Australian Government
Australian Transport Safety Bureau

Loss of control and collision with terrain involving de Havilland Canada DHC-1 Chipmunk, VH-UPD

Coffs Harbour, New South Wales | 29 June 2014

Investigation

ATSB Transport Safety Report
Aviation Occurrence Investigation
AO-2014-114
Final – 4 February 2016

Front cover source: Recreational Pilots.

Released in accordance with section 25 of the *Transport Safety Investigation Act 2003*

Publishing information

Published by: Australian Transport Safety Bureau
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Addendum

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Safety summary

What happened

On the morning of 29 June 2014, the pilot of a de Havilland Canada DHC-1 T Mk 10 Chipmunk aircraft, registered VH-UPD, was taking a passenger for a brief, private flight over Coffs Harbour Regional Airport, New South Wales.

According to pilot and passenger reports, after conducting a series of aerobatic manoeuvres, the pilot climbed to about 3,800 ft and accelerated to about 85 kt. The pilot then made a short dive to build up speed to about 120 kt before commencing a loop.

VH-UPD accident site

Source: ATSB

At the top of the loop, the aircraft stalled while inverted, most likely as the result of excessive elevator input. The aircraft rolled and entered an upright spin, which became flatter as it developed. Later, the pilot reported that attempts to recover were unsuccessful. The spin continued until the aircraft impacted terrain. The pilot and passenger sustained serious injuries and the aircraft was seriously damaged. There was no fire.

What the ATSB found

The pilot reported undertaking training to conduct loops, but there was no record of an endorsement and the instructor did not recall approving the pilot to conduct loops. As a result, at the time of the accident, the pilot likely did not possess the necessary skills and judgement to conduct the manoeuvre safely and consistently.

The pilot probably did not apply and maintain the spin recovery control inputs appropriate for a fully-developed spin in a Chipmunk aircraft. Furthermore, the pilot was taught a spin recovery method that was not effective for recovering from such spins in the aircraft.

In addition, the accident aircraft's flight manual had not been approved by the Civil Aviation Safety Authority and did not include advice on spin recovery. The mandatory, Civil Aviation Safety Authority-approved flight manual contained spin recovery advice.

What's been done as a result

The flying school that provided the pilot's aerobatic training reported that a briefing process was undertaken with all current aerobatic instructors to ensure that consistent terminology is used to describe and teach aerobatic manoeuvres. It also reported that a programme of standardisation flights for all current aerobatic instructors will include the training of spin and unusual attitude recovery for aerobatic students.

Safety message

Pilots and instructors, particularly those intending to conduct or teach aerobatic manoeuvres, should be familiar with any special handling requirements for a particular aircraft type as well as recovery from both incipient and developed spins. Furthermore, they should ensure that they hold the appropriate aerobatic endorsement before attempting a manoeuvre.

Contents

The occurrence

On the morning of 29 June 2014, the pilot of a two-seat de Havilland Canada DHC-1 T Mk 10 Chipmunk aircraft, registered VH-UPD (UPD), was making a series of short, private flights in the vicinity of Coffs Harbour Regional Airport, New South Wales. The pilot carried a different passenger on each flight, and flew the aircraft from the front seat.

After about three or four flights, and with a new passenger on board, the pilot requested and received air traffic control clearance to conduct ‘airwork’ over the airport, not above 4,000 ft above mean sea level.[1] The pilot took off at about 1127 Eastern Standard Time[2] on what was the first flight of the day that was intended to include aerobatic manoeuvres.

After climbing to about 3,800 ft, the pilot conducted a series of manoeuvres. The aerobatic sequence usually flown by the pilot consisted of a shallow dive to accelerate to about 120 kt, followed by a loop, an aileron roll and two wingovers (the latter manoeuvres were each commenced at 100 kt). The pilot reported that the sequence usually finished about 1,000 ft lower than the initial height.

The pilot reported that he subsequently climbed back to 3,800 ft and accelerated to about 85 kt. The pilot then made a short dive to again build up speed to about 120 kt before commencing a second loop. The aircraft’s height during the manoeuvres could not be confirmed with any accuracy but, based on the pilot’s report and calculations derived from witness reports, the entry height for the second loop was probably higher than 3,000 ft.

Witnesses reported that while inverted at the top of the manoeuvre, the aircraft stalled and rolled to the right. The aircraft then entered an upright spin to the right which became flatter as it developed. The pilot reported being aware of the spin and feeling ‘panicked’, finding that his attempts to recover from the spin were unsuccessful. The pilot tried different control inputs in an attempt to recover, including right and left rudder and applying left and right aileron, but did not recall moving the control stick forward. The passenger later reported that during the descent, the pilot was manipulating the controls and talking, but the passenger could not recall how the controls moved.

Video footage taken by witnesses showed the last 15 seconds of the flight with the aircraft established in a slow, upright spin to the right from about 1,200 ft. The aircraft’s pitch attitude was about 30° nose-down during the spin. The spin continued until the aircraft impacted terrain at about 1136, in a narrow strip of forested land between the airport and the beach. The airport’s air traffic controller observed the spin and immediately initiated emergency and rescue procedures.

The pilot and passenger sustained serious injuries and the aircraft was seriously damaged. There was no fire.

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1 The airport elevation is 18 ft above sea level.

2 Eastern Standard Time (EST) was Coordinated Universal Time (UTC) + 10 hours.

Context

Pilot information

General

The pilot held a Private Pilot (Aeroplane) Licence that was issued in 2004, and a valid Class 2 Medical Certificate with a condition to have reading correction available when exercising the privileges of the licence. The medical certificate was valid until May 2016.

The pilot's logbook indicated a total aeronautical experience of 155.7 hours, not including the four or five brief flights on the day of the accident. The pilot last completed an aeroplane biennial flight review on 24 May 2014.

The pilot later reported feeling well rested, healthy and in a good mood on the day of the accident. He had no significant medical conditions and had not taken any medications or consumed any alcohol.

Aerobatic training and flying history

To be authorised to conduct aerobatics as pilot-in-command, a pilot must hold a logbook endorsement for spin recovery and a logbook endorsement for the aerobatic manoeuvres to be conducted.

The pilot's aerobatic and spin recovery endorsement training was conducted in another de Havilland Canada DHC-1 T Mk 10 Chipmunk operated by a flying school. The flying school's syllabus estimated 1.0 hour's instruction each for unusual attitude recovery, aileron rolls, wingovers and loops, and 1.5 hours for spin recovery. According to the syllabus, unusual attitude recovery and spin recovery competency were prerequisites for aerobatic endorsements. All of the pilot's spin training was to the left.

According to the pilot's logbook, endorsements for wingovers, aileron rolls and spin recovery were approved on 7 July 2013, after 3.5 hours of aerobatic instruction. There was no recorded endorsement for loops and the flying school instructor later reported that he had probably demonstrated a loop but that he did not formally endorse the pilot to conduct them as pilot-in-command. The pilot thought he held the appropriate endorsement to conduct loops.

The pilot's logbook recorded an instructional flight on 1 February 2014 that was labelled 'aerobatic sequence'. This brought the pilot's total dual aerobatic instruction time to 4.4 hours.

The combined total dual and solo time recorded in the pilot's logbook for aerobatic flights in the Chipmunk was 10.2 hours, all of which was in UPD and the flying school's Chipmunk. Of those flights, two also included circuits.

The most recent recorded aerobatic flight in a Chipmunk was on 22 March 2014.

Prior to their Chipmunk training, the pilot had conducted spin recovery training in a DH-82 Tiger Moth and an American Champion Citabria. The pilot reported that those aircraft were more responsive to spin recovery control inputs when compared with the Chipmunk.

An instructor who had flown with the pilot reported that the pilot's flying was 'hard to fault' and 'diligent'.

Spin recovery training

The pilot reported that his actions for spin recovery were normally to apply full opposite rudder and a small amount of opposite aileron, and to centralise the elevators. The method did not vary between any of the aircraft types flown by the pilot.

Two instructors were recorded in the pilot's logbook as having taught the pilot aerobatics in the Chipmunk. Both instructors were suitably qualified and approved to conduct aerobatic training.

The flying instructor who endorsed the pilot for spin recovery reported using and teaching the following method for spin recovery in the Chipmunk:

- throttle closed
- full opposite rudder
- neutral aileron
- move the elevators about two thirds of the way from full back towards the central stick position but not all the way.

The instructor stated that the aim was to place the flight controls in a position that produces maximum lift, and that this helped stop the stall that would otherwise sustain the spin. The instructor stated the elevator control should not be put fully-forward to prevent entering an inverted spin.

The second instructor could not specifically recall teaching the pilot, but described a similar spin recovery method with the exception that the pilot should continue pushing the control stick forwards (elevators down) until the rotation ceases. The flying school's chief flying instructor reported that forward stick should be applied during spin recovery.

The pilot and first instructor reported that during instruction and evaluation in the Chipmunk, spin recovery action would commence after about one or one and a half turns (that is, 360°–540° from the original heading). They reported that the spin would cease after a further one or one and a half turns. The flying school's operations manual did not include instructions on the appropriate number of turns in a spin before recovery should be attempted, and the chief flying instructor advised that spin recovery would normally be initiated within about two turns.

The flying school did not maintain records of aerobatic and spin recovery training and approvals unless a student had already obtained a licence through the school. The instructor who signed the pilot's logbook endorsements for wingovers, aileron rolls, and spin recovery held the appropriate Civil Aviation Safety Authority (CASA) qualifications to do so.

Aircraft information

General

The aircraft, a de Havilland Canada DHC-1 T Mk 10 Chipmunk, was built in the United Kingdom (UK) in 1950 with the constructor's number C1/0111. It was first registered as a civilian aircraft in Australia in 1956 (Figure 1).

The Chipmunk was designed for ab initio military flight training. It is a two-seat, low-wing, single-engine aircraft with a mainly light aluminium alloy sheet airframe and fabric covered wings and control surfaces. The aircraft was powered by a de Havilland Gipsy Major 10 Mk 2 four-cylinder piston engine driving a two-blade wooden Hoffman H0.21-198B/140L fixed-pitch propeller.

The ATSB assessed that the aircraft was within its weight and centre of gravity limits at the time of the accident, with the centre of gravity towards the rear limit.

Figure 1: DHC-1 Chipmunk, registered VH-UPD, in 2009

Source: http://www.recreationalpilots.com.au/

Maintenance

A current maintenance release was not carried in the aircraft and was later provided to the ATSB by the owner. It recorded that the aircraft's most recent inspection was completed on 26 June 2014 at 5,129.25 hours time in service, with no outstanding defects.

Wreckage and impact information

The accident site was located about 400 m east of the Coffs Harbour Regional Airport runway 03[3] threshold (Figure 2).

The main wreckage was in an upright position, oriented towards the east (Figure 3). The damage to the aircraft and impact marks on the surrounding foliage and the ground indicated that the aircraft impacted terrain in a near vertical descent while yawing from left to right and in a slightly nose-low attitude. The fuselage and undercarriage absorbed much of the ground impact forces, as did the foliage and relatively soft, sandy ground.

All of the aircraft components were accounted for in the immediate area of the accident site. There was no evidence of any pre-impact failure.

Flight control continuity was established. The flaps appeared to be retracted at the time of impact. The elevator trim position could not be accurately determined due to the structural deformation of the fuselage.

A loose washer was found in an area behind the rear control box. Visual examination of the washer revealed no damage that would indicate that it had been jammed in the controls.

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[3] Runways are named with a number representing the magnetic direction of the runway. Runway 03 is approximately aligned to 030 °M.

Both fuel tanks were compromised and there was a strong smell of fuel in the area underneath the tanks, indicating that fuel had drained from the tanks into the ground. The carburettor bowl was drained of about 80 mL of fuel, which was free from water and visible debris and had the appearance and smell of aviation gasoline.

Propeller damage was indicative of rotation without significant power. A limited on-site examination found that the engine rotated freely with good compression on the two undamaged rear cylinders and spark plugs indicating normal combustion. There was no evidence of oil contamination or oil leaks.

Figure 2: VH-UPD accident site location

Source: Google earth, modified by the ATSB

Figure 3: VH-UPD accident site

Source: ATSB

Survivability

The pilot sustained serious head, pelvic and leg injuries requiring hospitalisation. The passenger had a compressive back injury requiring hospitalisation. Both occupants were wearing four-point harnesses, which were reported to be fastened securely. Neither occupant was wearing a helmet.

ATSB analysis based on estimates of aircraft speed and rate of descent, impact angle, and energy absorption indicated that the impact forces imparted to the occupants would normally be expected to result in moderate to serious injuries.

Weather information

An automatic terminal information system (ATIS)[4] report for Coffs Harbour Airport at 1039 indicated a north-easterly wind at 5 kt, more than 10km visibility and few[5] cloud at 5,000 ft. At 1116, as part of normal air traffic communications, the air traffic controller informed the pilot that the surface wind was 8 kt from 100 °M.

Spins and spin recovery

Overview

An aerodynamic spin is a sustained spiral descent in which an aircraft's wings are in a stalled condition,[6] with the outer wing producing more lift and less drag than the other wing. The

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4 An automated pre-recorded transmission indicating the prevailing weather conditions at the aerodrome and other relevant operational information for arriving and departing aircraft.

5 Cloud cover is normally reported using expressions that denote the extent of the cover. The expression few indicates that cloud was covering about a quarter of the sky.

6 A stall occurs when the airflow separates from the wing's upper surface and becomes turbulent. It occurs at high angles of attack, typically 16°–18°, and results in reduced lift.

associated forces sustain the rotation and keep the aircraft in the spin. A spinning aircraft will descend more slowly than one in a vertical dive and it will have a low airspeed, which may oscillate. The pitch angle can also vary considerably.

Intentional spins are normally entered from a stall in straight and level flight, and the application of full back elevator and full rudder in the intended direction of rotation at the moment of stall. The circumstances of a spin entry near the top of a loop may be very different. If a loop is not carried out correctly, the aeroplane can flick-roll[7] or stall at the top of the loop and, if not in balanced flight, may enter an upright spin.

When entering a spin, an aircraft's motion through the air is irregular at first. This is known as the incipient phase of the spin. Though the nature of the incipient spin is heavily dependent on the aircraft type and the manner of entry, recovery may be more rapid and require less control input in this stage compared with recovery from a developed spin.

After a number of rotations and depending on the aircraft type, loading, and control inputs, an aircraft in an incipient spin may then settle into a regular rotating descent, known as a developed spin. A spin may steepen (nose-down) or flatten (nose more horizontal) as it continues, potentially requiring different recovery techniques. Flight test reports indicate that a Chipmunk that enters a spin from a straight and level stall normally takes about three full rotations to enter a fully-developed spin.

CASA Civil Aviation Advisory Publication (CAAP) 155-1(0) outlines the following standard spin recovery method, which 'should be applicable in most situations and aircraft, but the procedure specified in the aircraft's flight manual is the ultimate authority':

- Close throttle;
- Centralise ailerons;
- Identify if the aircraft is spinning, the direction, and whether upright or inverted;
- Full rudder opposite to rotation (opposite to yaw);
- Pause;
- Elevator forward [nose down] for upright and back for inverted as required to unstall;
- When rotation stops - centralise rudder;
- Roll wings level and recover to level flight.

With regard to elevator input in an upright spin, Stowell (2007) recommends pushing the elevator control forward using whatever force is necessary until either the spin stops (which may occur with the control stick between fully aft and neutral in aerobatic designs) or the forward control limit is reached.[8] Some publications recommend letting go of the control column, especially if the pilot is unsure whether the spin is upright or inverted, but in some aircraft types this may not result in recovery.

Chipmunk spins and recovery

The UK Civil Aviation Authority (UK CAA), Civil Aircraft Airworthiness Information and Procedures CAP 562 dated 29 November 2013, Leaflet B-250, *Chipmunk Spinning and Aerobatics*[9] gave the following instructions to recover from a spin in a Chipmunk:

> Spin Recovery must be started at least 3,500 feet above ground level, in order to retain level flight by 1,500 feet, consistent with a height loss during recovery of up to 2,000 feet.
>
> a) check throttle CLOSED;

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7 A flick-roll is a very rapid roll, the speed of which is promoted by stalling one wing only.

8 See also Stowell, R. (2012). *Guidelines for Pilots Seeking All-Attitude Training*, available through www.safepilots.org.

9 Available through www.caa.co.uk.

> b) check ailerons CENTRAL;
>
> c) apply full OPPOSITE RUDDER;
>
> d) PAUSE;
>
> e) move the stick firmly FORWARD against the increasing stick force and stick buffet, IF NECESSARY TO THE FRONT STOP and hold it there until rotation ceases;
>
> f) when rotation ceases CENTRALISE the rudder control and ease out of the ensuing dive.

In June 1960 the Australian Department of Civil Aviation (DCA)[10] published a report that addressed contemporary concerns about the behaviour of the Chipmunk during spin recovery (refer Appendix A – Aviation Safety Digest No.22 extract – *The CHIPMUNK SPIN THE FACTS*). The report stated that 'the point at which pressure is felt in the forward travel of the stick varied considerably and is occasionally almost at the fully forward position' and could be heavy or light.

The ATSB reviewed several documents dating from 1958 onwards, including flight test reports and correspondence between UK authorities and the aircraft manufacturer and type design organisation. These documents addressed the spin and spin recovery behaviour of the Chipmunk. Collectively, the evidence indicated that Chipmunks always recovered from spins using the UK CAA-suggested recovery method described above.

The documents reviewed by the ATSB were consistent in their emphasis on the importance of forward stick movement, with more force than is normally used, and in maintaining full opposite rudder and increasing forward stick (up to the stop if necessary) until rotation ceases. This could take between one and four and a half turns after the application of correct control inputs. Stowell (2007) stated that 'it is vital, therefore, to maintain spin recovery inputs for as long as is needed throughout the entire recovery process; otherwise, recovery could be delayed even longer.'

The training material used by the flying school did not contain spin recovery advice specific to the Chipmunk aircraft type. With regard to elevator control position, the 'standard' spin recovery method provided by the flying school's training material did not emphasise the need for forward control stick movement against the control force (as opposed to neutrally forward from the rearward position).

Chipmunk semi-stalled spiral dive

A Chipmunk may enter a state known as the 'semi-stalled spiral dive' that may be confused with the spin. In this case, the aircraft's attitude is steeply nose-down, with higher airspeed and, according to UK CAA Leaflet B-250, 'upon releasing the controls the aeroplane will recover by itself, or with some opposite rudder, after rotating through one quarter to one half [of] a turn.'

The Australian DCA 1960 report stated that, in most cases, the aircraft will first spiral from the stall and that two or three turns may result before the spin proper is entered. The report stressed the need to differentiate between the semi-stalled spiral dive and the spin and emphasised the importance of using correct recovery procedures in each case.

A 1958 flight test report by the aircraft manufacturer stated that:

> Recovery from the spiral dive is easy and quick whereas recovery from a spin requires deliberate and positive control for a longer time. Anti-spiral dive control will not result in recovery from a spin. When pilots, who have been used to spiral dives, find themselves in a spin they tend either not to apply adequate anti spin control or not to persist with the correct control movements for long enough.

Anti-spin strakes

The Chipmunk could be fitted with strakes on the rear fuselage that were intended to aid the recovery of the spin. According to the 1958 report, the strakes produce a 'small but definite

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10 The Australian Department of Civil Aviation was the national aviation authority until 1973.

improvement in spin recovery' but do not affect the aircraft's ability to enter a spin. Despite this, they were commonly referred to as 'anti-spin strakes.'

For UK-registered aircraft, an airworthiness directive[11] mandated fitment of strakes for aircraft approved for aerobatic manoeuvres and spins, along with a placard advising that 'SPIN RECOVERY MAY NEED FULL FORWARD STICK UNTIL ROTATION STOPS'. Aircraft without strakes were required to display a placard stating 'AEROBATICS AND SPINS PROHIBITED'.

In Australia, neither strakes nor related placards were mandated through an airworthiness directive; however, the strakes and placards were a requirement in accordance with the appropriate Australian flight manual (see *Aircraft flight manuals for the DHC-1 Chipmunk*). UPD and the other Chipmunk aircraft that the pilot flew were not fitted with anti-spin strakes.

Aircraft flight manuals for the DHC-1 Chipmunk

Aircraft flight manual for VH-UPD

The accident aircraft was a DHC-1 T Mk 10, a military variant, which was not issued with a civil type certificate[12] and, originally, had no civil aircraft flight manual (AFM).[13]

In Australia prior to 2002, CASA and its predecessors prepared, approved and issued AFMs for light civil aircraft. The flight manual in use for UPD was one such manual, approved specifically for that aircraft by CASA's predecessor in 1988. It did not include guidance on spin recovery. It permitted any combination of various manoeuvres including spins and inside loops.

In 2002, changes to Australian regulations meant that aircraft owners needed to replace any flight manuals prepared by CASA, or its predecessors, with a type design organisation-approved flight manual. Until that date, the Chipmunk type design organisation had not produced, and had not been required to produce, a flight manual for civil operation of the military T Mk 10 variant. The type design organisation satisfied the CASA requirement and produced a flight manual for that aircraft type for use in Australia only. It included specific precautions for the operation of 'Aircraft NOT Fitted with Anti-spin Strakes'. CASA advised that operators of civil T Mk 10 aircraft were required to use the 2002 flight manual.

According to the aircraft type design organisation, the owner of UPD did not purchase the newer flight manual. CASA records indicated that the aircraft's owner made an application for approval of the 1988 flight manual in 2002. A subsequent letter from CASA advised the owner of 'approval of the aircraft manufacturer's flight manual for VH-UPD'; the accompanying approval form gave the reference number of a 2002 flight manual (see the next section), not the older flight manual. Records held by CASA did not contain evidence that the Civil Aviation Authority (Australian CAA)[14] produced AFM, dated 1988, had been approved as the aircraft's AFM in 2002.

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11 UK Civil Aviation Authority AD No. 2799 PRE 80.

12 A type certificate is a document issued by an airworthiness authority to indicate approval of the type design of a particular model of aircraft.

13 An AFM is a book containing the limitations, procedures, performance and other information and instructions required to operate a particular aircraft safely.

14 CASA was formerly known as the Civil Aviation Authority (CAA).

Aircraft type design organisation's flight manual

The type design organisation's 2002 generic[15] aircraft flight manual produced specifically for Australian-registered T Mk10 Chipmunks contained more information than the 1988 flight manual, including type-specific handling techniques that were not required under the CASA regulations. On spin recovery, it provided similar advice to the Leaflet B-250 (see the section titled *Spins and spin recovery).*

The flight manual also stated that all civil Chipmunks cleared for aerobatics must display a cockpit placard with the following information: 'SPIN RECOVERY MAY NEED FULL FORWARD STICK UNTIL ROTATION STOPS (also see Flight Manual)'. Aircraft not cleared for spins and aerobatics were required by the type design organisation's flight manual to display a placard prohibiting aerobatics and spins.

Training aircraft

A flight manual for the Chipmunk used by the pilot's flying school was a reprint of a 1966 UK military flight manual and was not specifically approved for, or tailored to, the flying school's Chipmunk. On spin recovery, it gave similar advice to the Leaflet B-250 (see the section titled *Spins and spin recovery*).

An 'aircraft information booklet' (not an approved flight manual) for the Chipmunk that was used by the flying school recommended a loop entry speed of 130 kt.

Prior to publication of this ATSB report, the flying school ceased using the Chipmunk for flying training.

Related occurrences

The first fatal spin accident in a Chipmunk in Australia occurred on 19 January 1957 near Goulburn, New South Wales, and the reasons for the accident were not determined. After this accident and three other fatal Chipmunk spin accidents (in 1959 and 1960) for which the reasons were not determined, the Australian DCA conducted a detailed set of test flights to determine whether the Australian Chipmunk had suitable spin recovery handling characteristics. The results were disseminated in the 1960 DCA report discussed previously (see the section titled *Chipmunk spins and recovery*).

There were four other spin-related accidents involving Chipmunk aircraft in Australia between 1961 and 1968. While the last accident in January 1968 involved spin training, this accident was due a coin obstructing the elevator control system, which deprived the pilot of the elevator movement necessary to recover from the spin.

There were no other reported spin-related accidents involving Chipmunk aircraft in Australia between 1969 and 2014.

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15 The AFM issue viewed by the ATSB did not contain data that was unique to an aircraft (such as weight and balance information) that needed to be included when approved for a particular aircraft.

Safety analysis

Stall and spin entry

Based on the pilot, passenger, and witness reports, the aircraft stalled at or near the top of an attempted loop, rolled upright and entered an upright spin that then became flatter. The pilot's control inputs are not known with certainty, but the stall was most likely initiated by too much elevator (stick back) control input for the aircraft's relatively low speed at the top of the loop.

If an aircraft's speed is too low when approaching the top of a loop, a pilot can mistakenly apply too much elevator (stick back) control when trying to correct for the low speed. The subsequent increased angle of attack could then produce a stall. There can be several reasons for a low airspeed at the top of a loop, such as:

- low entry speed
- insufficient throttle increase during the first part of the loop
- too little g[16] throughout the loop, increasing the loop circumference and resulting in excessive altitude gain
- too much g load throughout the loop, producing increased induced drag.

A single-propeller aircraft in a powered stall would be expected to roll. The direction of UPD's roll and spin was consistent with its natural tendency to roll and spin to the right (opposite to the direction of propeller rotation) in a positive-g, inverted stall. Control authority would have been greatly reduced by the low airspeed and any excessive application of aileron or rudder would have increased the risk of the roll developing into a spin.

The pilot reported receiving training to conduct loops and thought that he held the appropriate endorsement to do so as pilot-in-command, but did not have documentary evidence of it. The pilot's instructors reported that the pilot had not yet demonstrated the required skills to be endorsed to conduct loops as pilot-in-command. This indicated that the pilot had not demonstrated the necessary competence required to perform a loop consistently or execute a recovery from an unsuccessful loop.

Unsuccessful spin recovery

According to the results of numerous flight tests, a Chipmunk can be recovered from a spin if there is sufficient recovery height available, and the ATSB estimated that the aircraft had enough height for a successful recovery in this case. Both UPD and the flying school's Chipmunk were used for aerobatic flight without being fitted with anti-spin strakes. According to most reports, a Chipmunk without strakes will recover from a spin but somewhat more slowly than one fitted with that capability. If anti-spin strakes had been installed on UPD, they may have assisted a recovery if the correct flight control inputs were made and held for a sufficient length of time. Additionally, the Chipmunk T Mk 10 (Australia Only) flight manual specifies greater heights above ground level for spinning manoeuvres.

The pilot later reported that, at the time, he recognised that the aircraft was in a spin but did not have a complete recollection of how he attempted to recover from the spin. It was not possible to conclusively determine why the recovery attempts were unsuccessful but it is likely that correct control inputs (particularly opposite rudder and progressively forward control stick) were not made, or not held for long enough to be effective. However, there are a number of factors which probably had an influence.

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16 G Load is the nominal value for acceleration. In flight, g load values represent the combined effects of flight manoeuvring loads and turbulence. This can be a positive or negative value.

The method of spin recovery taught by the pilot's flight instructor, and practised by the pilot during training, was to apply opposite rudder and approximately central control stick. The application of central control stick allows recovery in some Chipmunks, particularly from an incipient spin or semi-stalled spiral dive. It also works for some newer aircraft types that are designed to exhibit more benign spin behaviour. However, it does not work for all Chipmunks, especially once a spin has fully developed. The method of spin recovery described by the pilot would probably have been ineffective once the spin was fully developed. The aircraft also might have entered a fully-developed spin more rapidly than during the pilot's training because of the unusual manner of entry, or as the result of weight and aerodynamic differences between it and the training aircraft.

To recover from a fully-developed spin in a Chipmunk, it is important to push the control stick forward – fully forward if necessary – after applying full opposite rudder. The pilot's training apparently did not emphasise full forward movement of the stick against any resistive control force, a degree of movement that was recommended by the aircraft type design organisation for this particular aircraft type. It is also possible that, in attempting to apply central control stick, the pilot unwittingly held a more rearward stick position than intended due to the control forces. This is a hazard highlighted by the 1960 Australian Department of Civil Aviation flight test report, which stated:

> Frequently the resistance encountered as the stick moves forward will be high and this could be confused with the stick having reached the forward limit of travel. A conscious effort is necessary to avoid this confusion.

Finally, it is uncertain whether the pilot actually applied positive spin recovery control properly, or for long enough for it to be effective. The pilot learned about spin recovery under controlled and relatively predictable conditions, as well as receiving a pre-flight briefing and discussion regarding the spin training flight. In these circumstances, the spin entry is relatively smooth, consistent and expected. In contrast, about a year after having learned and practised how to manage spins (only to the left), the pilot encountered an unexpected spin to the right from an attempted loop. This can be disorienting and slow the identification of the problem and application of the correct control inputs, especially if the responses were not recently practiced. Infrequently used knowledge and infrequently practiced skills degrade over time, and in an emergency the ability to recall them rapidly and accurately is generally impeded further. Regularly reviewing important knowledge and skills, particularly as part of self-briefing prior to a flight, may facilitate a more rapid and accurate recall 'in the heat of the moment'.

Instructor training

The pilot's flight instructor taught and used a method for Chipmunk spin recovery that was reasonably effective in the early stages of a spin, but would become less effective as the spin developed. It was different to the standard method of spin recovery recommended by the Civil Aviation Safety Authority, and to the Chipmunk-specific method recommended by the type design organisation. The flying school's training materials did not include Chipmunk-specific spin recovery methods, and did not clearly emphasise the forward control stick movement necessary for some aircraft.

Civil Aviation Order 40.0 stated that a flight instructor must be '…satisfied that the holder can safely recover an aeroplane from a *fully developed* upright spin' (emphasis added), but the pilot was taught to recover from an early-stage and possibly incipient spin rather than when fully-developed. Although modern aircraft may recover from a spin using less than optimal control inputs, it is important to teach and demonstrate competence in recovering from spins in the manner most appropriate to the aircraft type that the student pilot intends to fly, especially if aerobatic manoeuvres are planned.

The instructor's objective of using a more central elevator position was to put the control stick in a position that would allow a stalled aircraft to un-stall, as described in Civil Aviation Advisory Publication 155-1(0). That is:

> The fore and aft position of the control column determines the angle of the aircraft's wings to the airflow. For example, the stick positions for cruise, glide and the stall move progressively aft. Once the stick position for the stall has been determined (and remembered), it can be used as a measure of whether an aircraft's wing is stalled or not. If the stick is forward of the 'stalled stick position', the aircraft will always be in unstalled flight, regardless of aircraft attitude or airspeed.

While this concept may be correct under most conditions, it is not generally the case in situations such as a spin, where elevator authority is reduced and rotational forces become significant. As stated elsewhere in the advisory publication, it is important to use the aircraft's approved documentation as the primary and most reliable source of information.

Aircraft documentation

The Civil Aviation Safety Authority advised that the flight manual originally produced by the aircraft type design organisation in 2002 was the only currently approved manual for the T Mk 10 Chipmunk in Australia. Records show that the aircraft's flight manual approval lapsed in 2002 and that the newer flight manual was not obtained by the owner. Consequently, pilots of UPD were using information that was out of date. Although there was no requirement for spin recovery guidance to be included, the approved flight manual provided by the aircraft type design organisation did include such guidance and would have provided a reliable source of valuable information for the pilots of UPD to follow.

The flying school had a different flight manual for its Chipmunk aircraft, which was also not approved. Although that flight manual contained generally appropriate spin recovery advice, it did not incorporate the latest approved information. There are variations between aircraft of the same type, often due to modifications and repairs, and using an unapproved flight manual increases the risk that the information within it is not appropriate for that particular aircraft.

Findings

From the evidence available, the following findings are made with respect to the collision with terrain involving de Havilland Canada DHC-1 Chipmunk, registered VH-UPD, that occurred at Coffs Harbour, New South Wales, on 29 June 2014. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

Safety issues, or system problems, are highlighted in bold to emphasise their importance. A safety issue is an event or condition that increases safety risk and (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operating environment at a specific point in time.

Contributing factors

- The pilot attempted to conduct a loop without the required qualification.
- The aircraft entered an upright spin after a stall or flick-roll at the top of an attempted loop.
- The pilot probably did not apply and maintain the spin recovery control inputs appropriate for a fully-developed spin in a Chipmunk, and the spin continued until impact with terrain.

Other factors that increased risk

- The flight instructor who taught the pilot spin recovery did not teach the method to recover from a developed spin that was appropriate for the aircraft type.
- **The spin recovery methods taught by the flying school were inconsistent across instructors and training material, and were not always appropriate for the Chipmunk aircraft type used by the school. [Safety Issue]**
- The approval for the accident aircraft's flight manual had been revoked, and the flight manual in use lacked the spin recovery instructions that would have been present in a flight manual issued by the aircraft type design organisation.
- The flying school's Chipmunk aircraft was used for aerobatic instruction and endorsement without having a current, approved flight manual that contained spin recovery instructions.

Safety issues and actions

The safety issues identified during this investigation are listed in the Findings and Safety issues and actions sections of this report. The ATSB expects that all safety issues identified by the investigation should be addressed by the relevant organisation(s). In addressing those issues, the ATSB prefers to encourage relevant organisation(s) to proactively initiate safety action, rather than to issue formal safety recommendations or safety advisory notices.

All of the directly involved parties were provided with a draft report and invited to provide submissions. As part of that process, each organisation was asked to communicate what safety actions, if any, they had carried out or were planning to carry out in relation to each safety issue relevant to their organisation.

The initial public version of these safety issues and actions are repeated separately on the ATSB website to facilitate monitoring by interested parties. Where relevant the safety issues and actions will be updated on the ATSB website as information comes to hand.

Flying school spin recovery training

Number:	AO-2014-114-SI-01
Issue owner:	Airborne Aviation Pty Ltd
Operation affected:	Aviation: General Aviation
Who it affects:	Instructors and student pilots undertaking aerobatic and spin recovery instruction

Safety issue description:

The spin recovery methods taught by the flying school were inconsistent across instructors and training material, and were not always appropriate for the Chipmunk aircraft type used by the school.

Proactive safety action taken by Airborne Aviation Pty Ltd

Action number: AO-2014-114-NSA-005

The flying school reported that, after this accident, a briefing process was undertaken with all of its current aerobatic instructors. The aim was to ensure that consistent terminology is used to describe and teach aerobatic manoeuvres. A programme of standardisation flights for all current aerobatic instructors commenced on 16 July 2014 and included spin recovery training and unusual attitude recovery for the school's aerobatic students. This briefing and training is ongoing.

Current status of the safety issue

Issue status: Adequately addressed

Justification: The ATSB is satisfied that the action taken by Airborne Aviation Pty Ltd adequately addresses this safety issue.

General details

Occurrence details

Date and time:	29 June 2014 – 1130 EST	
Occurrence category:	Accident	
Primary occurrence type:	Loss of control	
Location:	Coffs Harbour, New South Wales	
	Latitude: 30° 20.294’ S	Longitude: 153° 06.718’ E

Pilot details

Licence details:	Private Pilot (Aeroplane) Licence, issued 2004
Endorsements:	Single Engine Aeroplanes less than 5,700 kg Maximum Take-off Weight; Tailwheel Undercarriage; Manual Propeller Pitch Control
Medical certificate:	Class 2, valid to May 2016
Aeronautical experience:	156 hours
Last flight review:	May 2014

Aircraft details

Manufacturer and model:	de Havilland Canada DHC-1	
Year of manufacture:	1950	
Registration:	VH-UPD	
Serial (constructor’s) number:	C1/0111	
Total Time In Service	5,129 hours (as of 26 June 2014)	
Type of operation:	Private – Pleasure/travel	
Persons on board:	Crew – 1	Passengers – 1
Injuries:	Crew – 1 (serious)	Passengers – 1 (serious)
Damage:	Substantial	

Sources and submissions

Sources of information

The sources of information during the investigation included:

- the pilot and passenger
- the flying school and instructors
- the aircraft owner
- the air traffic controller
- air traffic recordings
- a number of witnesses
- de Havilland Support Limited (type design organisation)
- Civil Aviation Safety Authority (CASA)
- the Bureau of Meteorology.

References

United Kingdom Civil Aviation Authority. (2013) *CAP 562 Civil Aircraft Airworthiness Information and Procedures, Leaflet B-250, Chipmunk Spinning and Aerobatics*. www.caa.co.uk.

Stowell, R (2007). *The Light Airplane Pilot's Guide to Stall/spin Awareness: Featuring the PARE Spin Recovery Checklist*. Rich Stowell Consulting Ventura.

Stowell, R. (2012). *Guidelines for Pilots Seeking All-Attitude Training.* www.safepilots.org.

Submissions

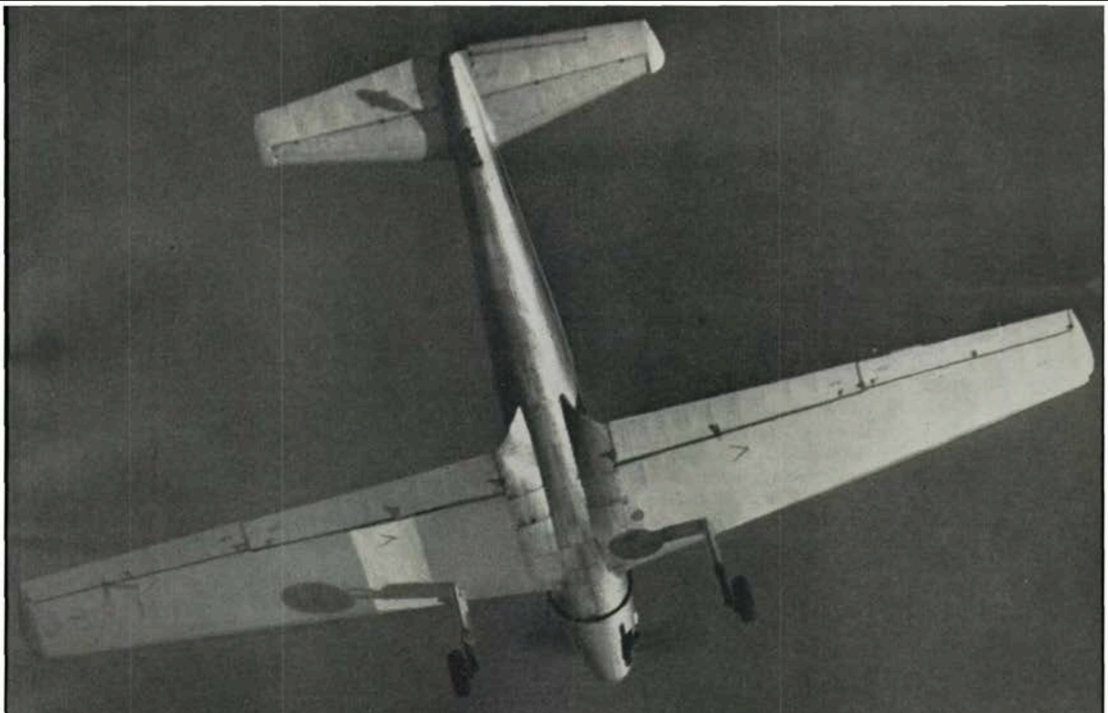
Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003* (the Act), the ATSB may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to the pilot, aircraft owner, United Kingdom Air Accidents Investigation Branch, type design organisation, flying school and CASA.

Submissions were received from the United Kingdom Air Accidents Investigation Branch, type design organisation and CASA. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.

Appendices

Appendix A – Aviation Safety Digest No.22 extract



The CHIPMUNK SPIN
THE FACTS

The DH Chipmunk was first introduced to Australia as a training aircraft in 1949 and since then some 80 of these aircraft have been imported for the purpose of flying training. The aircraft came from the R.A.F. with a very good reputation as a basic trainer, and in the first eight years of its use in Australia it proved to be not only an eminently suitable training type but reliable and economical in operation. The first fatal accident involving a Chipmunk in Australia occurred at Goulburn in January, 1957, when the aircraft did not recover from a spin. The type had just been introduced to the particular club and the instructor, who was killed, had just completed his conversion. These facts pointed rather strongly to limited type experience being an important factor in the accident. Nevertheless, Departmental pilots and several club C.F.I's. conducted extensive spinning tests at this time in order to be sure that no hidden spinning vice had suddenly come to the surface to produce this accident. These tests failed to reveal even the slightest suspicion that the Chipmunk had any dangerous spinning tendencies.

At about the same time several reports were made to the Department of particular Chipmunk

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aircraft behaving in an unexpected manner in the spin. Each of these reports were thoroughly checked and each aircraft was spun several times by experienced pilots. In no case could any unsafe characteristics be reproduced and the aircraft under test never failed to recover normally upon application of the prescribed recovery technique. In the United Kingdom, where experience of the Chipmunk had commenced earlier than in Australia, there had also been some misconceptions regarding the spin behaviour of the aircraft. The De Havilland Aircraft Co. Ltd. conducted evaluation tests and issued several reports with the dual objects of dispelling some of the misconceptions that had arisen and making more widely known the spinning characteristics of the Chipmunk. During the periods of evaluation the airworthiness authorities in the United Kingdom and in Australia laid down spinning limitations both in respect of height for spin initiation and the number of turns before recovery. In Australia the Department regarded these limitations purely as a temporary precaution and they have since been removed.

The first De Havilland report on Chipmunk spinning was issued in 1956 and summarised the experience of pilots who had spun something like 1,000 Chipmunk aircraft, before delivery, in normal and extreme conditions of centre of gravity. The report stressed the need to differentiate between the spin and the spiral and emphasised the importance of using correct entry and recovery procedures. It was pointed out that in most cases the aircraft will first spiral from the stall and as many as three turns may result before the spin proper is entered. This report also showed that in some 20% of the aircraft tested some difficulty in inducing the spin was experienced. Usually this amounted to a reluctance of the aircraft to spin one way whilst being very ready to spin in the opposite direction. Various remedies for this situation were tried, such as altering the flap rigging or aileron droop within tolerances, but the manufacturer has reported that if a careful examination of the mainplane leading edges for any slight flattening or dinting was made and these were removed or dressed out, the difficulties would usually disappear. The report went on to describe the three distinct spinning modes which had been observed —

(a) The steady comfortable spin in which the rotation rate is about 120 degrees per second—nose-down attitude 50-65 degrees, some three turns being completed in each 1,000 feet of height lost.

(b) The less comfortable pitching spin in which the nose regularly rises and falls through an angle of some 15-20 degrees.

(c) The uncomfortable hesitant spin in which the aircraft regularly transits from spin to spiral and then flicks back into the spin.

Finally the report points out that not one of these aircraft had failed to recover from any of these spins or gave cause for any concern on this point to the pilot. In the worst case an aircraft loaded to give an aft centre of gravity condition had taken 2½ turns to recover after eight turns had been completed but, generally, recovery was effected in ½-¾ of a turn with a nose-down angle of some 80 degrees. The first-stage flap setting was used to see if a quicker recovery could be achieved but it had no noticeable effect except in the acceleration to flying speed following recovery. The manufacturer also experimented with the fitting of fuselage strakes* to ascertain if they would reduce recovery time. It was found that although the strakes had no effect on the spin entry, on the spin itself or on the recovery of an aircraft with good recovery characteristics, they did tend to shorten the recovery time slightly on an aircraft normally slow to recover, but it was only a reduction in the order of three-quarters of a turn in the worst case.

After considering these reports and the results of tests conducted in Australia, the Department decided that each and every Chipmunk should be spin-tested at maximum all-up-weight and with the centre-of-gravity fully aft, fully forward and neutral. In the case of each aircraft on the Australian register its behaviour was found to be normal, in that the spin characteristics and responses to controls were safe and within the performance envelope described by the manufacturer. The temporary spin limitations were then removed.

In June, 1959, an experienced and well qualified instructor reported that a student was unable to recover from a spin despite the use of proper recovery techniques and, on taking over, he found a complete lack of stick forces and only recovered by moving the throttle and stick forward and back together. Some 3,000 feet of altitude was lost in this spin. Following this, the instructor immediately climbed to a safe altitude and spun the aircraft in the opposite direction from which recovery was quite normal. Needless to say, this

* These strakes protruded from each side of the rear fuselage forward of the tailplane and in the line of its mean-chord. They were 36 inches long, 3 inches wide and abutted the tailplane leading edge at its root.

experience had a disquieting effect in the club concerned and the Department decided to exhaustively check this aircraft both statically and in flight and, at the same time, instrument it in such a way that its behaviour in the spin could be measured in quantitative terms. This programme has now been completed and its results are presented to you in the belief that not only will they speak for themselves but they will help you to better understand the characteristics of the Chipmunk spin and the basis of the Department's convictions in respect of this aircraft type.

The rigging and movement of all control surfaces, including flaps, were checked on the ground by representatives of the operator, the manufacturer and the Department immediately following the incident and subsequently in greater detail. In all respects these results showed that this aircraft was rigged within the prescribed tolerances and that the control surfaces and actuating mechanisms were completely serviceable. The aircraft was then checked in the air for aerodynamic symmetry before any spinning tests were conducted. At the stall no pronounced wing dropping or yawing tendencies were found. In fact, the aircraft "squashed" without much pitching and sometimes one or the other wing dropped gently. The aircraft's stalling speed with flap up was 45 knots with the usual buffet warning commencing at 49 knots. Observation of wool tufts affixed to the wing indicated that the stall commenced symmetrically at the root trailing edges at 51 knots and that the progression of the stall towards the tips was quite normal. There were no irregularities in the trim of the aircraft and the aileron settings in level flight were port in-line and starboard slightly drooped. Similarly there were no irregularities in the yawing or rolling moments due to sideslip.

The aircraft was then instrumented for the spinning tests. The edges of the perspex panels in the canopy were indexed so that, in the spin, an observer could note and record where the horizon cut the canopy on both sides. From these records the angle of the mean chord of the aircraft above or below the horizon could then be measured with the aircraft in the rigging position. An accelerometer was rigidly mounted on the coaming between the cockpits and the ball of the turn and bank indicator was indexed to facilitate precise measurements. Finally, a stop watch was used to record the time per revolution in the spin.

The spin evaluation programme then started in earnest and almost 100 spins were carried out as well as many experiments in respect of flying control and engine power settings in order to determine the effectiveness of these factors in altering the spin characteristics of the aircraft. Before any spin measurements were taken the circumstances of the incident were simulated to see whether the aircraft's reported behaviour could be easily reproduced using a normal entry technique. Although four spins in both directions, including one of 13½ turns, were carried out, recovery was at all times positive with the stick reaching approximately the neutral position.

A series of spins was then carried out in which the behaviour of the aircraft was measured. As in all Chipmunk aircraft the spin entry was not direct and as many as the first four turns were in the nature of a spiral with the airspeed steady at approximately 50 knots after which the nose lifted, the buffeting of the spiral disappeared and the aircraft settled into the true spin at about 45 knots. It was found that this aircraft had three distinct spinning modes characterised by angles of the mean wing chord below the horizon of 24 degrees, 35 degrees and 43 degrees. Each of these angles were achieved on several occasions and in almost all cases it was apparent that a state of equilibrium had been reached. It is interesting to note that the spinning mode most commonly achieved was the flattest of the three observed (i.e. mean chord 24 degrees below the horizon) and that it was almost the inevitable result of a spin entry using the prescribed standard technique.

The fact that three distinct modes were achieved is by no means a surprising situation since, when an aircraft is stalled, its subsequent motion is governed by the system of forces and moments acting on it. At any particular instance these forces and moments are functions of the lateral and longitudinal attitudes of the aircraft and angular velocities and accelerations about its three axes. Thus the motion of the aircraft is continuously modified unless and until a state is reached in which both the forces and moments are in equilibrium and the motion of the aircraft is then steady or uniform. It is quite common in dynamic systems of this sort to find that there is more than one state of equilibrium.

Other interesting data which these measured spins revealed was that the aircraft rather consistently executed five turns per thousand feet loss in height and turned through 150 degrees on the average each second. In the flattest spin (i.e. mean chord 24 degrees below the horizon) the rate of descent was 4,560 feet per minute, the effective wing tilt* was 9½ degrees, the sideslip

* The angle between the vertical axis of the aircraft and the resultant of the gravity and centrifugal inertia forces.

was towards the axis of the spin at an angle of almost five degrees and the radius of the spin was calculated to be 2½ feet. Comparing these results with the second spinning mode (i.e. mean chord 33 degrees below the horizon) we find that the rate of descent increased to 5,340 feet per minute, the effective wing tilt was one degree less at 8½ degrees, the angle of sideslip was also lower, being just under 4 degrees and the radius of spin calculation showed an increase to something slightly in excess of three feet.

Some experiments were then carried out to discover the effect of various spin entry techniques and some interesting results were obtained. Firstly, the entry speed was varied between 45 and 55 knots and the pre-selected entry speed was approached in a variety of ways. It was found that the most direct entry was obtained from straight and level flight yawing the nose at 50 knots and then applying full back stick and opposite aileron. If a burst of power was used at entry the aircraft would not enter the spin proper until the power was removed. When entry to a right-hand spin was attempted from medium gliding turns or sideslips to the left the usual result was a violent pitching oscillation from which the aircraft would not always enter the true spin. When power of up to 1,600 r.p.m. was applied in the spin it noticeably flattened the angle to about 20 degrees below the horizon, but on closing the throttle the nose dropped again and recovery was quite normal. Full rudder and opposite aileron at 50 knots without full back stick was also tried, but this rarely produced anything but a normal sideslip. The tests did not reveal any simple correlation between entry techniques and the spinning mode but, nevertheless, factors such as an aft centre of gravity position, applications of power, use of full back stick and full rudder from a low nose position at entry all tended to flatten the spin attitude. There is an interaction of so many variable factors in spin initiation that the spin characteristics may appear to be unpredictable, but it is considered that this is a false impression and that the aircraft wil repeat a spinning mode without exception if a consistent entry method can be repeated with sufficient precision.

The effectiveness of ailerons for spin entry and recovery was evaluated and it was found that, in both cases, there was a noticeable result. Opposite aileron increased the yawing moment and is, therefore, a useful pro-spin control. The effect of using aileron in the direction of the spin was to produce a slow change in lateral attitude, the inner-wing dropping. This action is therefore unlikely to accelerate recovery from a normal spin, but it could assist towards recovery if the aircraft's lateral attitude became very flat in a spin.

Attention was then turned to the spin recovery characteristics of the aircraft. At no time during the tests was any difficulty experienced in recovery, and the stick position using the prescribed recovery method was usually at or just aft of the neutral position with resistance to forward stick movement becoming noticeable before the spin stopped. The number of turns for recovery ranged from 1¼ to as many as 3½ turns. It was found in these and many other Chipmunk spin tests that the point at which pressure is felt in the forward travel of the stick varied considerably and is occasionally almost at the fully forward position. Sometimes the pressure was found to be heavy (i.e. as high as 25 lbs.) and sometimes light. In an attempt to explain this phenomenon some radical departures from the standard recovery procedure were used.

When the stick was held back whilst opposite rudder was applied, the rate of rotation decreased and the nose dropped but no further change towards recovery occurred until forward movement of the stick was initiated. Recovery was then normal. The method was then reversed with full rudder in the direction of the spin being held on whilst the stick was moved forward. In this case, the rate of rotation increased with little change in attitude. The stick force was quite heavy at about one-third of forward travel and it remained heavy until recovery was effected after three turns by applying full opposite rudder. Since this combination of controls quickened the rotation, tests using full forward stick were carried a stage further to ascertain if the high centrifugal forces would produce control reversal, but this was not found to occur and the spin characteristics and stick pressures remained constant right through the forward travel of the stick. There was no sign of recovery whilst the rudder was held in the direction of the spin. It seems almost certain from these tests that the stick position and stick force at recovery is dependent upon the co-ordination of controls during recovery. If forward movement of the stick is delayed until the opposite rudder has had time to take effect, recovery will be obtained with a lighter stick force and at a more forward stick position. If rudder and stick are moved together a heavier stick force results and recovery probably occurs at a slightly earlier stick position.

A number of other experiments were undertaken during this test programme but they produced nothing new or of importance. It is quite significant that the results of the evaluation tests conducted by the manufacturer have been confirmed on all major points by the test results in Australia. There are some minor differences of detail, but it must be remembered that the manufacturer's production testing results refer to a very large number of aircraft each of which was spun relatively few times. Although there have been several exhaustive tests on other aircraft in Australia this latest series of tests in Australia was confined to one aircraft which had been reported as exhibiting dangerous spin characteristics and which was spun many times. Some deviations from the manufacturer's test results must be expected in these circumstances, quite apart from the fact that the test conditions were not similar in each case. No doubt slightly different measurements would be obtained if yet another Chipmunk was to be exhaustively tested in the same manner, but there can be no doubt that similar tendencies and similar recovery results would be obtained.

Like any aircraft type the Chipmunk has its own personality and it is extremely important that the pilot should appreciate what to expect from it. Clearly it would be wrong to expect the Chipmunk to behave in the spin like its training predecessor the Tiger Moth, but it is highly probable that this unreasonable expectancy has led to many of the reports of "rogue" Chipmunks. After all, it is a completely different aircraft in so many respects that it would be foolish not to expect it to behave differently.

At this stage some of the Chipmunk spin features will bear repetition:

(a) The aircraft is reluctant to spin properly and it will first of all spiral, but there is little doubt that the entry technique prescribed by the manufacturer is the most reliable method of consistently producing the true spin.

(b) This spiral must be distinguished quite clearly from the spin, but if the pro-spin controls are held on a spin proper will develop.

(c) The spiral can be recognised by a comparatively steep nose-down attitude, an airspeed above the stalling speed and by buffeting.

(d) The number of spiral turns will vary from as little as a quarter of a turn to as many as four turns and the transition to the spin is recognisable by a lifting of the nose, a consequent fall in airspeed, combined with a cessation of buffeting.

(e) An aircraft may spin much more readily and differently one way compared with the other.

(f) Recovery from the spiral using the standard spin recovery method is quick and, in fact, the aircraft will stop spiralling if the controls are released.

(g) The aircraft will not recover from the spin proper by releasing the controls and proper spin recovery action must be taken.

(h) The aircraft may not always adopt the same spinning mode or even a steady spin pattern. Variations in respect of attitude, spin radius, speed of rotation and rate of descent must be expected because of the inevitable small variations in entry technique.

(i) *The proper recovery technique requires full opposite rudder and the stick must be moved progressively forward until the rotation stops*— in some cases full forward stick may be necessary and care must be taken to ensure that the harness adjustment will enable this position to be reached.

(j) The number of turns from recovery initiation to actual recovery can be as many as 3½ turns and full spin recovery control must be maintained until the rotation is stopped— *interruption of this control application will only delay the recovery.*

(k) In all cases application of spin recovery control will tend to lower the nose and speed up the spin rotation— *this is a sure sign that the recovery process has begun and full recovery will eventuate.*

(l) Frequently the resistance encountered as the stick moves forward will be high and this could be confused with the stick having reached the forward limit of travel. A conscious effort is necessary to avoid this confusion.

(m) Despite many reports, there has been no confirmed case of a Chipmunk failing to recover from a spin if the standard recovery technique is applied *and held on*— nor is there any confirmed evidence which would cast doubt on the aircraft's spin recovery ability.

(n) It should be remembered that, if the aircraft spirals through four turns and is allowed to spin three revolutions and full forward stick becomes necessary for recovery, the total loss of height may be as high as 3,000-4,000 feet — provision must be made for this in the selection of height for entry, remembering that it is required that normal flight be resumed not lower than 3,000 feet.

Those of you who have flown the Chipmunk will agree that it is a delightful aircraft to fly. It is not suitable for everybody's needs, but in the training field it represents a big advance on the veteran Tiger Moth. If your pleasure in its flying ability has been completely matched with a confidence in its breeding, a lot of the assurances in this article will have been superfluous. On the other hand, if the article serves to explain some of the phenomena you have already noticed and thereby leads to techniques that are a little more polished, it will not have been wasted. For those of you who have not been happy with the Chipmunk spin it is hoped that this article will cause you to reflect a little on your past experiences and, maybe, more easily to decide whether you have unwittingly blamed the aircraft for behaviour that has been due to an imperfection in your technique or a gap in your knowledge. It is true that the Chipmunk takes a little more knowing than the Tiger Moth, but we hope that this frank discussion of what to expect from it will overcome that problem. The Department has a very real responsibility for ensuring that aircraft types perform safely and in accord with the manufacturers' claims and it would be the first to take action, as it has done in the past, whenever there is doubt. The Department has no hesitation in declaring its complete confidence in the spinning and recovery characteristics of the Chipmunk and fully endorses the techniques prescribed by the manufacturer.

Australian Transport Safety Bureau

The 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; 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.

Purpose of safety investigations

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

Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

When safety recommendations are issued, they focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on a preferred method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation to a person, organisation or agency, they must provide a written response within 90 days. That response must indicate whether they accept the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes it appropriate. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

Australian Transport Safety Bureau

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Investigation

ATSB Transport Safety Report
Aviation Occurrence Investigation

Loss of control and collision with terrain involving de Havilland Canada DHC-1 Chipmunk, VH-UPD, Coffs Harbour, New South Wales
29 June 2014

AO-2014-114
Final – 4 February 2016