CAA OCCURRENCE 20/3747

TAYLOR MONOPLANE U/L, ZK-DKQ

DEPARTURE FROM CONTROLLED FLIGHT

4.6 NM SE OF PUKAKI AERODROME, CANTERBURY, NEW ZEALAND.

25 July 2020

ZK-DKQ Source: David Paull (nzcivair.blogspot.com)

Foreword

New Zealand's legislative mandate to investigate an accident or incident is prescribed in the Transport Accident Investigation Commission Act 1990 (the TAIC Act) and Civil Aviation Act 1990 (the CA Act).

Following notification of an accident or incident, TAIC may conduct an inquiry. The CAA may also investigate subject to Section 72B(2)(d) of the CA Act which prescribes the following:

72B Functions of Authority

(2) The Authority has the following functions:

(d) To investigate and review civil aviation accidents and incidents in its capacity as the responsible safety and security authority, subject to the limitations set out in Section 14(3) of the Transport Accident Investigation Commission Act 1990

The purpose of a CAA safety investigation is to determine the circumstances and identify contributory factors of an accident or incident with the purpose of minimising or reducing the risk to an acceptable level of a similar occurrence arising in the future. The safety investigation does not seek to ascribe responsibility to any person but to establish the contributory factors of the accident or incident based on the balance of probability.

A CAA safety investigation seeks to provide the Director of Civil Aviation with the information required to assess which, if any, risk-based intervention tools may be required to attain CAA safety objectives.

Contents

Page number

Tables

Figures

Appendices

Glossary of abbreviations:

ATO	Authorised Testing Officer
BFR	Biennial flight review
CAA	Civil Aviation Authority
C of G	centre of gravity
FIG	Flight Instructor Guide
GAP	Good Aviation Practice
lb	pound (s)
ltr	litre (s)
NM	nautical miles
NZST	New Zealand Standard Time
RAANZ	The Recreational Aircraft Association of New Zealand
SAC	Sport Aircraft Corp Limited

Data summary

Aircraft type, serial number, and registration:	Taylor Monoplane U/L, AACA/125/1, ZK-DKQ
Number and type of engines:	One, Volkswagen 1600 cc
Year built:	1975
Date and time of accident:	25 July 2020, between 1415 - 1530 hours[1]
Location:	4.62 NM south-east of Pukaki aerodrome Latitude[2]: S 44° 15.4' Longitude: E 170° 13.35'
Type of flight:	Private
Persons on board:	Crew: 1
Injuries:	Crew: 1 (fatal)
Nature of damage:	Aircraft destroyed
Pilot-in-command's licence:	Microlight Instructor Certificate
Pilot-in-command's total flying experience:	1068 hours, 4.72 on type
Investigator in charge:	Ms L Child

1 All times in this report are New Zealand Standard Time (UTC + 12 hours) unless otherwise specified.

2 World Geodetic System 1984 (WGS-84).

Executive summary

Taylor Monoplane Class 1 Microlight, ZK-DKQ, was operated on a private flight in the vicinity of Pukaki aerodrome on 25 July 2020.

The pilot was in the process of self-rating[3] on the single-seat aircraft and departed Pukaki aerodrome around 1355 to practise stalling[4].

The investigation determined the aircraft entered an unrecovered flat spin[5] most likely subsequent to a wing drop stall. It was not possible to determine whether correct recovery inputs were made during the spin without recovery, or whether aircraft factors prevented recovery.

Once the aircraft entered the fully developed flat spin, recovery may not have been possible, regardless of pilot control inputs.

Following the accident, a Part 149 Aviation Recreation Organisation (ARO), the Recreational Aircraft Association of New Zealand (RAANZ) made changes to the pilot currency and renewal requirements in their exposition. Due to this action, no safety recommendations were issued to the ARO.

This accident serves to remind all pilots that a lack of pilot currency is a well-known contributing factor to many accidents. The CAA recommends pilots to obtain dual instruction if they are not current in specific exercises or an aircraft type.

---

3 Teaching himself versus undergoing instruction to gain proficiency on the aircraft type.

4 Aerodynamic stall is a condition where the wing's angle of attack increases beyond a certain point such that lift begins to decrease. The angle at which this occurs is called the critical angle of attack.

5 A spin is a sustained spiral descent of a fixed-wing aircraft, with the wing's angle of attack beyond the stall angle.

1. Factual information

1.1 History of the flight

1.1.1 On Saturday 25 July 2020, the pilot prepared ZK-DKQ for a local flight from Pukaki aerodrome.

1.1.2 The pilot was in the process of self-rating on the aircraft. This flight was the sixth training flight, the purpose of which was to practise stalling.

1.1.3 Witnesses stated the pilot had prepared in advance for the flight. This included discussing the stalling exercise with ZK-DKQ's owner, choosing a weekend when family were present, and the flight would be in ideal weather conditions.

1.1.4 The weather that day was ideal, so the pilot decided to do the flight before conducting a gyroplane[6] lesson later that afternoon. He stated to several people that he would have five hours of fuel and was going to do the exercise from 6500 feet.

1.1.5 A friend witnessed the pilot preflight the aircraft and helped check the seatbelts and pilot helmet. The pilot stated he was "only going to do stalling" and "that it [ZK-DKQ] has a nasty wing drop". Another witness said he also talked to the pilot just prior to departure and he seemed fully aware of the potential risks of the stalling exercise.

1.1.6 Witnesses reported ZK-DKQ departed Pukaki aerodrome around 1355, initially heading south then turning north towards Mt Cook.

1.1.7 The pilot's friend took off shortly after ZK-DKQ and heard a radio transmission from the pilot stating his position and "climbing through 6100 feet".

1.1.8 No further radio transmissions or sightings of the aircraft were reported.

1.1.9 When the aircraft did not return as expected, family and friends tried to contact the pilot by radio and cell phone, with no reply.

---

6 Gyroplanes are also known as autogyros or gyrocopters.

1.1.10 Local pilots then mounted an aerial search and a local commercial aviation operator initiated their overdue aircraft procedures.

1.1.11 At 1711 one of the search aircraft located the wreckage of ZK-DKQ. The pilot was observed motionless in the cockpit. The search aircraft pilot notified the aviation operator's flight follower, who in turn alerted the RCCNZ.

1.1.12 Search and rescue personnel arrived on the scene at 1717. They confirmed the pilot was deceased.

1.1.13 The accident occurred in daylight, most likely between 1420 and 1530, 4.62 NM south east of Pukaki aerodrome at an elevation of 1422 feet. Latitude S 44° 15.4', longitude E 170° 13.35'.

Figure 1: Map of accident area (for illustrative purposes only). Source: Google Earth™

1.2 Injuries to persons

Injuries	*Crew*	*Passengers*	*Other*
Fatal	1	0	0

Table 1: Injuries to persons

1.3 Damage to aircraft

1.3.1 The aircraft fuselage was significantly damaged. The engine received moderate damage but could be started and run after the accident. The wings and tailplane received minor surface marks and had areas of crumpling and puncture damage.

1.4 Other damage

1.4.1 Nil.

1.5 Personnel information

Flying hours	Other aeroplanes[7] /gliders	Taylor Monoplane	Gyroplanes
Last 24 hours	0	1.62	0
Last 7 days	0	2.92	1.3
Last 30 days	0	3.12	6.87
Last 90 days	0	4.72	13.32
Last 12 months	0.5	0	134
Total hours	66/459	4.72	543

Table 2. Pilot flight hours

1.5.1 The pilot commenced flying gliders in 1987 and had accumulated 459 hours with the last recorded glider flight in 2008. He commenced flying fixed wing, Group B (3-axis) microlight[8] aircraft in 2003, and Group G (gyroplanes) in January 2015.

1.5.2 The pilot held a current Senior Instructor Microlight Certificate issued by the Sport Aviation Corp Limited (SAC) in accordance with Part 149 of the Civil Aviation Rules. He was also a SAC Authorised Testing Officer (ATO).

---

7 Certificated aeroplanes and microlight Group B (3-axis) aircraft.

8 Microlight aircraft means a basic low performance aircraft designed to carry not more than two persons which meets low momentum parameters that are acceptable to the Director.

1.5.3 The pilot's most recent microlight instructor renewal was in a gyroplane in August 2019.[9] He scored an "excellent" grade in the flight test and the examiner noted "his typical high standard" in the comments section of the flight test report.

1.5.4 The pilot's most recent Group B microlight certificate renewal was on 12th September 1998. The pilot achieved grades of A (excellent) and B (above average) for all exercises including stalling.

1.5.5 The only record of spin training was in a glider in September 2001.

1.6 Aircraft information

1.6.1 The Taylor Monoplane is a single-seat, tailwheel, low-wing, amateur-built aircraft of conventional wood construction. Aircraft are normally fitted with Volkswagen automotive engines of between 1500 and 1834cc capacity, standard non-trimmable flight controls and optional split flaps.

1.6.2 Taylor JT-1 Monoplane U/L (ultralight) ZK-DKQ was originally built in 1975. Following an accident and rebuild, it was re-registered in 2007 in the amateur-built aircraft category.

1.6.3 It was re-designated as a Microlight Class 1 in 2017 on request of the new owner.[10].

1.6.4 The aircraft was powered by a Volkswagen 1600cc engine driving a Rishton two-bladed wooden propeller.

1.6.5 At the time of the accident the aircraft and engine had accrued 134 hours total flight time.

1.6.6 An annual microlight aircraft inspection and flight permit validation inspection was completed on 21 May 2020. No discrepancies or defects were noted. The pilot had not raised any concerns about ZK-DKQ's airworthiness with the owner.

---

[9] Valid for two years from date of flight test.

[10] The Certificate of Registration recovered from the aircraft was the previously issued certificate in the amateur-built designation. The CAA aircraft files had recorded the change to Microlight class 1 designation.

1.6.7 Fuel is gravity-fed to the engine from a fuel tank mounted above the engine. The aircraft did not have a carburettor accelerator pump and the owner reported that aggressive throttle movements could cause lags in power delivery.

1.6.8 Instead of a standard aircraft magneto system, ZK-DKQ's engine ignition was battery-powered with an alternator charging the battery. The engine would stop if there was an electrical failure.

1.6.9 The owner stated the aircraft tended to pitch up in flight, due to the way the horizontal stabiliser was mounted.

1.6.10 The aircraft had an operating limitation 'intentional spins are prohibited'. A placard 'spins are prohibited' was affixed on the control panel.

1.6.11 Through calculation and weighing the aircraft wreckage, the aircraft all up weight was determined to be between 787 and 804 pounds (lbs) at the time of the accident. Both these values are above the maximum allowable all-up (MAUW) take-off weight of 707 lbs.

1.6.12 The aircraft's centre of gravity was within the MAUW forward and aft limits as stipulated in the Light Aircraft Association (LAA) Type Acceptance Data Sheet, TADS 055 "*Operating Limitations and Placards*"[11].

1.7 Meteorological information

1.7.1 A situation of high pressure existed over the South Island with no significant weather forecast.

1.7.2 The Pukaki aerodrome automated weather report at 1430 recorded clear skies, a light south-easterly wind and temperature of 10°Celcius (C). Local pilots also reported it was a sunny day with clear skies and light winds.

---

[11] As an uncertificated aircraft there is no aircraft manual for the Taylor Monoplane. The LAA, United Kingdom issues type acceptance data for amateur aircraft designs.

1.7.3 The reported range of afternoon temperatures (5° to -1°C) and dewpoints (-1 to -10°C) between 3000 and 6500 feet created conditions conducive to engine carburettor icing, especially at idle power.

1.8 Aids to navigation

1.8.1 Not applicable.

1.9 Communications

1.9.1 Pilots transmit position and intentions on a Pukaki area common frequency. This radio frequency is not recorded. The pilot's last (known) radio transmission was just after 1400 "climbing through 6100 feet".

1.10 Aerodrome information

1.10.1 Pukaki aerodrome (NZUK) is an unattended[12] aerodrome and is outside the range of air traffic control radar surveillance.

1.11 Flight recorders

1.11.1 Nil fitted nor required to be.

1.12 Wreckage and impact information

1.12.1 The aircraft impacted flat terrain in an approximately 30° nose down attitude on a heading of 350°M. Refer to Figure 2.

1.12.2 The wreckage signatures indicated high vertical forces with little forward energy with rotation to the left. These signatures were consistent with the aircraft being in a left-hand flat spin just prior to impact. Refer to Figure 3.

[12] Unattended means no air traffic aerodrome service is being provided.

Figure 2: Side view of accident. Source: CAA site investigation.

Figure 3. Aerial view of accident. Source: New Zealand Police photo.

1.12.3 The engine and propeller had twisted to the right. One propeller blade fragmented and was embedded in the ground to a depth of 14 cm. The other propeller blade was undamaged and remained attached to the propeller hub.

1.12.4 The fuel tank is usually mounted under the engine cowling but was dislodged in the impact. The fuel cap was dislodged but some fuel remained in the tank. Fuel had pooled in the engine impact crater. Fuel stained the ground and there was a strong smell of fuel. The cockpit fuel selector was on.

1.12.5 The throttle was closed, and the carburettor heat selected 'on'. Both selections were consistent with a stalling exercise.

1.12.6 The engine controls and switches were set in a position appropriate for the exercise. There were no readings from the engine or cockpit instruments.

1.12.7 Both flap actuators were severed, allowing the flaps to move freely. The flap selector operates by depressing a button on top of the lever which engages a pin into the desired detent. The selector was found in the full flap detent.

1.12.8 Pre-impact control integrity was established. Both rudder pedals had fractured and underwent specialist inspection.

1.12.9 No evidence was found of any mechanical or flight control system failure that may have contributed to the accident.

1.13 Medical and pathological information

1.13.1 Post-mortem examination determined that the pilot died from "immediately fatal, irretrievable injuries" consistent with a "very high-energy impact".

1.13.2 Toxicological tests showed no substance other than (aviation-permitted) prescribed medication.

1.13.3 The pilot held a SAC Medical Certificate and Declaration valid until 10/02/2021.

1.13.4 It was unlikely that pre-existing conditions resulted in incapacitation or affected the pilot's ability to fly the aircraft.

1.14 Fire

1.14.1 Fire did not occur.

1.15 Survival aspects

1.15.1 The impact forces were not survivable.

1.15.2 The pilot was fully restrained by the 4-point harness and marks on the pilot's flight helmet showed he was wearing it at the time of the accident.

1.15.3 The aircraft was not equipped with an emergency locator transmitter, nor is it required to be.

1.15.4 While the accident was not survivable, the pilot was well prepared by carrying a Personal Locator Beacon (PLB) and advising people of his intentions to ensure a timely rescue in the event of a survivable accident.

1.16 Tests and research

Engine inspection

1.16.1 The engine was removed and inspected by a CAA engineer with the assistance of another licensed engineer.

1.16.2 Some parts of the fuel system had received impact damage, so required straightening. Once a new fuel line and propeller were fitted, the engine was started and ran without issue.

1.16.3 The carburettor heat cockpit selector was found 'on' which corresponded to the position of the engine heat sleeve valve. The carburettor heat was confirmed to be most likely on at the time of impact.

Rudder inspection

1.16.4 Both upper portions of the rudder pedals were found separated but control integrity to the rudder remained.

1.16.5 Detailed inspection by an expert in wooden aircraft construction confirmed the damage was impact related and not due to an inflight failure. The expert also noted, "The method of construction to be correct for the aircraft type, and the construction of the components were of a high standard of workmanship".

Weight and balance calculations

1.16.6 To determine the aircraft weight and balance at the time of the accident, the aircraft wreckage was weighed, and measurements taken to establish datum points for the fuel tank and pilot seat.[13]

1.16.7 The aircraft weight was 528.5 lbs which was 2.82 lbs lighter than that recorded in the aircraft's weight and balance documents (CAA 2173) in 2007[14.] This is an acceptable 0.531% difference in weight and likely due to the fragmentation of parts of the wreckage.

1.16.8 The pilot seat position moment was calculated as aft 29.5" and the fuel tank moment as forward 4.75".

1.16.9 The fuel tank maximum capacity was determined to be 51.3 litres (ltr).

1.16.10 The test results were used to calculate a range of all-up weights and possible centre of gravity (C of G) positions for the flight.

The CAA 2173 aircraft empty weight of 531.32 lbs was used. Witnesses reported the pilot filled the fuel tank to full (approximately 50 ltr) prior to departure. The pilot weight was calculated to be 198.41 lbs[15.]

1.16.11 The CAA aircraft registration records showed a higher MAUW (750 lbs) than the CAA 2173 (707 lbs). There is no weight and balance data for the higher (CAA registration) weight. The CAA 2173 limitations are used as this is specific for this aircraft.

---

[13] Conducted by a specialist technical investigation organisation and a CAA licensed engineer.

[14] The aircraft was weighed and centre of gravity calculations conducted last in 2007, Job M06-225.

[15] Post-mortem information plus estimates for clothing and helmet.

Time *	Fuel** litres pounds	All-up weight pounds	Centre of gravity inches
1355 (Take-off)	50 82.67	812.39	13.41
1415* (1st stalling exercise)	45 74.4	804.12	13.6
1500* (subsequent exercise)	35 57.87	787.59	13.98
Aircraft C of G limits: forward 11.4" and aft 15.4" Aircraft maximum all-up weight (MAUW): 707 lbs (ZK-DKQ CAA 2173)			

Table 3: Weight and balance calculations.
*Time estimates based on witness reports and aircraft performance. Refer to Analysis Section 2.14.
**Fuel burn estimated at 12 ltr/hour given type of operation (extended climbs).

1.16.12 It was calculated that the aircraft was operated above the MAUW but within the CAA 2173[16] C of G range in all the above scenarios. With this pilot the aircraft was above the MAUW of 707 lbs prior to loading fuel. To carry a full fuel load, a pilot could not weigh more than 136 lbs.

Taylor Monoplane design research

1.16.13 The aircraft type had a limitation 'intentional spins prohibited'. Terry Taylor[17] was approached for information about the known spin characteristics. No information was held, and it is unlikely the aircraft was spun during test flights.

1.16.14 One aircraft accident investigation [18] into a Taylor Monoplane spin-related accident reported "the spin entry surprised him [the pilot] and highlights the importance of stall-spin awareness training".

[16] The CAA2173 figures are for 707lbs MAUW. No data is available outside of this MAUW.
[17] The son of the Taylor Monoplane designer assisted the CAA investigation. http://www.taylortitch.co.uk/
[18] AAIB Bulletin no:11/2001 Taylor J.T.1 Monoplane, G-BEEW, Air Accidents Investigation Branch, UK.

1.16.15 The aircraft's wing design does not incorporate washout, a feature which encourages inboard sections of the wing to stall before the outboard sections. This design feature helps prevent uncontrollable rolling moments caused by one wing tip stalling before the other, as well as helping to ensure aileron effectiveness at low airspeeds.

1.16.16 A test pilot reviewed a Taylor Monoplane[19] for *Kitplanes* magazine. He reported benign stall characteristics in the test aircraft G-BYAV. Through correspondence with him it became apparent that ZK-DKQ flight characteristics were quite different to G-BYAV and direct comparisons could not be made.

1.16.17 A common feature of amateur-built aircraft is that no two are alike due to differences in construction and rigging. This aircraft category is not subject to the same design, testing, and monitoring processes as type-certificated aircraft[20].

1.17 Organisational and management information

1.17.1 Microlight activities in New Zealand are administered by an ARO. The Director of Civil Aviation delegates authority for the issue of Pilot Certificates (and authorisation of microlight inspectors) to a nominated senior person in a Part 149 ARO.

1.17.2 The pilot's ATO and instructor certificates were issued by the Sport Aviation Corp Limited (SAC) Part 149 ARO.

1.17.3 At the time of the accident the SAC exposition[21] stated:

"4. Privileges

An Authorised Testing Officer may self-rate themselves on an aircraft type which is new to their area providing they hold a microlight certificate valid for the appropriate category; and

5. Renewal

[19] Grimstead, B. "Taylor Monoplane", *Kitplanes, May 2009*.https://www.kitplanes.com/taylor-monoplane/

[20] A type certificate is issued by a regulatory authority for an approved design (type) of manufactured aircraft.

[21] SAC exposition Section 6.1 Training Micro 6 Authorised Testing Officers 1 (sportflying.co.nz)

(a) An Authorised Testing Officer is appointed as required by SAC and shall be flight tested by another SAC ATO every 2 years after which the appointment may be terminated."

1.18 Additional information

Pilot currency requirements

1.18.1 The microlight groups (B) and (G) are classed as aircraft ratings unlike Rule 61.7 *Pilot licences, ratings, and permits* which mandates separate pilot licences must be held for aeroplane and helicopters.

1.18.2 A biennial flight review (BFR) is required for every Part 61 pilot licence held by a pilot. Microlight pilots must also complete a BFR but only for the microlight certificate held, not for each group rating. Additionally, both Part 61 and (most) microlight pilots must conduct three take-offs and landings every 90 days in the aircraft category or configuration of aircraft they fly.

1.18.3 Microlight instructors are required to pass an annual flight review every 13 months, but again, not for each group rating held. Refer to Appendices A and B for SAC and RAANZ certificate structures.

Stalling exercise

1.18.4 Wing-drop stalling[22] is taught in the advanced stages of microlight pilot training and is a BFR flight test item for Group B microlight pilots. Aircraft type ratings include stalling exercises to familiarise the pilot with the stall characteristics of each aircraft type.

1.18.5 Pilots need to know about stalling to avoid an inadvertent stall when operating at slow speeds, especially near terrain.

1.18.6 The CAA Flight Instructor Guide (FIG) provides information about teaching basic, advanced, and wing-drop stalling exercises.[23] The guide details the preparation for the stalling exercise, execution, and recovery.

1.18.7 Standard wing-drop stall recovery is summarised in Figure 4.

---

22 In a wing-drop stall one wing reaches the critical angle first, stalls before the other, losing lift, causing a roll at the stall.

23 Basic stalling | aviation.govt.nz, Advanced stalling | aviation.govt.nz, Wing-drop stalling | aviation.govt.nz

5. Air Exercise

Entry

- **HASELL** checks
- Prominent reference point
- Carb heat HOT
- Set power to ______ rpm
- Keep straight with rudder, and maintain altitude with backpressure
- Below ______ kts (white arc), select flap
- Through ______ kts (stall warning) – carb heat COLD
- At the stall, altitude is lost, nose pitches down, and one wing may drop

Recovery

To unstall	Keep ailerons neutral
At the same time	Simultaneously • decrease the back pressure/check forward and • apply sufficient appropriate rudder to prevent further yaw
To minimise the altitude loss	Smoothly but positively apply full power. At the same time: • level the wings with aileron, • centralise the rudder, and • raise nose smoothly to horizon – to arrest the sink and minimise altitude loss

- Hold nose at level attitude, reduce flap setting immediately
- At safe height, safe airspeed and positive RoC – raise remaining flap (counter the pitch change)
- Regain starting altitude and reference point

Figure 4: Flight Instructor Guide, wing-drop stalling, air exercise. Source: CAA.

1.18.8 The FIG notes:

"Excessive rudder may cause a stall and flick manoeuvre in the opposite direction to the initial roll (wing-drop)", and

"Once the wing stalls, aileron will not stop the roll, it will worsen the situation. If the wing-drop is not promptly recovered, a spin may develop. The purpose of this exercise is to stop the [pilot's] natural tendency to pick the wing up with aileron and to practise the correct method of recovery."

Spin recovery

1.18.9 The CAA Good Aviation Practice (GAP) booklet *Spin Avoidance and Recovery*[24] provides information regarding unintentional spins, and recovery. (Refer to Appendix C). The introduction summarises the key aspects of a spin:

---

24 Good Aviation Practice (GAP) - *Spin Avoidance and Recovery* - Revised 2014

"When an aircraft spins, a stall occurs together with yaw, and self-perpetuating rotating forces develop. These forces keep the aircraft in the spin until positive and correct control inputs from the pilot stop them. In a fully developed spin, the aircraft follows a spiral flight path about an axis going straight down, pitching up as well as rolling and yawing towards the spin axis. Descent rates during a stable spin in light aircraft are typically about 5000 to 8000 feet per minute."

Of note are the statements:

*"All aircraft will spin, but not all aircraft can be recovered from a spin"***,** and

"The most common cause of spin is being out of balance at the stall".

1.18.10 The flat spin is discussed on page 14 of the GAP booklet:

"In a flat spin both wings end up in a highly stalled angles of attack. The aircraft attitude is about level with the horizon and it lacks the roll and pitch oscillations of a conventional spin. Instead it consists almost entirely of yaw about the vertical axis. With the exception of some specialised aerobatic aircraft, flat spins may be unrecoverable."

1.18.11 Standard spin recovery is summarised in Figure 5.

PARES Spin Recovery		
P	POWER	off (close throttle)
	Identify you are in a spin and the direction of rotation	
A	AILERONS	neutral
R	RUDDER	full opposite to direction of spin… Pause
E	ELEVATOR	move stick or control column progressively and centrally forward until spin stops
	Perform steps sequentially – centralise when spinning stops	
S	Spin STOPS	rudder neutral and ease out of ensuing dive

Figure 5: PARES Spin Recovery, *GAP Spin Avoidance and Recovery,* page 22. Source CAA.

1.18.12 The United States Federal Aviation Administration Airplane Flying Handbook, Chapter 4: *Maintaining Aircraft Control: Upset Prevention and Recovery Training*[25] also provides useful spin information.

1.19 Useful or effective investigation techniques

1.19.1 Nil.

2. Analysis

2.1 The aircraft departed controlled flight, entered an unrecovered spin, and impacted the ground.

2.2 The absence of forward impact ground scars, no wing tip damage and the overall wreckage pattern indicated the aircraft was in a left-hand, flat spin on impact.

2.3 The purpose of the flight was to practise stalling and the pilot was heard climbing to a height suitable[26] for the exercise. The aircraft controls and flap selector were found in positions consistent with that of an advanced stalling exercise. Therefore, it is most likely that the spin occurred subsequent to a wing-drop stall.

2.4 The pilot was a respected ATO, current gyroplane instructor and the Pukaki aerodrome manager. He consistently scored "excellent" grades in gyroplane renewal flight tests. His most recent Group B Microlight Certificate renewal was 12 years prior to the accident date. The pilot achieved "excellent" or "above average" grades for all exercises, including stalling.

2.5 Since that Group B renewal, his pilot logbook recorded one hour in an aeroplane[27] prior to commencing the Taylor Monoplane type rating.

However, family reported the pilot had flown aeroplanes with friends over the years. Correctly, these flights were not recorded in his pilot logbook as he was not the pilot in command or under instruction. It is unlikely wing drop stalling was

---

25 Airplane Flying Handbook (FAA-H-8083-3B)

26 Flight Instructor Guide, *Wing-drop stalling exercise* recommends: "HEIGHT (not altitude) Regained or sufficient to recover by not less than 2500 feet above ground level."

27 That was in Jan 2009. He also conducted a BFR (0.5 hours) for another pilot in 2019. As the ATO, he would have been observing the candidate's flying rather than flying himself.

practised on these flights as this is usually conducted as part of a BFR or instructional flight.

2.6 Though a current gyroplane pilot, he was not current in the stalling exercise as this is not applicable to the gyroplane aircraft type. The last recorded stall/spin training was in a glider in 2001.

2.7 The pilot conducted the flight in accordance with SAC rules in that a current proficiency flight test is not required for each group rating. ATOs are also permitted to self-rate on aircraft.

2.8 SAC and another ARO, RAANZ stated that most ATOs with Group B and G ratings regularly fly both aircraft types and so currency is maintained. It is possible this ATO was an outlier, in that, prior to self-rating on ZK-DKQ, he was almost exclusively flying gyroplanes. Other microlight certificate holders[28] must undergo instruction for new type ratings, with specific procedures for single seat aircraft ratings.

Microlight pilots are not required to complete a BFR for each aircraft group they fly. This exposes pilots to risks related to a loss of proficiency in skills specific to each group, such as stalling.

2.9 After the accident, RAANZ purchased SAC and the two organisations merged. RAANZ revised the pilot currency and renewal requirements in their exposition.

2.10 The pilot had systematically gained ground and flight handling skills in ZK-DKQ before progressing to advanced exercises.

He prepared ahead by reviewing the stalling exercise and ZK-DKQ's stall characteristics with its owner. As ZK-DKQ is a single-seat aircraft it was not possible to practise the exercise dual. His comments just prior to departure indicated he was aware of the possible risks with wing-drop stalling and the possibility of entering a spin.

2.11 The pilot did not undertake dual instruction in a two-seat aircraft prior to the flight in ZK-DKQ. This may have required travel outside of Pukaki and it is not known if he considered this option. It cannot be concluded that regaining proficiency in stalling

---

28 Except pilots with a microlight Test Pilot rating.

whilst under instruction, prior to practising in ZK-DKQ would have prevented the accident.

2.12 This accident serves to remind all pilots that a lack of pilot currency is a well-known contributing factor to many accidents. The CAA recommends pilots to obtain dual instruction if they are not current in specific exercises or an aircraft type.

2.13 The pilot selected an ‘ideal’ weather day and advised people of his flight intentions. He conducted a thorough preflight, checked his harness and helmet, and filled the fuel tank to ensure a forward aircraft C of G.

He selected an open area with plenty of emergency landing options. It was likely the stall practice commenced, as planned, from 6500 feet. This provided 5000 feet [29] to recover from a wing-drop stall which should have been sufficient.

2.14 It is estimated the accident occurred between 1420 and 1530. ZK-DKQ took off at approximately 1355, taking around 20 minutes to fly to the area and height for the stalling exercise. The pilot was heard making a radio call “climbing through 6100 feet” shortly after he departed. No one flying at the time reported hearing further calls from ZK-DKQ as would have been expected for this pilot.

2.15 The accident likely occurred after starting the wing-drop stall exercise/s.

2.16 The absence of recorded data or witnesses limited the ability of the investigation to determine how the aircraft departed controlled flight. Two scenarios that could not be excluded were aircraft factors, a pilot handling error, or a combination of both.

Aircraft factors

2.17 ZK-DKQ’s owner stated the aircraft had a pronounced stall in which the nose would pitch up followed by an “aggressive” wing-drop to the left. This was aggravated if flap was selected. He had briefed the pilot of these stall characteristics and advised him to practise with “plenty of height”. He also advised to “push forward” to recover but even if he did nothing, “the aircraft would recover itself”.

---

[29] The accident site was 1422 feet above sea level.

2.18 Neither the owner nor previous owner had spun the aircraft, so could not comment on its spin characteristics. Apart from the aircraft type limitation ‘intentional spins prohibited’ no further information was available from TitchTaylor or the LAA.

Test flight data (if available) for ZK-DKQ after it was rebuilt, was not documented in the aircraft files.

2.19 Examination of the wreckage and aircraft maintenance history found no defects which may have contributed to, or prevented recovery from, the spin. However, several aspects may have predisposed the aircraft to the significant wing-drop stall described by the owner:

a) the slab wing design and lack of wing washout

b) possible differences in rigging and /or build between the two wings

c) use of full flap increases lift on the inner wing and the tendency for the outer wing to stall first

d) a wing may drop more readily if partial power is used, due to the modifying effect of the propeller slipstream on the angle of attack on each wing.[30]

2.20 The engine stopped at some stage prior to impact. Post-accident engine inspection found no defects and the engine was started and ran normally. Several causes for the stoppage were considered:

a) Interruption to the electrical power would cause the engine to stop. It is unlikely this occurred as the pilot would not have commenced a stall exercise. He would have conducted a forced landing and likely made a radio call to that effect.

b) It is possible that the fuel supply to the engine was interrupted due to the forces involved in the spin.

c) Conditions were conducive to carburettor icing and though carburettor heat was selected ‘on’, it is possible carburettor icing was present.

Either of these latter two conditions, or a combination of both, could have contributed to the engine stopping.

---

[30] Refer to the *Flight Instructor Guide* Wing-Drop Stalling for more information.

2.21 Engine power is not required for the recovery from a stall or spin and is only applied afterwards to minimise height loss. With no data on the spin characteristics of the Taylor Monoplane or ZK-DKQ, it is not possible to determine whether engine power would have influenced the recovery from the spin.

2.22 An aft C of G can contribute to an aircraft entering a flat spin, and also can prevent spin recovery. Therefore, it was important to establish a range of possible C of G for ZK-DKQ at the time of the departure from controlled flight. In all scenarios the aircraft remained within the CAA 2173 C of G range. However, that range is only valid at a MAUW of 707 lbs.

An increase in MAUW can have the effect of reducing the C of G envelope. Without data for ZK-DKQ or the Taylor Monoplane, no conclusions can be made on the effect of the MAUW exceedance on the C of G envelope.

2.23 The pilot was conscious the risks an aft C of G posed and hence filled the fuel tank to full to prevent this.

2.24 The flaps were disconnected due to impact forces and so flap position could not be positively established. They were most likely in the ‘full flap’ position as selected by the pilot. It is not known what effect, if any, the flap position may have had on the spin characteristics or recovery.

2.25 Without any spin data for the Taylor Monoplane, or ZK-DKQ itself, it is not possible to draw any conclusions whether aircraft factors caused the entry and lack of recovery from the flat spin.

Pilot factors

2.26 The FIG stresses the importance of not using aileron in the wing-drop recovery and cautions that *“if the wing-drop is not promptly recovered, a spin may develop”.* Senior CAA flight examiners stated the incorrect use of aileron in the recovery of the wing-drop stall is the most common pilot error observed. The natural instinct to pick up the wing with aileron is very strong and it takes repetitive practice to overcome this instinct. They noted they even see this error made by current B Category instructors.

2.27 It is possible incorrect control inputs were made by the pilot leading up to the stall and/or during the wing-drop stall recovery. Aileron deflection or an out-of-balance condition at the point of stall would have exacerbated the known tendency for ZK-DKQ to suddenly wing drop. Errors in the initial wing-drop stall recovery technique such as use of aileron or incorrect rudder input could induce a spin.

2.28 A witness reported the pilot told them that the engine "may stop" during the stall. In anticipation of this the pilot may have left some power on during the stall entry and subsequent spin. As well as predisposing one wing to drop, power has the effect of pitching up the aircraft, which might have helped the spin to flatten.

2.29 The GAP states *"…in a spin that continues beyond about two turns, disorientation often occurs, and it will be very difficult for the pilot to make the correct recovery inputs, unless properly trained and experienced in spinning".*

The pilot was faced with a challenging situation given his lack of currency in wing-drop stalling and spinning, and likely a significant level of disorientation.

2.30 Once the aircraft entered the fully developed spin, recovery may have not been possible, regardless of pilot control inputs, especially once the spin flattened.

3. Conclusions

3.1 The pilot was conducting stalling exercises as part of self-type rating on the single-seat aircraft.

3.2 The pilot had prepared for the stalling exercise in advance and was aware that handling errors could lead to a spin.

3.3 The stalling exercise was conducted in ideal weather conditions, in a suitable area, and most likely from a height that provided more than sufficient time to recover from the stall.

3.4 The aircraft entered an unrecovered spin most likely subsequent to a wing-drop stall.

3.5 Spinning is prohibited for Taylor Monoplane aircraft, and the spin characteristics of the type and ZK-DKQ are unknown.

3.6 It is not possible to determine whether correct recovery inputs were made during the spin without recovery, or whether aircraft factors prevented recovery.

3.7 Once the aircraft entered the fully developed spin, recovery may have not been possible, regardless of pilot control inputs, especially once the spin flattened.

3.8 The pilot was appropriately certificated and fit, and conducted the flight in accordance with SAC rules.

3.9 Though a current gyroplane instructor and ATO, the pilot was not current in wing-drop stalling. However, it is not possible to conclude that currency in wing-drop stalling would have prevented the accident.

3.10 A current proficiency flight test is not required for each microlight group rating and ATOs are permitted to self-rate on aircraft.

3.11 No pre-accident aircraft defects were found.

3.12 The engine likely stopped as an outcome of the wing-drop stall or spin. Engine power is not required to recover from a stall. It is not possible to determine whether engine power would have influenced the recovery from the spin.

3.13 The aircraft was operated over the MAUW limit of 707 lbs but within the C of G envelope for that limit.

No conclusions can be made on the effect of the MAUW exceedance on the C of G envelope.

3.14 The pilot took positive actions to improve survivability by wearing a helmet, carrying a PLB and advising people of his intentions to ensure a timely rescue in the event of a survivable accident. However, this accident was not survivable.

4. Safety actions/recommendations

4.1 Safety action 22A272

Following the accident, RAANZ changed the pilot currency and renewal requirements in their exposition to include:

"Where privileges within a particular group have not been exercised for a period of more than 24 months then practical competence is required to be demonstrated to an instructor before use of the group is continued".

Due to this action no safety recommendations were issued to RAANZ[31].

4.2 Following this accident, Terry Taylor stated his concerns that Taylor Monoplanes were being built and operated well above the original design weight. Therefore, all new orders for Taylor Monoplane plans will include a covering letter with a caution to STICK TO THE DIMENSIONS STATED.

4.3 This accident serves to remind all pilots that a lack of pilot currency is a well-known contributing factor to many accidents. The CAA recommends pilots to obtain dual instruction if they are not current in specific exercises or an aircraft type.

Report written by:

Lou Child
Safety Investigator
Date: 24 November 2021

Authorised by:

Dianne Cooze
Manager Investigation Response

Civil Aviation Authority of New Zealand
Level 15, Asteron Centre
55 Featherston Street
Wellington 6011
OR
PO Box 3555
Wellington 6140
NEW ZEALAND

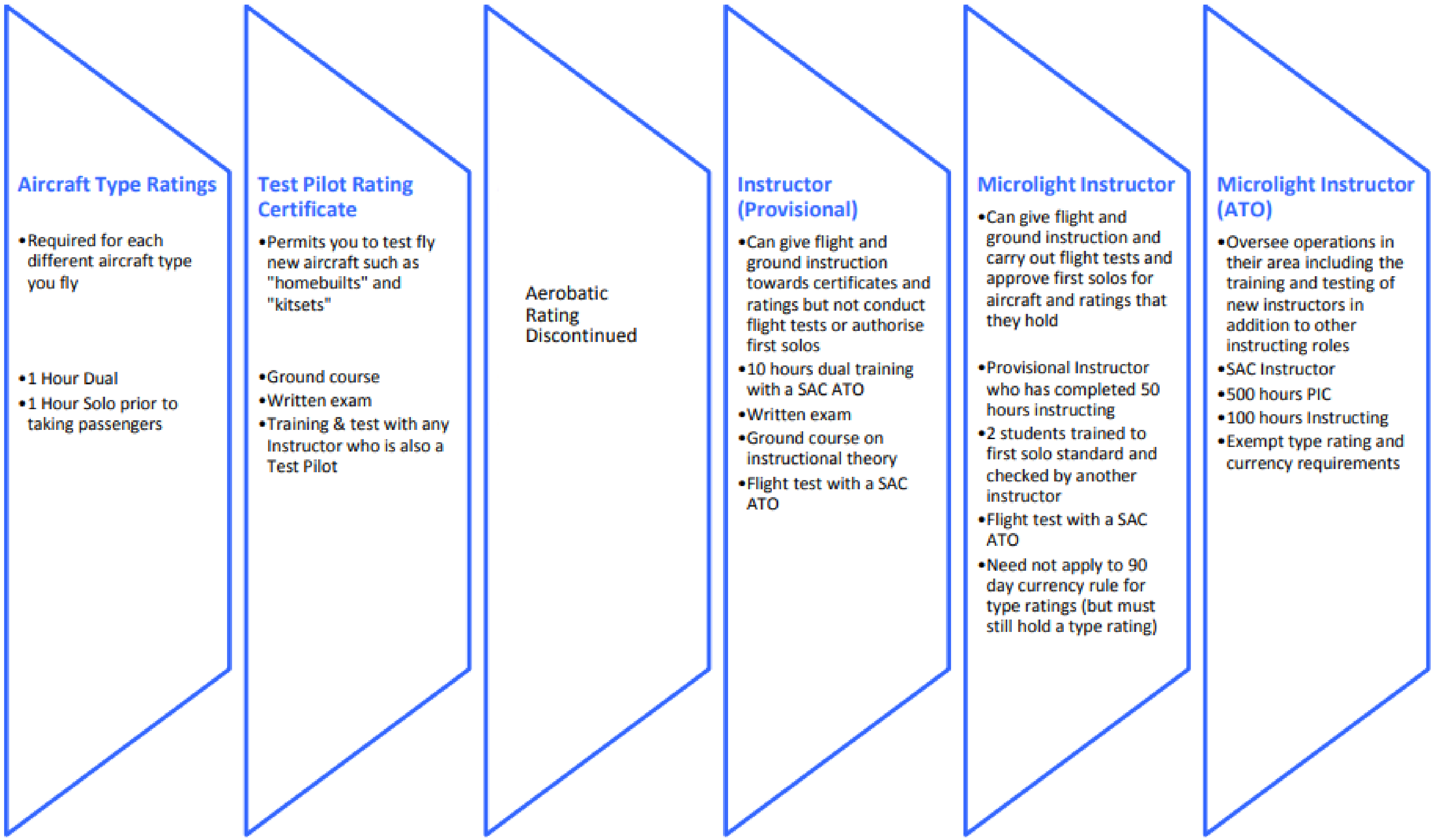
Tel: +64-4-560 9400 Fax: +64-4-569 2024
www.caa.govt.nz

[31]Since the accident, RAANZ purchased SAC and the two organisations merged, hence no actions were relevant to SAC.

Appendix A: SAC Microlight Pilot Certificate Pathway.

Microlight Pilot Certificate Pathway

Novice	10-15 hours dual training normally	Medical certificate from your own GP - as for all certificates	All solo flights must be authorised by your instructor	16 years of age to fly solo
Intermediate	25 hours total flying time	5 written exams (law, nav, met, radio and aircraf tech)	Flight test with an instructor	Restricted to flights within 10nm of your base
Advanced	35 hours total flying time including 10 hours cross country training	Exams and flight test as per intermediate	35 hours solo before being eligible for passenger rating	Valid for 24 months. Requires BFR test with instructor
Instructor	200 hours total flying time	Written Exam, Ground Course, 10 hours flight training with ATO	Valid for 13 months. Requires check with a SAC ATO	More details below


Aircraft Type Ratings
•Required for each different aircraft type you fly
•1 Hour Dual
•1 Hour Solo prior to taking passengers
Test Pilot Rating Certificate
•Permits you to test fly new aircraft such as "homebuilts" and "kitsets"
•Ground course
•Written exam
•Training & test with any Instructor who is also a Test Pilot
Aerobatic Rating Discontinued
Instructor (Provisional)
•Can give flight and ground instruction towards certificates and ratings but not conduct flight tests or authorise first solos
•10 hours dual training with a SAC ATO
•Written exam
•Ground course on instructional theory
•Flight test with a SAC ATO
Microlight Instructor
•Can give flight and ground instruction and carry out flight tests and approve first solos for aircraft and ratings that they hold
•Provisional Instructor who has completed 50 hours instructing
•2 students trained to first solo standard and checked by another instructor
•Flight test with a SAC ATO
•Need not apply to 90 day currency rule for type ratings (but must still hold a type rating)
Microlight Instructor (ATO)
•Oversee operations in their area including the training and testing of new instructors in addition to other instructing roles
•SAC Instructor
•500 hours PIC
•100 hours Instructing
•Exempt type rating and currency requirements

Recreational Aircraft Assn. of New Zealand (Inc.)

RAANZ Certificate Structure: Requirements, Privileges and Limitations

RAANZ Inc
Freepost 102829
PO Box 15-016
Dinsdale 3243
Hamilton

07 825 2800
office@raanz.org.nz
www.raanz.org.nz

current June 2007

Key
Mandatory requirement for certificate/endorsement
Optional requirement or optional privilege
Privilege NOT available
Limitation on certificate/privilege

Certificate level Endorsements	Min age	Medical declaration	Fit & Proper declaration	Min flight experience	Exam	FRTO	Cross country	Flight test	Pax rating	Flight limitations	Certificate validity
Novice	16	Required	Required on entry	None				None	No	All flights instructor approval	1 year
First solo	Logbook endorsement by Senior Instructor of completion of basic training syllabus										
Intermediate	16	Required	Required on entry	25 hrs 15 hrs for PPC	Required	If radio used or within 10NM controlled airspace		Required	No	10NM of base	1 year
Advanced Local	16	Required	Required on entry	40 hrs	Required	If radio used or within 10NM controlled airspace	Local cross-country	Required	Available	50NM of base	2 years
Advanced National	16	Required	Required on entry	45 hrs	Required	Required	National cross-country	Required	Available	None	2 years
Passenger Rating				45 hrs with 35 hrs PIC 30 hrs for PPC						3 t/o and landings in previous 90 days	
Local cross-country	Min of 4 exercises, 5 hrs total, 2 hrs solo x/c, including 1 hr/3 leg flight, high level, low level, mountain, weather diversion										
National cross-country	Min of 4 exercises, 10 hrs total, 4 hrs solo x/c, including 3hr/3 leg flight, high level, low level, mountain, weather diversion, controlled airspace										
Flight Instructor	Advanced National certificate, 150 hours (10 microlight, 10 x/c) Club recommendation, sponsor ATO Instruction/flight exam and test, Instruction Skills seminar (within 2 years),								No first solo authorisation No Advanced flight testing No Pax rating testing		1 year
Senior Flight Instructor	Flight Instructor certificate, 200 hrs TT, 50 hours flight instructing time 2+ students from ab initio to first solo, Instruction skills seminar Sponsor ATO discretion										1 year

Anatomy of a Spin

A spin will not exist without both stall and yaw.

Stall

The stall angle of attack is the critical angle which, when exceeded, will cause the normally streamlined flow of air that follows the curvature of the upper wing surface to separate from the wing and leave as turbulent air flow. At the stall angle of attack, lift reduces rapidly.

Pilots use a quoted indicated airspeed (for straight and level flight at a given weight and configuration) to correspond to this stall angle for each aircraft. But in reality this speed varies depending on the weight the wing has to support. Airspeed is only an indirect measure of an approaching stall.

The quoted stall speed really reflects the 1G straight-and-level speed at a nominal aircraft weight. Increase aircraft weight, and the stall speed will increase. Enter a turn, and the stall speed will increase.

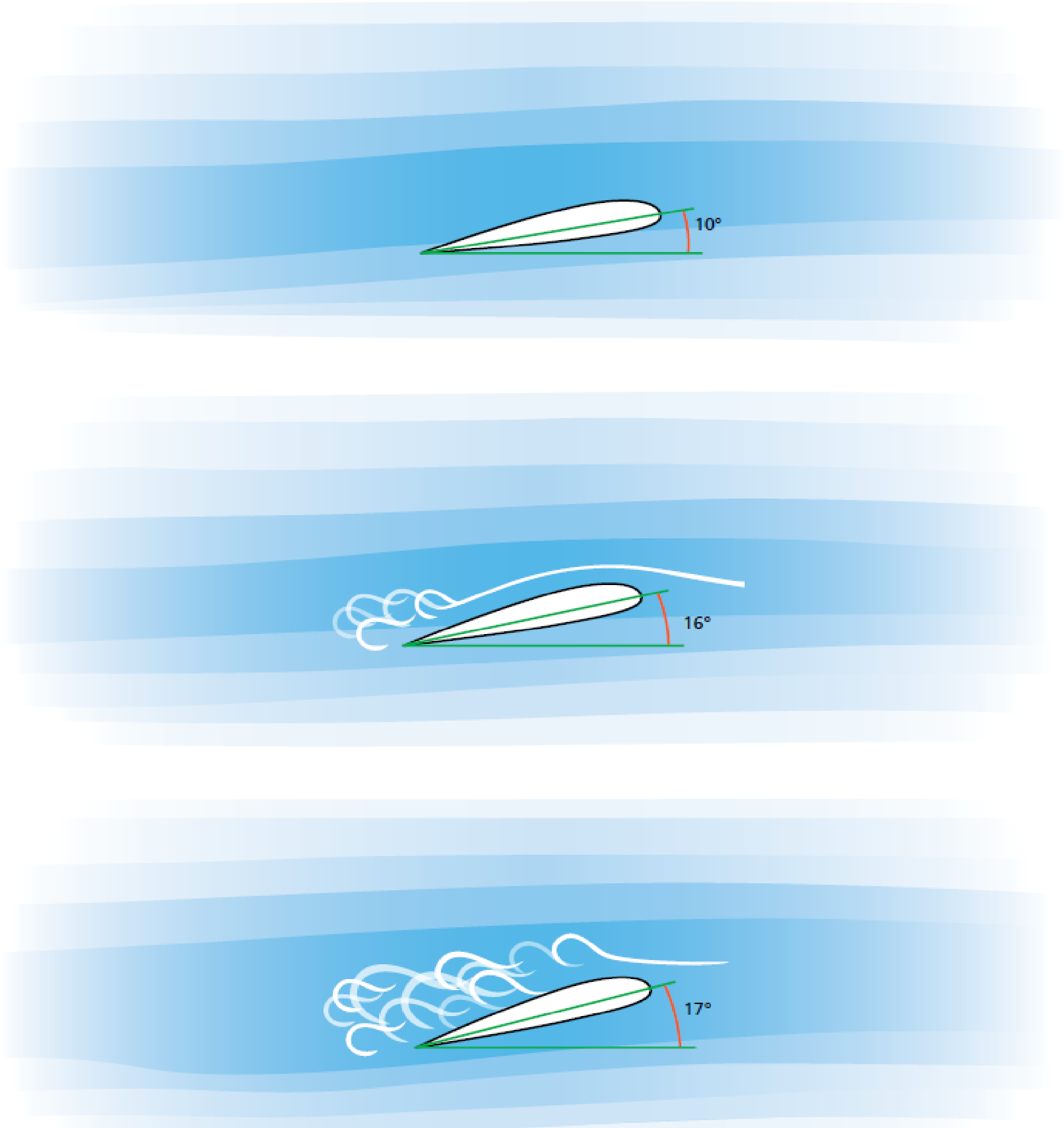
> Airspeed is only an indirect measure of an approaching stall.

A 60 degree banked steep turn at a constant altitude produces a 2G loading in all aeroplanes from Bantam to Boeing. The stall speed will increase with the square root of that loading – e.g.$\sqrt{2}$ is 1.4 and thus a basic stall speed of 40 knots becomes a little more than 56 knots (40 x 1.4) in a 60 degree (2G) steep turn.

When evaluating how close an aircraft is to the stall, pilots should think angle of attack rather than airspeed. The elevator position (how far back the stick or control column is held), is actually a better indication of how close to the stall the aircraft is.

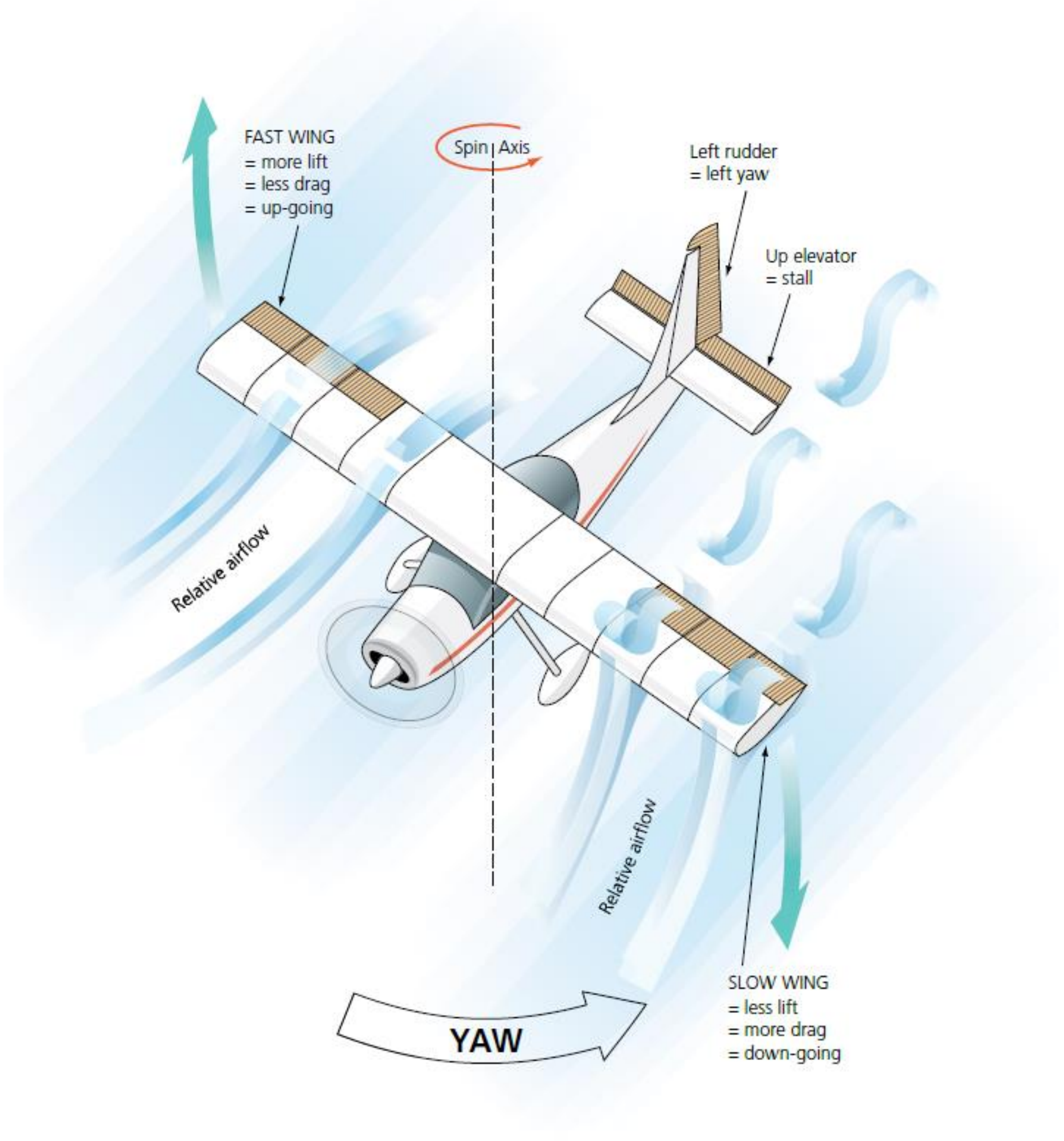
> Think angle of attack, rather than airspeed.

In a balanced, wings-level stall with the ball in the middle, both wings will remain at the same angle of attack. At the stall, aerodynamic forces may try to pitch the nose forward, but there should be no overall rolling or yawing.



When the stall angle of attack is reached, the normally streamlined flow of air over the wing becomes turbulent, reducing lift.

5



Stall and yaw combine to produce a new axis, the spin axis.

6

Yaw

If the aircraft is yawed, a roll will develop in the direction of yaw because the outer wing has increased speed, which has increased its lift. The descending (inner) wing gains an increased angle of attack. If this wing is at or near the stall angle, its lift reduces. When one wing goes down, the other will rise, and exactly the opposite happens to the rising wing. The relative airflow now produces a reduction in angle of attack on the up-going wing, which may be below the stall angle (in effect it has become less stalled). The effect of these differences in lift will be to produce an accelerating roll rate in the direction of the initial yaw.

These changing angles of attack also affect drag. The down-going wing with an increased angle of attack suffers increasing drag. The up-going wing gets a drag reduction. The difference causes even more yaw towards the down-going wing.

Autorotation

The yawed and stalled aircraft then starts to rotate. However, it not only rolls about the longitudinal axis due to the differences in lift from each wing, but also simultaneously rotates (yaws) about the vertical axis due to the differences in drag. The combination of these two movements gives us a new axis, the spin axis. The aircraft will continue in a self-perpetuating spin, or autorotation, about this axis until opposing forces come into play.

Causes of Yaw

- Out of balance flight caused by inducing (or not preventing) yaw with rudder.
- Wing drop at the stall, due to rigging or dimensional differences between wings.
- Application of aileron will cause aileron drag. On some aircraft when stalled, this will produce yaw.
- Gyroscopic effect from the propeller when the aircraft is pitching with power on, such as falling out of an aerobatic manoeuvre. This effect is more pronounced in high-powered aircraft.
- Gusts.
- One wing producing more lift, due to ice or damage to a wing surface.
- Asymmetric power on twin-engine aeroplanes.

By far the most common cause of entry to an unintentional spin is the first of these – yaw at the stall caused by out-of-balance flight.

> The most common cause of spin is being out of balance at the stall.

Spin **Characteristics**

The development and characteristics of a spin vary between aircraft types, but an aircraft will usually rotate several times before it settles down into a state of spinning steadily. The spin stabilizes once a complicated balance is reached between the various aerodynamic and inertial forces acting on the aircraft.

The pitch angle it finally adopts may be steep (60 degrees or more with the nose low) or flat (nose on the horizon).

The aircraft will lose altitude rapidly and descend along a vertical path about the spin axis. The rates of roll and yaw, and the pitch attitude, can all oscillate.

Spin characteristics vary depending on aircraft type, but even a given type of aircraft can have markedly changed spin characteristics depending on the aircraft weight, the aircraft centre of gravity, and how the controls (including engine power) are handled during the spin.

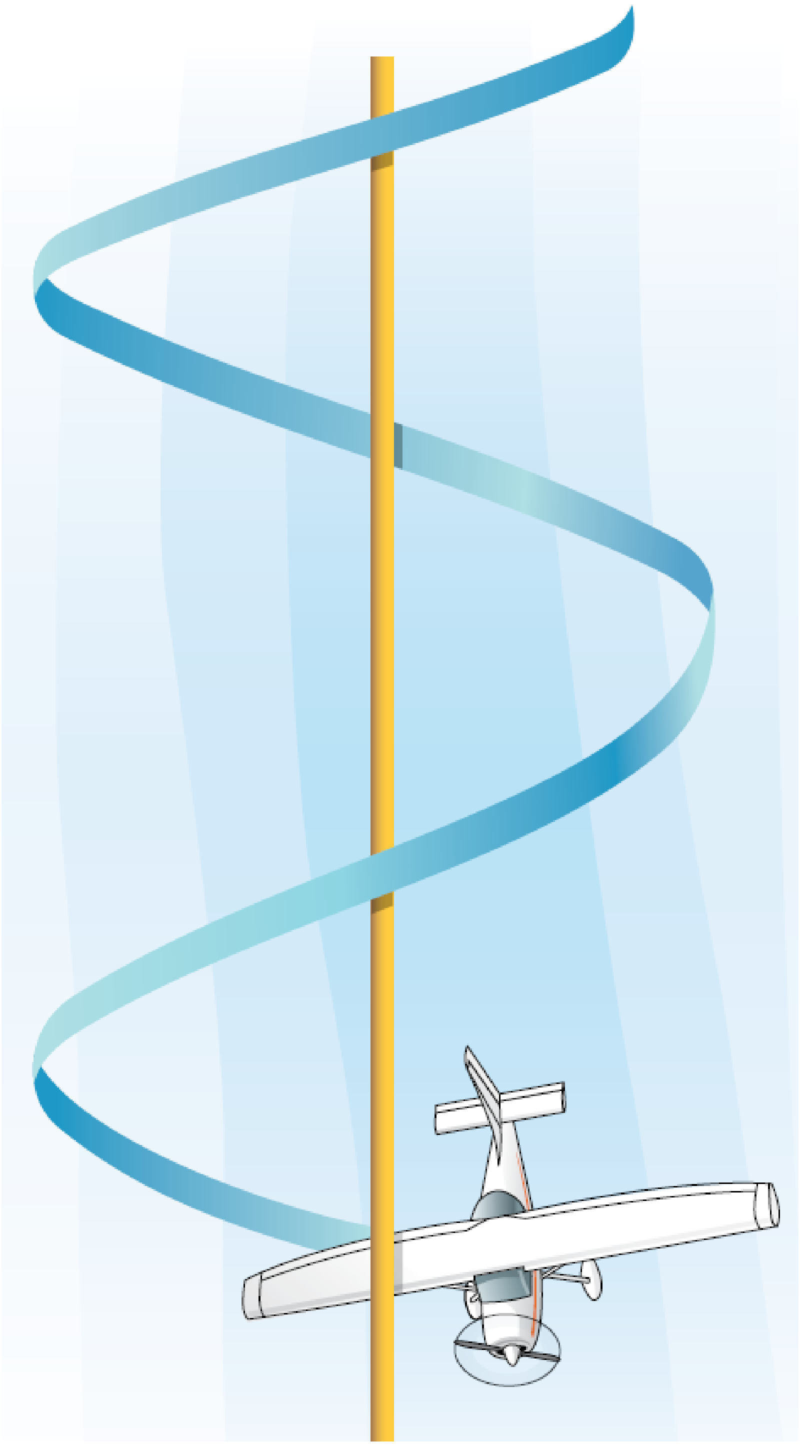
A four-seat aircraft with docile stall and spin characteristics at training weights with two people on board can have very different characteristics at maximum all up weight with an aft center of gravity due to people and baggage in the back.

Spiral Dive

The spiral dive can be confused with the spin. Spirals are steep, descending turns that become progressively tighter over time. They occur at lower angles of attack (the wing is not stalled) and display the same over-banking tendency common to all steep turns. They are characterised by high or increasing airspeeds and G forces.

The fundamental problem of the spiral dive is too much bank. Spiral dives become tighter if nose-up elevator inputs alone are applied. Attempting to arrest the rate of descent with more 'up' elevator without other remedial inputs will aggravate the spiral dive.

To recover, close the throttle, use the ailerons to reduce the bank angle, and ease the aeroplane out of the ensuing dive. The aircraft is likely to be at a high speed and will be very easily overstressed, so ease out of the dive using gentle back pressure.



An aircraft descends about its spin axis at a steep, nose low attitude.

9

Three Stages of Spin

Incipient Stage

This is the transitional stage, during which the aircraft progresses from a fully developed stall into autorotation. This progression may be very rapid and is sometimes described as a flick. It may last only two turns, during which time the rotation tends to accelerate towards the rate found in the developed stage. The final balancing of aerodynamic and inertial forces has yet to occur.

The incipient stage is generally driven by pilot inputs. As a very general rule, if pro-spin control inputs are removed in the incipient stage (the elevator is moved forward to unstall the wings, or the out-of-balance yaw is removed), then the aircraft will not continue to enter a stable spin.

In some aircraft, recovery may not be possible if the spin is allowed to progress to the developed stage. Therefore, recovery must be initiated at the first sign of a spin.

Developed Stage

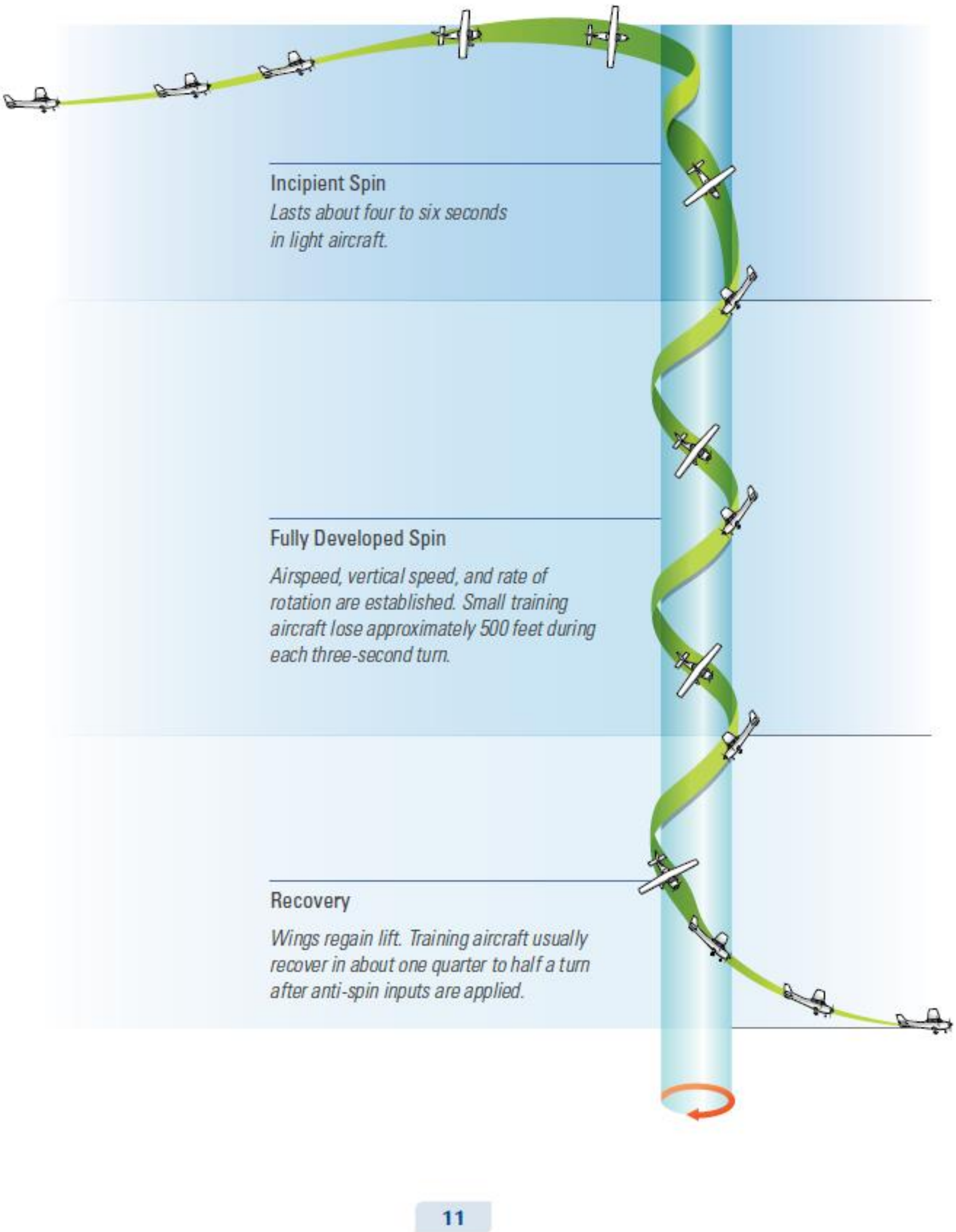
In the developed stage, a state of equilibrium is reached, characterised by a low and constant airspeed. Rates of descent will be as high as 5000 to 8000 feet per minute. At this stage the spin will be self-perpetuating. If the pilot does nothing about it, the spin is likely to continue until the aircraft hits the ground. Positive anti-spin control inputs will be required to recover from the fully developed spin.

Recovery Stage

Spinning ceases only if and when opposing forces and moments overcome auto-rotation. Since yaw coupled with roll powers the spin, the pilot must forcibly uncouple them by applying full opposite rudder. After a brief pause, this is followed by forward movement on the stick or control column.

During the recovery phase, the nose attitude typically steepens and the rate of rotation may momentarily accelerate as well, giving the impression that the spin is actually getting worse. It is not, and the anti-spin control inputs must be maintained until the spin stops.

Spin recovery is not instantaneous. It may take up to several turns for the anti-spin control inputs to finally overcome pro-spin forces. The longer an aircraft is in a spin, the more turns it may take to recover. Spins are recoverable only when the cumulative effects of the interacting variables favour recovery and there is enough altitude.


Incipient Spin
Lasts about four to six seconds in light aircraft.
Fully Developed Spin
Airspeed, vertical speed, and rate of rotation are established. Small training aircraft lose approximately 500 feet during each three-second turn.
Recovery
Wings regain lift. Training aircraft usually recover in about one quarter to half a turn after anti-spin inputs are applied.
11

Disorientation

Pilots understand which way is up via three sensory mechanisms – proprioceptive (seat of the pants), visual (eyes) and vestibular (inner ears).

Proprioceptive inputs provide information about joint position and muscle tension, but generally play only a small part in the total picture. Visual sensation is the most reliable, whereas vestibular inputs are very powerful but frequently misrepresent the rotational motion of flight. Therefore the eyes, through the interpretation of instruments and outside references are important to orientation. Disorientation occurs when there is a conflict between the visual and vestibular sensations – your eyes tell you one thing, but your inner ear says something else.

Within the ear, three semicircular canals are structured perpendicular to each other, so that a canal lies in each of the three planes of the human body. Information from these semicircular canals affects visual tracking.

During the initial stages of a spin, the eye is able to remain oriented. However, in a spin that continues beyond about two turns, disorientation often occurs and it will be very difficult for the pilot to make the correct recovery inputs, unless properly trained and experienced in spinning.

After about five turns, the eye becomes out of synch with the aeroplane rotation. Vision will blur and the speed of rotation appears to increase. Now the pilot has difficulty in determining the number of turns in the spin, its direction, and the effectiveness of any actions taken to exit the spin.

Upon stopping a spin, the fluid within the semicircular canals continues to move in the same direction as the spin rotation. The brain must contend with a conflict between this indication of turning one way and a visual indication of turning in the opposite direction, when there may be no actual rotation at all.

Special Spins

Flat Spin

In a flat spin, both wings end up at highly stalled angles of attack. The aircraft attitude is about level with the horizon and it lacks the roll and pitch oscillations of a conventional spin. Instead it consists almost entirely of yaw about the vertical axis. With the exception of some specialised aerobatic aircraft, flat spins may be unrecoverable.

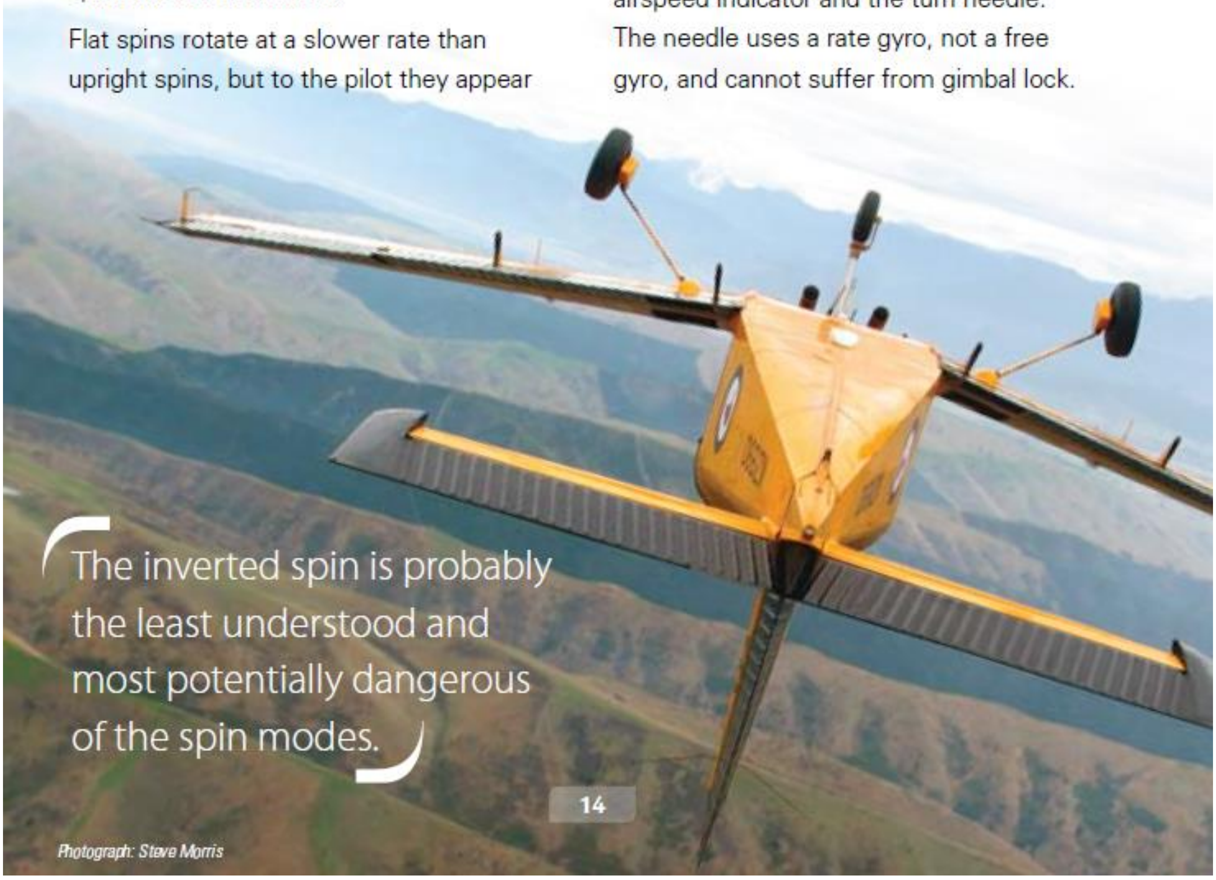
Most general aviation aircraft have design features that preclude a flat spin, but not all. Those that are prone to unintentional flat spins are likely to have an annotation in the Pilot Operating Handbook/Flight Manual that spins are not authorised.

Flat spins rotate at a slower rate than upright spins, but to the pilot they appear to be rotating much faster. That's because the pilot's line of sight is parallel to the horizon – you see much more going past. Yaw rates in a flat spin are usually very fast, but the rate of altitude loss per turn is usually less than in a steep nose-down spin.

Recovering from an established flat spin requires the nose to be forced down. In the initial stages of recovery, this will increase the rate of rotation, which can be disconcerting.

Spins in IMC

In Instrument Meteorological Conditions (IMC), pilots should rely primarily on the airspeed indicator and the turn needle. The needle uses a rate gyro, not a free gyro, and cannot suffer from gimbal lock.



Photograph: Steve Morris

The turn needle will indicate the direction of yaw, which will be the same as the direction of spin. During a spin to the left, the turn needle will show a turn to the left. The ball cannot be trusted. It is likely to be centrifuged away from the centre of the aeroplane and its reaction may depend on where it is mounted on the aircraft in relation to the centre of gravity.

Attitude and heading indicators should also be distrusted as either could have toppled or be confusing to interpret.

During recovery from a spin in IMC, the change in rotation will act upon the ear semicircular canals and create an illusion of spinning inthe opposite direction. This may well tempt the pilot to put the aircraft back into its original spin. The turn needle must be trusted implicitly during IMC spin recovery.

In IMC, rely on the turn needle to show direction of spin.

Inverted Spin

The inverted spin is probably the least understood and most potentially dangerous of the spin modes because an unintentional inverted spin is so confusing to the senses of sight and feel.

Unlike the conventional upright spin, where roll and yaw are in the same direction, in the inverted spin roll is opposite to yaw.

Because of the near overwhelming tendency to identify a spin by the direction of roll rather than yaw, the surest way to determine the direction of the inverted spin is by reference to the turn needle. The turn needle always acts as the yaw indicator in the spin.

The turn co-coordinator has a tilted gyro, which indicates both yaw and roll. It may give unreliable readings in an inverted spin, although its readings will be valid in an upright spin.

The ball should not be used because of its unreliability in different aircraft types.

It is often difficult to tell at the incipient stage if an upright or inverted spin will result.

The recovery actions for an upright spin will guarantee an inverted spin keeps autorotating. The recognition and recovery of the inverted spin is a specialised aerobatic skill, and is not described here.

In an inverted spin, only the turn needle (left) can be trusted to show the spin direction. The ball, and the turn coordinator (right) may give unreliable readings.

Spin **Recovery**

To have a chance at recovery, the pilot must immediately recognise the spin, and its direction, know exactly what to do in the right order, and then execute the procedure correctly the first time.

In most aircraft there is only about three seconds to do all this. The minimum altitude loss for a text-book recovery will be about 1000 to 1500 feet.

> The minimum altitude loss for a text-book recovery will be about 1000 to 1500 feet.

Direction of Spin

A serious problem in perceiving spin direction occurs when the pilot's attention is directed, perhaps unconsciously, to roll direction. The spin (yaw) direction will always be correctly indicated by the turn needle, as this reacts to rotation only in the yawing plane.

The turn co-coordinator has a tilted gyro. This indicates both yaw and roll and may give unreliable readings in an inverted spin, although its readings will be valid in an upright spin.

The ball cannot be trusted. It is likely to be centrifuged away from the centre of the aeroplane and its reaction may depend on where it is mounted on the aircraft in relation to the centre of gravity.

In an upright spin, both the turn needle and the turn coordinator will correctly indicate the direction of spin. The ball cannot be trusted.

Recovery Technique

Spin recovery does not follow a pilot's natural instincts.

Incipient Spin

Recovery from an incipient spin (a spin that has just started) requires instant recognition (critical at low level), an immediate check forward on the stick or control column (to unstall the wing) and sufficient opposite rudder to eliminate yaw and further wing drop. This must be instinctive. Be wary of pitching forward too much. Applying only sufficient forward stick or control column to unstall the wing ensures maximum lift is still being achieved and height loss is minimised. Jamming the stick or control column fully forward could make the aircraft enter an inverted spin. Similarly, only sufficient rudder to eliminate yaw should be used. Any more applied at high angles of attack may cause the aircraft to flick or spin the other way.

With control now restored, aileron may be used to reduce bank angle.

Developed Spin

In a developed spin, full deflection of controls is required. Although there is no universal spin recovery technique, one of the most widely used is PARES. Be warned that this technique may worsen a spin in certain aircraft. You should follow the procedures outlined in your aircraft's Pilot Operating Handbook/Flight Manual.

PARES Spin Recovery

P	POWER	off (close throttle)
	Identify you are in a spin and the direction of rotation	
A	AILERONS	neutral
R	RUDDER	full opposite to direction of spin… Pause
E	ELEVATOR	move stick or control column progressively and centrally forward until spin stops
	Perform steps sequentially – centralise when spinning stops	
S	Spin STOPS	rudder neutral and ease out of ensuing dive

22

Power

Check that the throttle is closed.
This decreases forces from the propeller that might tend to hold the nose up, flattening the spin and possibly blanketing the elevator. It will also keep the engine from overspeeding during later stages of the recovery.

Ailerons

Never use aileron in an attempt to roll out of a spin. The result could be a flatter, faster, steadier spin.

The most appropriate aileron position for recovery from an unintentional spin in most standard light aeroplanes is neutral.

Rudder

Identifying which rudder is opposite to the direction of spin is critical.

- Look at the turn needle. It does not lie. Do not trust the artificial horizon, heading indicator or the ball. A turn co-ordinator will indicate the direction of yaw (and therefore spin) in an upright spin, but it may not indicate the right direction in an inverted spin.
- Change your field of vision by sighting straight down the nose of the aeroplane. By doing so, you will see only the yaw component of the spin. Force yourself to look beyond the nose and observe the ground movement. The ground will appear to flow past the windshield – apply the rudder fully in the direction of this flow. In a left spin the ground moves in a blur to the right – use right rudder for the recovery.
- Sample the rudder pedals – feeling for the one that offers the most resistance. Press the heavier one all the way to the control stop. Unless you have a lot of experience in spinning a particular type of aircraft, this technique may be the most difficult of the three to implement during an unintentional spin. It is not uncommon to lock both feet on the rudder pedals during an unintentional spin. Consciously relaxing your feet improves your sense of feel and will also reduce your tendency to oppose the application of full opposite rudder.

25

Photo: John King

Elevator

Move the stick or control column progressively forward until the spin stops to reduce the angle of attack and unstall the aircraft.

Stops

Once the spin stops, centralise rudder and aileron and ease gently out of the dive.

oto: John King