Australian Government

Australian Transport Safety Bureau

Loss of control and collision with terrain involving Cessna 206 floatplane, VH-NTK

6 km SE of Southport Airport, Queensland, on 5 June 2016

ATSB Transport Safety Report

Aviation Occurrence Investigation

AO-2016-055

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Addendum

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Loss of control and collision with terrain involving Cessna 206, VH-NTK

What happened

On 5 June 2016, the pilot of a Cessna 206 floatplane, registered VH-NTK, was taking off from the Southport Broadwater about 6 km south-east (SE) of Southport Airport, Queensland, for a charter flight with two passengers on board.

The wind was blowing from the west-north-west (WNW) at about 18 kt, with gusts of variable speed. The take-off direction to the north-west (NW) was too restrictive due to the presence of boats in the area, so the pilot elected to begin the take-off towards the south-west (SW) (Figure 1). Taking off to the SW would be through a jet-ski course and a crosswind from the right. Once clear of the jet-ski course, the pilot intended to veer right onto a more westerly (into wind) heading to complete the take-off.

The pilot set 20° flap and left the water rudders[1] in the down position to assist with directional control at the start of the take-off run. The pilot applied full power to start the take-off run and the aircraft pitched[2] backwards into the plowing position.[3] The pilot retracted the water rudders about five seconds into the take-off run, and about two seconds later, pitched the aircraft forward from the plowing position into the step position.[4] As the aircraft pitched forward onto the step it veered to the left onto a south-south-west (SSW) heading (this increased the crosswind experienced – see textbox 4 in Figure 1). The pilot maintained the aircraft on this heading until they sighted barrels in the water that were used to mark the jet-ski course.

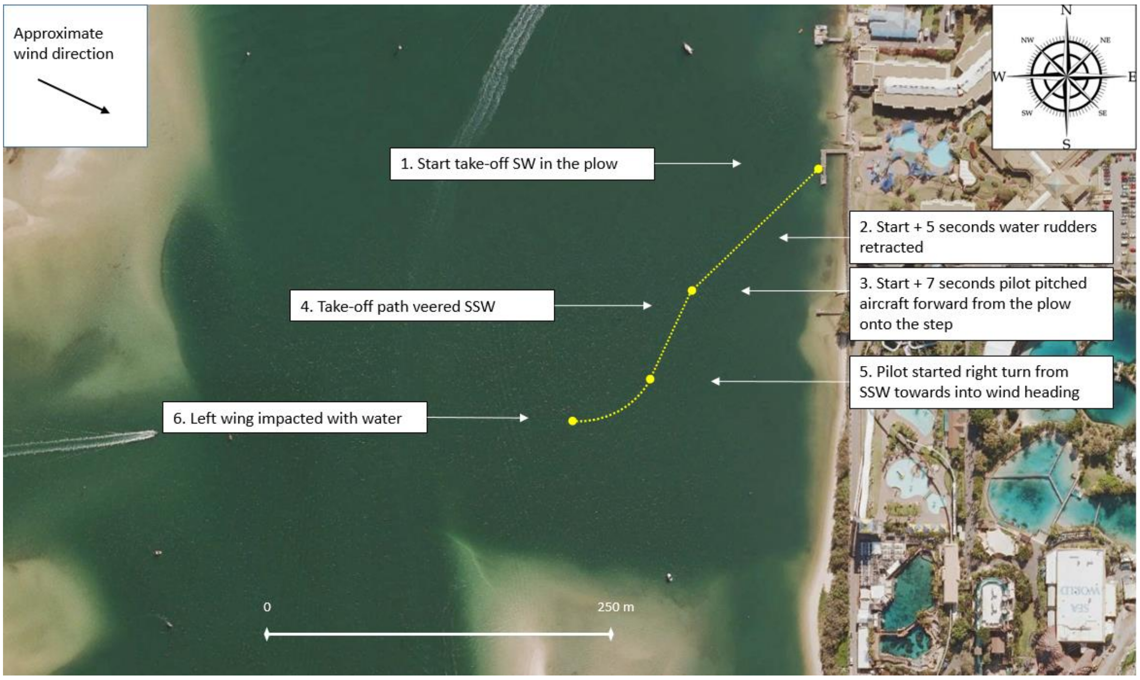
The pilot could not prevent the veer to the left, even with full right rudder, so after sighting the jet-ski course barrels, the pilot pitched the aircraft backwards into the plowing position to improve directional control on the water.[5] The pilot then alternated pitching the aircraft between the plow and step position in order to gradually veer to the right onto a more westerly heading (textbox 5 in Figure 1).

As the aircraft was passing a SW heading and was turning towards WSW, the right wing lifted and the aircraft rolled[6] to the left. The roll continued, despite the application of full right aileron by the pilot, until the left wing impacted the water. The aircraft rotated to the left through about 270° and the nose and propeller ploughed into the water. The aircraft then came to a stop in an upright position, facing in a westerly direction (Figure 1).

The pilot assessed the condition of the aircraft and elected not to evacuate the passengers. The aircraft was then towed to shore by a jet-ski. There were no injuries and the aircraft was substantially damaged (Figure 2 and 3).

1 Retractable control surfaces on the back of each float that can be extended downward into the water to provide more directional control when taxiing. They are attached by cables and springs to the air rudder and operated by the rudder pedals in the cockpit.
2 The term used to describe the motion of an aircraft about its lateral (wingtip-to-wingtip) axis.
3 A nose high, powered taxi characterised by high water drag and an aftward shift of the centre of buoyancy. The weight of the floatplane is supported primarily by buoyancy, and partially by hydrodynamic lift.
4 The attitude of the floatplane when the entire weight of the aircraft is supported by hydrodynamic and aerodynamic lift, as it is during high-speed taxi or just prior to take-off. This position, which is also referred to as the planing position, produces the least amount of water drag.
5 When on the step position the keel of the floats tend to resist turning motion.
6 Term used to describe movement of an aircraft about its longitudinal axis.

Figure 1: Approximate take-off path and key events



Source: Google earth modified by ATSB

Figure 2: VH-NTK left wing damage

Source: Owner

Figure 3: VH-NTK rear strut fracture (view of the left float facing forwards)

Source: Owner

Pilot comments

The pilot provided the following comments:

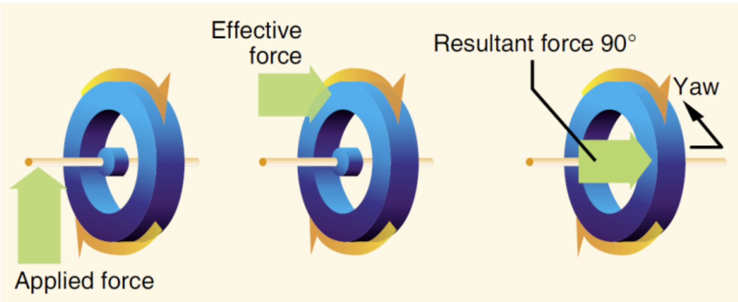
- the force that veered the aircraft to the left occurred when they pitched the aircraft forward from the plow position to the step position
- they were turning the aircraft right through SW towards WSW when it rolled
- they were holding full into wind (right) aileron control and therefore expected the left wing to lift prior to the right wing
- when they rolled to the left they were 'shocked' by the crosswind and 'surprised' they could not control the floatplane
- they estimated the strength of the gust that lifted the right wing was about 8–10 kt
- they had about 110 litres of fuel in the left wing tank and about 60 litres in the right wing tank, which may have contributed to the left roll
- the floatplane rolled left at about 30–35 kt airspeed
- the crosswind limit is 20 kt
- the take-off speed is 41 kt with 20° flap set.

Left turn effect

There are four distinct propeller forces, each of which produce a left turning force on an aeroplane, as follows:

- Torque effect: As the engine internal parts and propeller rotate clockwise, as viewed by the pilot, an equal force tries to rotate the aircraft in the opposite direction. This force places more weight and consequently more hydrodynamic drag on the left float of a floatplane.
- Slipstream effect: The clockwise spiralling motion of the propeller slipstream means that the slipstream strikes the left side of the vertical fin. This produces a yawing[7] moment to the left.
- P-factor: In a nose high attitude the 'bite of air' of the downward moving blade of the propeller is greater than the 'bite' of the upward moving blade, which moves the centre of thrust to the right side of the propeller disc. This also produces a yawing moment to the left.
- Gyroscopic effect: The rotating propeller behaves like a gyroscope. As such, any time a force is applied to deflect the propeller from its plane of rotation, the resultant force is 90° ahead in the direction of rotation, and in the direction of the effective force (Figure 4). As such, the gyroscopic effect results in a yawing motion to the left when the aircraft is pitched forward from the plow position to the step position.

Figure 4: Gyroscopic effect



Source: FAA pilot's handbook of aeronautical knowledge

Additional information is available from the United States Federal Aviation Administration (FAA) [*Pilot's handbook of aeronautical knowledge*, chapter 5: Aerodynamics of flight.]

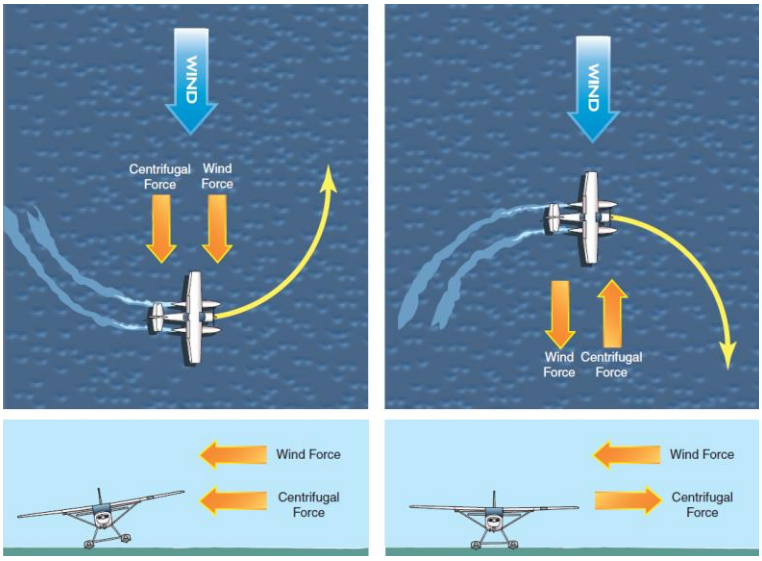
[7] Term used to describe the motion of an aircraft about its vertical or normal axis.

Crosswind take-off

According to the FAA *Seaplane operations handbook*, crosswinds can present special difficulties for floatplane pilots. If the aircraft turns towards the wind during a crosswind take-off, then centrifugal force will combine with the wind force to produce a rolling moment in the opposite direction to the turn (Figure 5). If strong enough, the combination of wind and centrifugal force may lift the upwind wing and submerge the downwind float, rolling the aircraft until the downwind wingtip strikes the water. This is known as a water-loop (Figure 6).

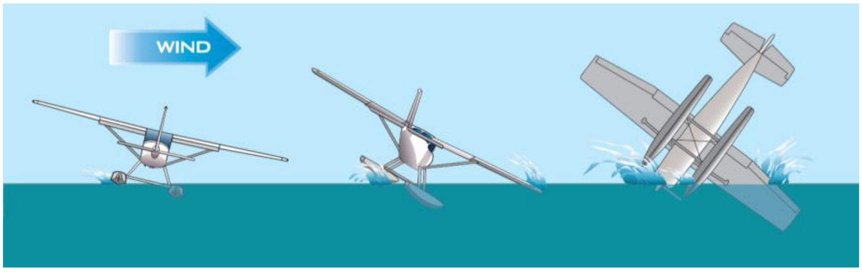
Centre of gravity[8] location also affects the floatplane's handling characteristics on the water. If the centre of gravity is located to one side of the centre-line, such as a fuel imbalance between the tanks, one float must support more weight and therefore displace more water than the other float, resulting in more water drag on that side (Figure 7).

Figure 5: Effect of wind force and centrifugal force



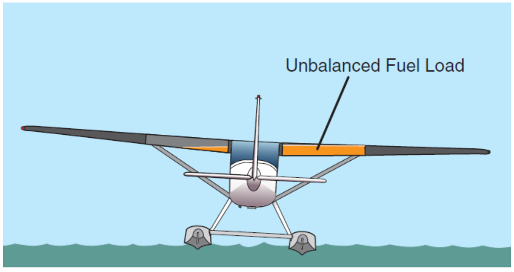
Source: FAA seaplane operations handbook

Figure 6: Water-loop



Source: FAA seaplane operations handbook

Figure 7: Effect of fuel imbalance on centre of gravity



8 Point through which resultant force of gravity acts, irrespective of orientation; in uniform gravitational field, centre of mass.

Source: FAA seaplane operations handbook

ATSB comment

The pilot reported that it was the force from the forward pitching motion of the aircraft from the nose-high plowing position to a nose-level step position that resulted in the aircraft veering left from the planned take-off path. The force that produces this motion is the gyroscopic effect. At the time of the uncommanded roll to the left the aircraft was turning right with a strong crosswind from the right and more fuel distributed in the left tank than in the right tank. These factors probably combined to elevate the risk of submerging the downwind float and lifting the upwind wing, resulting in a water-loop.

Safety action

Whether or not the ATSB identifies safety issues in the course of an investigation, relevant organisations may proactively initiate safety action in order to reduce their safety risk. The ATSB has been advised of the following proactive safety action in response to this occurrence.

Operator

As a result of this occurrence, the aircraft operator has advised the ATSB that they are taking the following safety actions:

Changes to operating procedures

The operator is updating their operations manual to incorporate the following procedural changes:

- The channel at the operating base is orientated north-south, which restricts movements orientated east-west, therefore if the wind is forecast to gust more than 20 kt from the west, or within 30° either side of west, the take-off must be rejected.
- If the aircraft veers to the left during the take-off run and requires full control inputs, then reject the take-off.

Safety message

This accident highlights the risk of a water-loop event during a crosswind take-off in a floatplane. The combined forces acting on a floatplane have the potential to significantly reduce the margin of control available to the pilot. The FAA *Seaplane operations handbook* provides several recommended crosswind take-off techniques, including the considerations associated with arcing manoeuvres during take-off. If an arcing manoeuvre is to be attempted then the FAA handbook recommends placing the centrifugal force and wind force on opposite sides, and reducing the radius of the arc as the floatplane speed increases.

Refer to the FAA *Seaplane operations handbook* for a detailed explanation of the recommended crosswind take-off techniques.

General details

Occurrence details

Date and time:	5 June 2016 – 1335 EST	
Occurrence category:	Accident	
Primary occurrence type:	Loss of control	
Location:	6 km SE of Southport Airport, Queensland	
	Latitude: 27° 57.60' S	Longitude: 153° 24.87' E

Aircraft details

Manufacturer and model:	Cessna Aircraft Company U206G	
Registration:	VH-NTK	
Serial number:	U20605862	
Type of operation:	Charter - passenger	
Persons on board:	Crew – 1	Passengers – 2
Injuries:	Crew – 0	Passengers – 0
Aircraft damage:	Substantial	

About the ATSB

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The ATSB is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; and fostering safety awareness, knowledge and action.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to operations involving the travelling public.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated.

It is not a function of the ATSB to apportion blame or determine liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

About this report

Decisions regarding whether to conduct an investigation, and the scope of an investigation, are based on many factors, including the level of safety benefit likely to be obtained from an investigation. For this occurrence, a limited-scope, fact-gathering investigation was conducted in order to produce a short summary report, and allow for greater industry awareness of potential safety issues and possible safety actions.