanism, had not been incorporated in this aircraft.

Causes and Contributing Factors

The pilot was unable to maintain control of the aircraft, equipped with Robertson and Flint Aero kits, during a take-off with 20 degrees of flap in strong cross-wind conditions. The distribution of the passengers and the complexity of opening the leaves of the rear cargo door with the flaps extended to 20 degrees contributed to the difficulty of the evacuation.

Safety Action

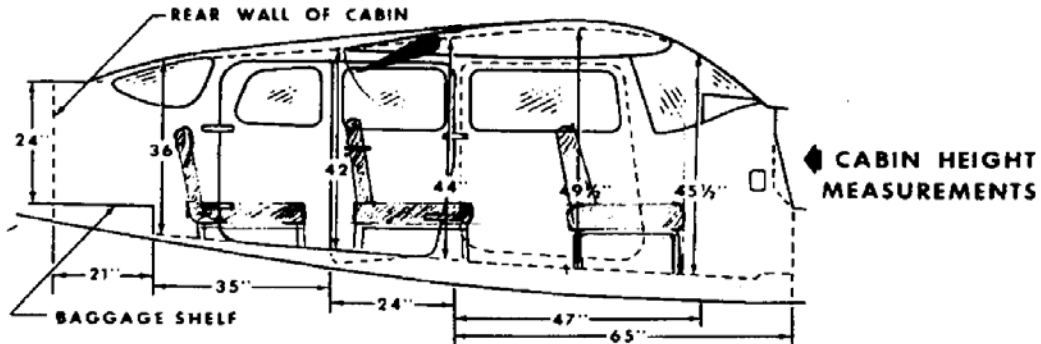
Subsequent to this accident, and based on the TSB investigation process, Transport Canada (TC) expressed its concern about the adequacy of the emergency exit of the Cessna U206 aircraft to the FAA in a letter dated 27 November 1996. TC acknowledged that, "While incorporation of the Cessna modification kit improves the situation somewhat, it does not, however, resolve the basic problem - the Cessna U206 emergency exit procedure, when the flaps are down, remains a multi-step procedure that can be difficult to execute under emergency conditions." TC encouraged the FAA to make the Cessna modification (SEB91-04) mandatory for in-service aircraft. The letter further states that should production of the U206 resume, TC would strongly recommend that the FAA require Cessna to incorporate a solution which eliminates the interference problem between the flaps and the emergency exit. The TSB understands that TC has not received a response to date regarding this concern.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board, consisting of Chairperson Benoît Bouchard, and members Maurice Harquail, Charles Simpson and W.A. Tadros, authorized the release of this report on 29 July 1997.

Appendix A - Diagram of Cabin (from the

**INTERNAL CABIN DIMENSIONS
FOR CARGO LOADING**

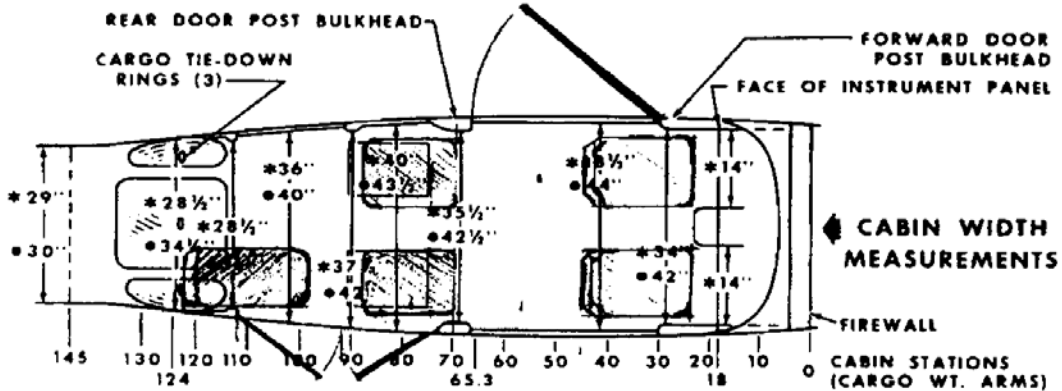
FLAPS AT 20 DEGREES



DOOR OPENING DIMENSIONS

	WIDTH (TOP)	WIDTH (BOTTOM)	HEIGHT (FRONT)	HEIGHT (REAR)
CABIN DOOR	32 1/2"	37"	41"	39"
CARGO DOORS	43"	40"	39 1/4"	37 1/2"

— WIDTH —
* CABIN FLOOR
● LWR. WINDOW LINE



NOTES:

1. Use the forward face of the rear door post as a reference point to locate C. G. arms. For example, a box with its center of weight located 13 inches aft of the rear door post would have a C. G. arm of (65.3 + 13.0 = 78.3) 78.3 inches.
2. Maximum allowable floor loading: 200 pounds/square foot. However, when items with small or sharp support areas are carried, the installation of a 1/4" spruce or fir plywood floor is highly recommended to protect the aircraft structure.

