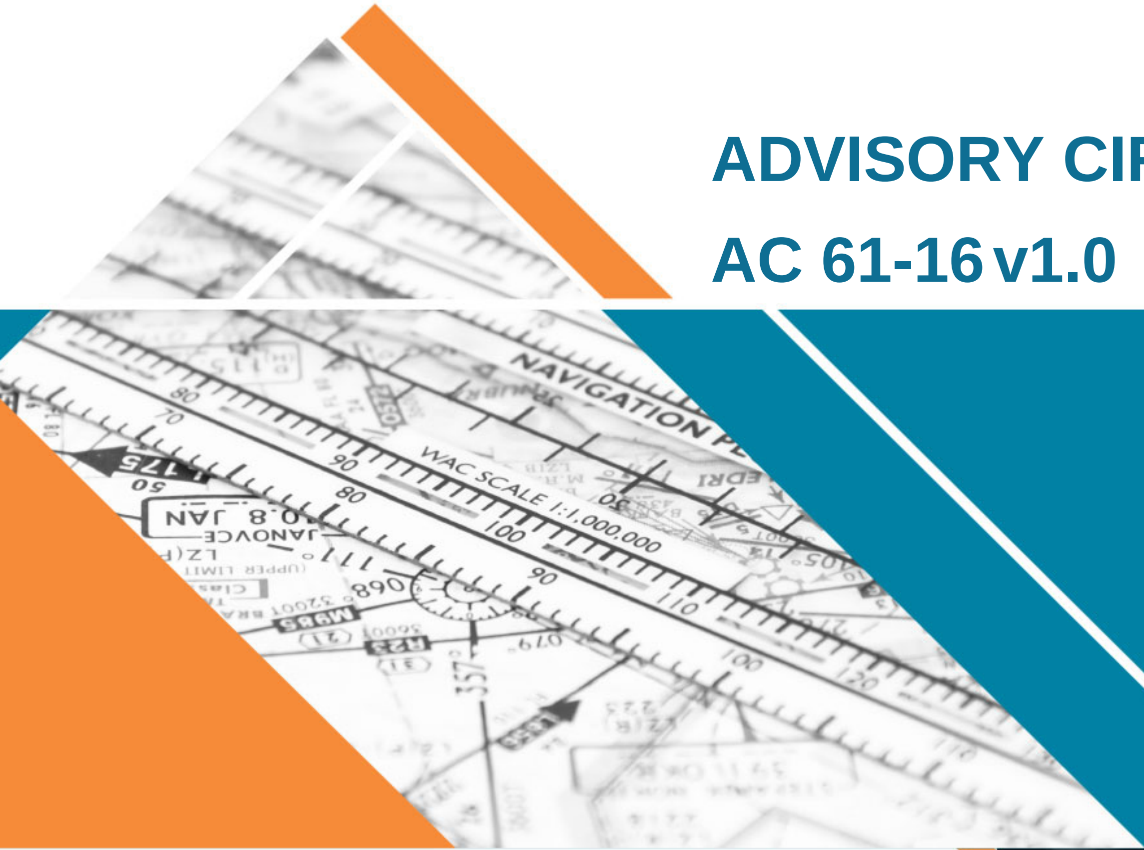
Australian Government
Civil Aviation Safety Authority



ADVISORY CIRCULAR
AC 61-16 v1.0

Spin avoidance and stall recovery training

Date	December 2019
File ref	D19/268466

Advisory Circulars are intended to provide advice and guidance to illustrate a means, but not necessarily the only means, of complying with the Regulations, or to explain certain regulatory requirements by providing informative, interpretative and explanatory material.

Advisory Circulars should always be read in conjunction with the relevant regulations.

Audience

This advisory circular (AC) applies to:

- pilots
- flight instructors
- Flying Training Organisations; in particular, heads of operations under
  - RAAus
  - Part 141
  - Part 142
- testing officers.

Purpose

This AC highlights the risks associated with advanced stalling training when conducted in aircraft that are not certified for intentional spinning. It clarifies definitions of wing drop at the stall and the incipient phase of a spin, and the interpretation of aircraft flight manual manoeuvre limitations with respect to spinning. It also provides guidance on acceptable methods of training and testing wing drop stalls and spins.

For further information

For further information, contact CASA's Flight Standards Branch (telephone 131 757).

Status

This version of the AC is approved by the Manager, Flight Standards Branch.

Version	Date	Details
v1.0	December 2019	Initial AC.

Unless specified otherwise, all subregulations, regulations, divisions, subparts and parts referenced in this AC are references to the *Civil Aviation Safety Regulations 1998 (CASR)*.

Contents

1 Reference material

1.1 Acronyms

The acronyms and abbreviations used in this AC are listed in the table below.

Acronym	Description
AC	Advisory circular
CAAP	Civil Aviation Advisory Publication
CAR	*Civil Aviation Regulations 1988*
CASA	Civil Aviation Safety Authority
CASR	*Civil Aviation Safety Regulations 1998*
FAA	United States of America Federal Aviation Administration
FAR	United States of America Federal Aviation Regulation
MOS	*Manual of Standards*
NACA	United States of America National Advisory Committee for Aeronautics

1.2 References

Regulations

Regulations are available on the Federal Register of Legislation website https://www.legislation.gov.au/

Document	Title
Part 61 MOS	1. Schedule 2 -Competency standards, Section 4: a. A5.2 Aeroplane advanced manoeuvres b. G5 Glider advanced manoeuvres c. LL-A Aeroplane low-level operations d. FAE-8 Spinning 2. Schedule 5 - Flight test standards: a. Appendix G.1 RPL Aeroplane category rating flight test b. Appendix H.1 PPL Aeroplane category rating flight test c. Appendix I.1 CPL Aeroplane category rating flight test d. Appendix L.1 Single-engine aeroplane class rating flight test e. Appendix Q.1 Low-level rating flight test f. Appendix R.1 Aerial application rating and aerial application endorsement flight test

International Civil Aviation Organization documents

International Civil Aviation Organization (ICAO) documents are available for purchase from http://store1.icao.int/

Document	Title
ICAO Annex 1	Personnel Licensing
ICAO (Doc 10011)	Manual on aeroplane upset prevention and recovery training

Advisory/Guidance material

CASA's advisory circulars are available at http://www.casa.gov.au/AC

CASA's Civil Aviation Advisory Publications are available at http://www.casa.gov.au/CAAP

Document	Title
CASA Flight instructor handbook	• 9 Stalling • 13 Spins and spirals
CASA Flight examiner handbook	• 5 Recreational pilot licence – aeroplane • 7 Private pilot licence – aeroplane • 9 Commercial pilot licence – aeroplane • 14 Class rating – single engine aeroplane • 17 Type rating – single engine aeroplane • 28 Low level rating • 29 Aerial application rating • 31 Flight instructor rating
CAAP 155-1(0)	Aerobatics
Civil Aviation Authority of New Zealand Flight Instructor Guide	Advanced Manoeuvres - Wing-drop Stalling
FAA FAR Part 23 (to August 2017 – pre-amendment 64)	• 23.3 Airplane Categories • 23.201 Wings level stall • 23.203 Turning flight and accelerated turning stalls • 23.221 Spinning
FAA FAR Part 23 amendment 64	§23.2150 - Stall characteristics, stall warning, and spins
FAA AC 61-67	Stall and Spin Awareness Training
FAA Accepted Means of Compliance	Part 23 Airplanes (Amendment 23-64)
FAA AC 23-8C ACE-100	Flight Test Guide for Certification of Part 23 Airplanes
FAA AC 23.15A	Small Aircraft Certification
FAA AC 120-109A	Stall Prevention and Recovery Training
FAA Accepted Consensus Standards	Light-Sport Aircraft
FAA-RD-77-26	General Aviation Pilot Stall Awareness Training Study
ASTM F2245	12d Design and Performance of a Light Sport Airplane1
EASA_REP_RESEA_2008_3	Safety Aspects of Light Aircraft Spin Resistance Concept

Document	Title
Research Project	
Aircraft Flight Manuals and Pilot Operating Handbooks	

2 Introduction

This advisory circular (AC) provides important warnings regarding the risks associated with advanced stalling training, when conducted in in aircraft that are not certified for intentional spinning and urges caution. It also:

- provides knowledge of flight manual limitations, and of entry and recovery actions in those aircraft that are certified for intentional spinning
- clarifies the definitions of 'wing drop at the stall' and the 'incipient phase of a spin', and the interpretation of aircraft flight manual manoeuvre limitations with respect to spinning
- provides guidance to pilots, flight instructors, flying school operators and testing officers on acceptable methods of training and testing stalls with a wing drop and minimises the potential for negative training transfer
- describes policy consistent with ICAO and international aviation regulators regarding spin avoidance and stall recovery training standards for licensing and upset prevention and recovery training.

Stalling and spinning are aerodynamic phenomena as old as aviation itself and remain common causes of fatalities due to departures from controlled flight in all categories of aeroplanes. Unrecognised stall or poor recovery technique continue to be contributing factors even in transport category accidents.

Stall - spin related accidents continue to account for approximately one-quarter of all fatal general aviation accidents worldwide, many during dual instruction. The majority of unintentional spins other than during dual instruction occur at altitudes too low for recovery, generally on climb after take-off and turns onto final approach.

Recent fatal accidents involving spins in training aircraft suggest a lack of instructor and flying training organisation understanding of aircraft limitations as applied to the advanced stall with wing drop air exercise, and training in recovery from a spin at the incipient phase. In particular, it appears that spinning has been actively induced in aircraft not certified for intentional spinning with the intention of teaching recovery from 'incipient spin', and that understanding of incipient spin and wing drop at the stall has been confounded over time.

3 Background

Recent stall-spin accidents[1] during flight instruction and student solo exercises have highlighted that:

- Incipient spin flight training is being conducted in aircraft which are not certified for intentional spinning.
- Aeroplane flight manual manoeuvre limitations may not be well understood with regard to spinning.
- Demonstration of recovery from spins at the incipient phase is likely being initiated by application of full rudder at the stall.
- Inducing a spin in an aircraft not certified for intentional spinning may consume the margins of safety provided by the aircraft's certification standards

[1] Examples of stall-spin accidents may be found in ATSB Transport Safety Reports, Aviation Occurrence Investigations:

- AO-2017-096, Collision with terrain involving Diamond DA40, VH-MPM, 42 km west of Southport Aerodrome, Queensland, 26 September 2017.
- This report also cites:
    - Occurrence 201704820 – VH-YTE – S.O.CA.T.A. – Groupe Aerospatiale TB-10
    - Occurrence 201403058 – VH-EZT – Czech Sport Aircraft – PIPERSPORT
    - AO-2018-066 Collision with terrain involving BRM Aero s.r.o. Bristell S-LSA, VH-YVX, near Stawell, Victoria, on 5 October 2018
    - AO-2014-083 Loss of control involving a Cirrus SR22, N802DK, near Katoomba, NSW on 10 May 2014
- Collision with terrain involving BRM Aero s.r.o. Bristell, 24-7954, near Clyde, Victoria on 3 August 2011
- Collision with terrain involving PIPER Sport Cruiser, near Bundaberg, Qld, on 19 March 2012

4 The historical requirement for training in the recovery from a spin at the incipient phase

Recovery from the incipient phase of a spin has been included in advanced stall training due to the probability of stall, wing drop and spin occurring during slow flight, unusual manoeuvres and icing conditions. In particular, trim changes and turns on departure, go around and onto final approach are situations where recognition of approaching stall and avoidance, or swift recovery, are critical.

In Australia, recovery from a spin has long been a test requirement for pilot licences. Training syllabuses have catered for this requirement since Robert Smith-Barry's training doctrine of 1917, which 'clearly stressed that students were not to be led away from potentially dangerous manoeuvres but were instead to be exposed to them in a controlled environment in order that the student could learn to recover from instinctive errors of judgement.' The 1937 Air Navigation Regulations required that, before a person could undergo the practical flying tests for the issue of a Private Pilot's Licence, he had, 'without assistance from his instructor, caused an aircraft to spin and to recover from the spin on three separate occasions.' General flying manoeuvres from the 1982 syllabus of training for the issue of the Commercial Pilot Licence required a student to 'enter and recovery from the spin at the incipient stage'. The 1997 VFR Day Syllabus and 2014 CASR Part 61 MOS call for 'incipient spin recovery' to be trained and tested for the issue of recreational, private and commercial pilot licences.

International experience of fatalities resulting from accidents during stall and spin related training has caused ICAO training and testing requirements to change from induction and recovery from spins to 'flight at critically slow airspeeds; spin avoidance; recognition of, and recovery from, incipient and full stalls'.

5 Definitions of stall and spin

A stalled condition can exist at any attitude and airspeed, and may be recognized by continuous stall warning activation accompanied by at least one of the following:

- an uncommanded nose-down pitch that cannot be readily arrested, which may be accompanied by an uncommanded rolling motion (wing drop at the stall)
- buffeting of a magnitude and severity that is a strong and effective deterrent to further increase in AOA
- no further increase in pitch occurs when the pitch control is held at the full aft stop for 2 seconds, leading to an inability to arrest descent rate.

5.1 Wing drop at the stall

Wing drop at the stall is the observation of the departure from symmetrical lift when one wing stalls before, or further than, the other — roll is the main motion observed. The aircraft is not yet spinning, and the recovery technique is to break the stall using the elevator while preventing yaw with rudder. Inaction, or mishandling of recovery from a wing drop is likely to result in spin entry.

In the stalling exercise the phrase 'don’t pick up a dropped wing with aileron' due to the likelihood of further stalling the down-going wing and inducing a yaw is consistent with spin avoidance training.

Wing drop is tested under stalling certification standards. After the airplane has stalled it must be possible to regain wings level flight by normal (coordinated) use of flight controls without an uncontrollable tendency to spin.

6 Spin

A spin is a sustained autorotation at angles of attack above the stall, the stall being the aerodynamic loss of lift caused by exceeding the critical angle of attack.

In a spin, the stalled aircraft is yawing toward the down-going wing which has a greater angle of attack beyond the stalling angle, producing more drag than the upgoing wing, causing the aircraft to roll, yaw and pitch while describing a downward corkscrew path about a vertical axis.

6.1 Phases of a spin

The spin is commonly categorised in four phases; entry, incipient, developed, and recovery. No two aircraft will spin the same way; descriptions of spin phases and methods of recovery in this publication are necessarily generalised. However, themes common to spinning in most aircraft used for training are represented here.

6.1.1 Entry phase

Also known as the transition phase between the stall, the departure from controlled flight, and the incipient phase, the entry phase is the commencement of autorotation.

From balanced flight — this can be level or accelerated (where the wing must provide more lift than in level flight, as occurs when turning or pulling up from a dive) or in approach configuration — if the yaw produced following a wing drop at the stall is not arrested with sufficient opposite rudder, the aircraft will yaw towards this wing and enter a spin. Uncoordinated use of the ailerons to pick up a dropped wing is also likely to more deeply stall the down-going wing.

To deliberately enter a spin, full rudder used at the stall from balanced flight will induce a yaw which, if the rudder and backpressure are held, will rapidly accelerate to autorotation.

Uncountered wing drop or deliberate application of rudder at the stall are both likely to cause the aircraft to enter a spin as lift begins to decrease but drag increases rapidly on the downgoing wing due to its higher angle of attack.

Spin can still be avoided in this phase by breaking the stall with elevator and with coordinated use of rudder and aileron to bring the aeroplane back to wings-level.

6.1.2 Incipient phase

The incipient phase of the spin is the period between the commencement of autorotation and the developed, stable or steady phase of autorotation. The incipient phase of a spin will persist for two to four rotations until pitch, roll and yaw oscillations develop into relatively steady and predictable periods. During this phase yaw is produced by the unequal lift and drag on each wing and may be supplemented with yaw produced by the vertical stabiliser and rudder . The aeroplane has departed controlled flight and the accelerating yaw, pitch and roll will require prompt anti-spin recovery control inputs appropriate to the aircraft being flown to initiate recovery to a dive from the spin.

Some aircraft will recover into a dive from the incipient phase of a spin by relaxation of pro-spin controls; other aircraft exhibiting some spin-resistant characteristics may not accelerate into autorotation and may respond conventionally to control inputs in uncoordinated, unaccelerated stalled flight. Many aircraft exhibit spiral tendencies as the elevator's upward travel is restricted to prevent the entire mainplane from remaining in a stalled condition in unaccelerated flight.

The ability to recover with anti-spin control inputs, or to fly out of the stalled condition when controls are centralised, is the safety margin to which normal and utility category aircraft not certified for intentional spinning are tested. They must be able to recover from a one turn or three second spin, induced and maintained with full elevator and rudder application from the stall, within one turn of recovery control inputs, or have been shown to be resistant to spinning and controllable in the unbalanced stalled condition.

6.1.3 Developed or steady phase

In the developed or steady phase, the aerodynamic forces caused by the consistently held rudder, elevator and (usually) neutral aileron are balanced by the gyroscopic forces due to the rotation of the aircraft, causing a steady autorotational state. Flight control and power inputs will affect the rate of motion in one or more axes, but the aircraft is likely to continue to spin until specific recovery actions are taken.

Aircraft are usually designed to spin with a steep nose down attitude which keeps the angle of attack of the wing, though stalled, relatively low and the empennage surfaces unstalled and effective. This enables standard spin recovery control inputs to place the aircraft in a dive.

Rearward centre of gravity, use of aileron or power are likely to increase the already stalled angle of attack and 'flatten' the spin, which may also push the tail of the aircraft further from the axis of rotation of the spin and, in turn, stall the empennage surfaces and require different initial recovery control inputs until it steepens again, or may render the spin unrecoverable.

6.1.4 Recovery phase

Aeroplane design, capacity and loading characteristics have changed considerably since the following standard recovery actions were published by NACA in 1936:

a. Power idle
b. Ailerons neutral
c. Rudder opposite to the direction of spin and held
d. Elevator briskly through neutral
e. Hold these positions of controls until recovery is effected.

Rudder is neutralised after spin rotation stops, and the aircraft may be recovered from the ensuing dive.

While spin recovery actions are similar to the above for most aircraft, some may require different timing and order of inputs as found through flight and certification testing. Any differences from these actions will be published in an aircraft's flight manual and pilot operating handbook. Manoeuvre limitations and procedures for entry and recovery from spins are also listed in the aircraft flight manual.

Normal, utility or aerobatic aircraft certified for intentional spinning have been tested to be recoverable from a six-turn spin; light sport aircraft from a three-turn spin, within one and a half turns of recovery control application. In these aircraft a recoverable spin may be safely induced from a slowly and deliberately entered level stall with application of full rudder when the aircraft is loaded and handled in accordance with the aircraft flight manual.

6.2 Wing drop versus spin at the incipient phase

Arguably the terms 'incipient spin' and 'wing drop' have been used interchangeably over the years, leading to the understanding that, while teaching the incipient spin or wing drop exercise, the aircraft could be expected to roll off through the wing drop, and then yaw through a significant portion of a revolution of the incipient phase of a spin before spin recovery inputs are demonstrated.

Given the above definitions, use of the term 'recovery from a wing drop' does not suggest the commencement of autorotation before initiating recovery. Wing drop at the stall is more likely in some aircraft types than others and is generally easily countered by breaking the stall with elevator while preventing yaw with rudder.

Wing drop may occur through uncountered imbalance during the stall manoeuvre in association with the normal characteristics of the aircraft; rigging and asymmetry, flap and power, outboard angle of attack changes, aileron inputs, and the natural effects of slipstream as the aircraft decelerates. Induction of a wing drop by intentional application of rudder at the stall will result in accelerated yaw, with almost simultaneous roll and pitch change – the entry to a spin. The first method is an extension of the stalling exercise and a realistic demonstration of the precursor conditions and motions to the typical stall-spin incident; the second the induction of a spin.

7 Spin avoidance versus spin recovery

A wing drop at the stall may be recovered from with proactive stall recovery control inputs — this is stall recovery and spin avoidance. Failure to recover from the wing drop at the stall may result in spin entry.

By the incipient phase, a yaw has been allowed, or caused, to develop and accelerate. The aircraft has passed through the spin entry phase, whether from unrecovered stall with a wing drop or with pro-spin control inputs, and may require recovery with different, spin recovery control inputs.

7.1 Spin avoidance training for the issue of a licence

ICAO documents — Annex 1 personnel licensing, and Manual of upset prevention and recovery training — refer to spin avoidance rather than spin recovery, and require recognition of, and recovery from, approaching and full stalls. The concepts delivered in training are:

- Prevention - Timely action to avoid progression toward a potential upset.
- Recognition - Timely action to recognize divergence from the intended flight path and interruption of progression toward a potential upset.
- Recovery - Timely action to recover from an upset.

US FAA and European agencies' practical slow flight and stalling exercises focus on stall and spin avoidance and recommend distraction of the student in slow flight to provide a realistic approach to inadvertent stall-spin conditions, rather than conducting intentional spin entry.

This approach to training has the further benefits of not introducing control inputs which may result in negative training such as the application of pro-spin control inputs in order to learn recovery inputs. Neither does this method introduce control inputs for which an instructor, student, or any pilot should not practice without holding a spinning or spinning training flight activity endorsement.

7.1.1 Intended training outcomes

The purpose of spin avoidance and stall recovery training, whether for ab-initio training or as part of upset prevention and recovery training for experienced pilots, is to deliver the experience, knowledge and skills required to fly at speeds below the speed for minimum drag, and to recognise and recover from approaching stall and full stall including wing drop at the stall in the context of situations in which it is most likely to occur.

The training should be scenario-based to show the situations in which stall and spin incidents most commonly occur, with emphasis placed on characteristics of each flight regime, symptoms of impending departure from controlled flight, and the consistent method of recovery to controlled flight.

Common situations from which fatal stall/spin accidents occur are

- Climb:
  - flap retraction
  - climbing turns

- Turns onto approach, particularly when overshooting the runway centreline
- Unanticipated pitch changes from approach configuration trim when transitioning to a climb during a go-around
- Engine failure after take-off
- Slow flight
- Low flight
  - wind illusions
  - terrain avoidance manoeuvres
  - false visual horizons.

7.1.2 Distraction and human factors

Distraction multiplies the risks in any of these situations, highlighting the need for accurate trim and balance to minimise control workload and maximise feel for control forces while attention is directed at multiple activities. Intentional distraction by the instructor during these scenarios at safe altitudes also delivers valuable experience and motivation for maintaining flight discipline and situational awareness.

An intentional spin is not induced during spin avoidance training. Spin avoidance training is part of the advanced stalling exercise where the aircraft is placed in the configuration most likely to cause a wing to drop. At the wing drop the rudder is used to prevent yaw. Elevator remains the primary control used to unstall the wing, and balanced aileron may be used to return the aircraft to the desired flight path once the wing is unstalled.

7.1.3 Human factors and upset prevention and recovery training

Counter-intuitive control inputs may be required in spin avoidance and stall recovery such as pushing forward on the controls at low level to break a stall or to unload the wing to regain aileron effectiveness. Human factors must be considered in training these skills to avoid poor decision making and reduce the effects of counter-productive reflexes and responses at the moment of stress by providing exposure to, and coping strategies for, the scenarios mentioned above.

Through experience and positive outcomes delivered during training the following can be mitigated:

- Stress - The physiological, emotional and cognitive response to a perceived threat.
- Startle - A reflex, or involuntary and almost instantaneous response, to a sudden, threatening stimulus (such as a wing drop at the stall) which causes muscle reflex action, increased heart rate and increased blood pressure in preparation for a 'fight or flight' reaction to a surprise.
- Surprise reaction - Subsequent to the startle reflex, a response to an unexpected event which violates a pilot's expectations. The surprise reaction may also be known as the startle response; fight, flight or freeze.
- Disorientation - Conflict between visual, vestibular and proprioceptive inputs to the brain which prevent making sense of which way is up and rotation in the three planes.

Upset prevention and recovery training (UPRT) provides the exposure, and subsequent strategies to recover from stressful and unfamiliar situations by, at least to some extent, normalising the unusual attitudes and motions in a stall and wing drop, and providing opportunity to safely practise the counter-intuitive responses required to recover from them if they are not avoided.

7.1.4 Who may conduct spin avoidance training for the issue of a licence

A spinning flight activity endorsement, required for the issue of a grade 3 training endorsement (aeroplane), is required for an instructor to conduct spin avoidance training.

7.1.5 What aircraft may be used for spin avoidance training

Aircraft approved for intentional spinning are recommended for spin avoidance training.

Utility and normal category aircraft, and light sport aircraft not approved for spinning may be used for the advanced stalling exercise including stall with a wing drop as defined above, however the margin of safety in the event of mishandled recovery from a stall with a wing drop is smaller.

Recent accidents have shown that some normal category aircraft and light sport aircraft may not exhibit departure characteristics desirable for training purposes. Ensure any aircraft type used for spin avoidance training has proven recoverable from spins at least at the incipient stage.

7.2 Spinning and spin recovery training for exposure, refresher training, or the issue of an endorsement

Spin recovery training is highly recommended for any pilot at any level of licence or experience and is worth revision at any stage of a pilot's career.

Exposure to the characteristics of each phase of a spin, understanding the counter-intuitive control inputs required for recovery from each phase, and observation of height loss required for recovery from each phase are valuable deterrents to spin entry, and powerful motivation for attitude and speed monitoring and situational awareness at slow speeds, low altitudes and in high workload situations.

Training in the entry and recovery of spins is an independent flight activity endorsement. It is required as part of aerobatics training as a manoeuvre of its own, and also due to the likelihood of entering a spin as a result of "falling out" of other aerobatic manoeuvres.

Entry and recovery from inverted spins is not a part of the spinning flight activity endorsement.

7.2.1 Who may conduct spinning and spin recovery training

A spinning training flight activity endorsement is required for the conduct of spinning and spin recovery training.

A spinning flight activity endorsement is a prerequisite for the issue of a spinning training flight activity endorsement.

7.2.2 What aircraft may be used for spinning and spin recovery training

Spinning and spin recovery training must be conducted in aircraft approved for intentional spinning.

Aerobatic aircraft are approved for intentional spinning. Some utility and normal category aircraft, and a few light sport aircraft, are approved for intentional spinning.

Certification for intentional spins will be stated in the aircraft flight manual, along with any entry and recovery inputs particular to that aircraft.

8 Aircraft stall and spin certification requirements

8.1 Stall certification requirements

Aircraft certified in the normal and light sport aircraft categories but not certified for intentional spinning may be used for the stalling exercise in level flight and in turns up to 30º angle of bank. Where the aircraft exhibits wing drop at the stall during certification it must be possible to regain level flight by normal use of the flight controls.

These aircraft have also been tested to ensure they have a safety margin from mishandled stall recovery, having been recovered from a 1 turn or 3 second spin (whichever occurs sooner) induced using full elevator and rudder application at the stall, or having been shown to be resistant to spinning and controllable in the unbalanced stalled condition.

Inducing a spin at the stall in a normal or utility category aircraft not certified for intentional spinning using application of full pro-spin rudder may consume that category's safety margin and place the aircraft in an untested or unrecoverable state. For this reason, manufacturers of these aircraft prohibit intentional spinning.

A utility category aircraft or light sport aircraft certified for limited aerobatics but not approved for spinning must be treated as a normal category aircraft not approved for spinning with respect to the stalling exercise; i.e. remaining in balance at the stall to avoid inducing a spin, as it only has the safe margin of a single spin or 3 seconds of autorotation before potentially being unrecoverable.

8.2 Spinning certification requirements

Several categories of aircraft may meet certification requirements for intentional spinning. However, with the exception of aerobatic category aircraft, the flight manual must be consulted to confirm whether intentional spinning is permitted.

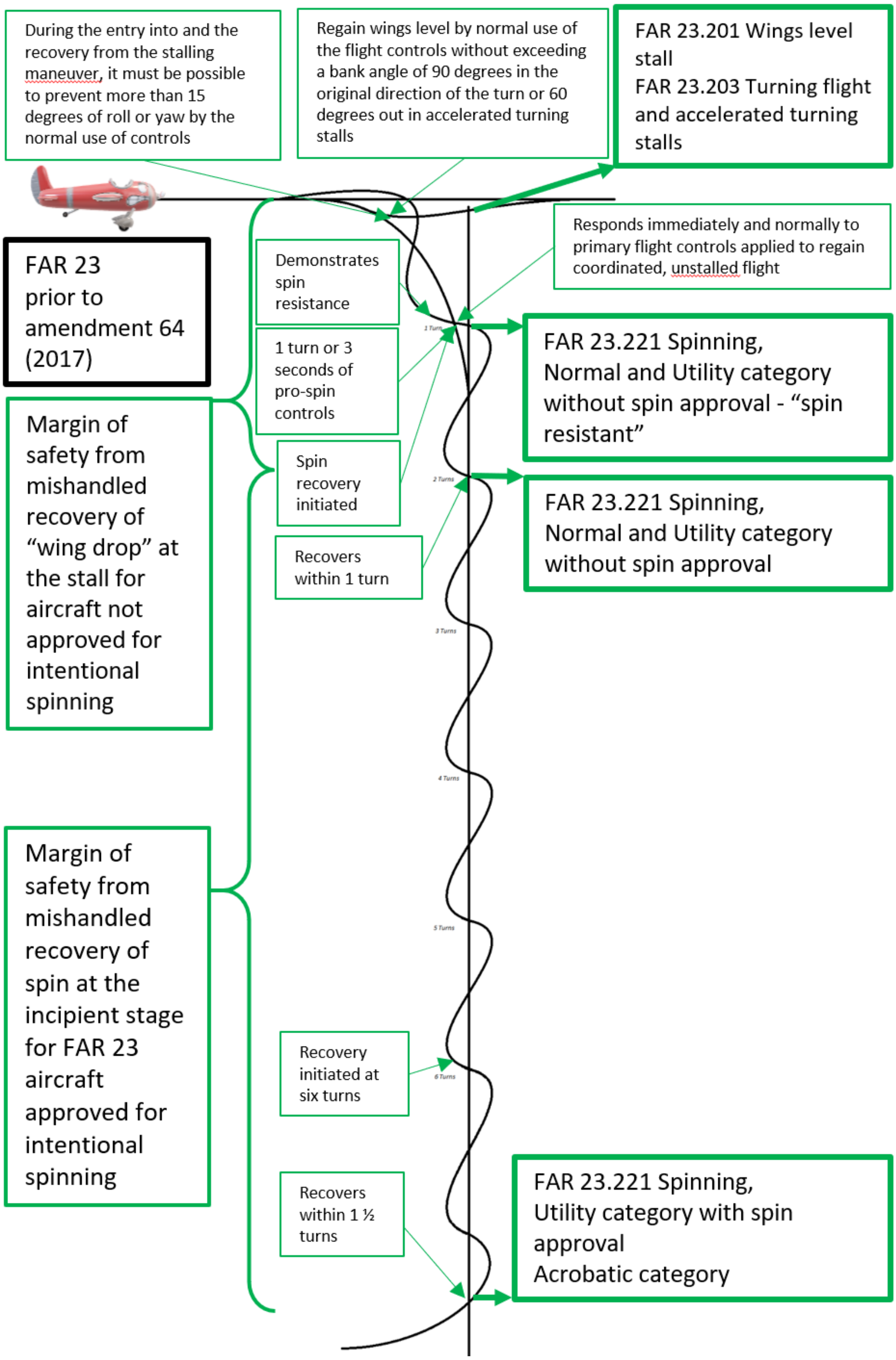
- Aerobatic (aka acrobatic) category aircraft has been tested to be recoverable from a six-turn spin within one and a half turns. A spin may be safely induced at the stall with application of full rudder.
- Utility category aircraft certified for limited aerobatics including spinning may be intentionally spun.
- Normal category aircraft certified before 2017 are not certified for intentional spinning

Note: Changes to certification standards in 2017 abandoned the utility category. Intentional spin certification for normal and aerobatic category aircraft continues to require a six-turn spin excepting that, beyond three turns, the spin may be discontinued if spiral characteristics appear. It is common for light aircraft to exhibit spiral characteristics; the wings unstalling at some point after entering the spin and the aircraft accelerating into a spiral dive with rapidly increasing airspeed.

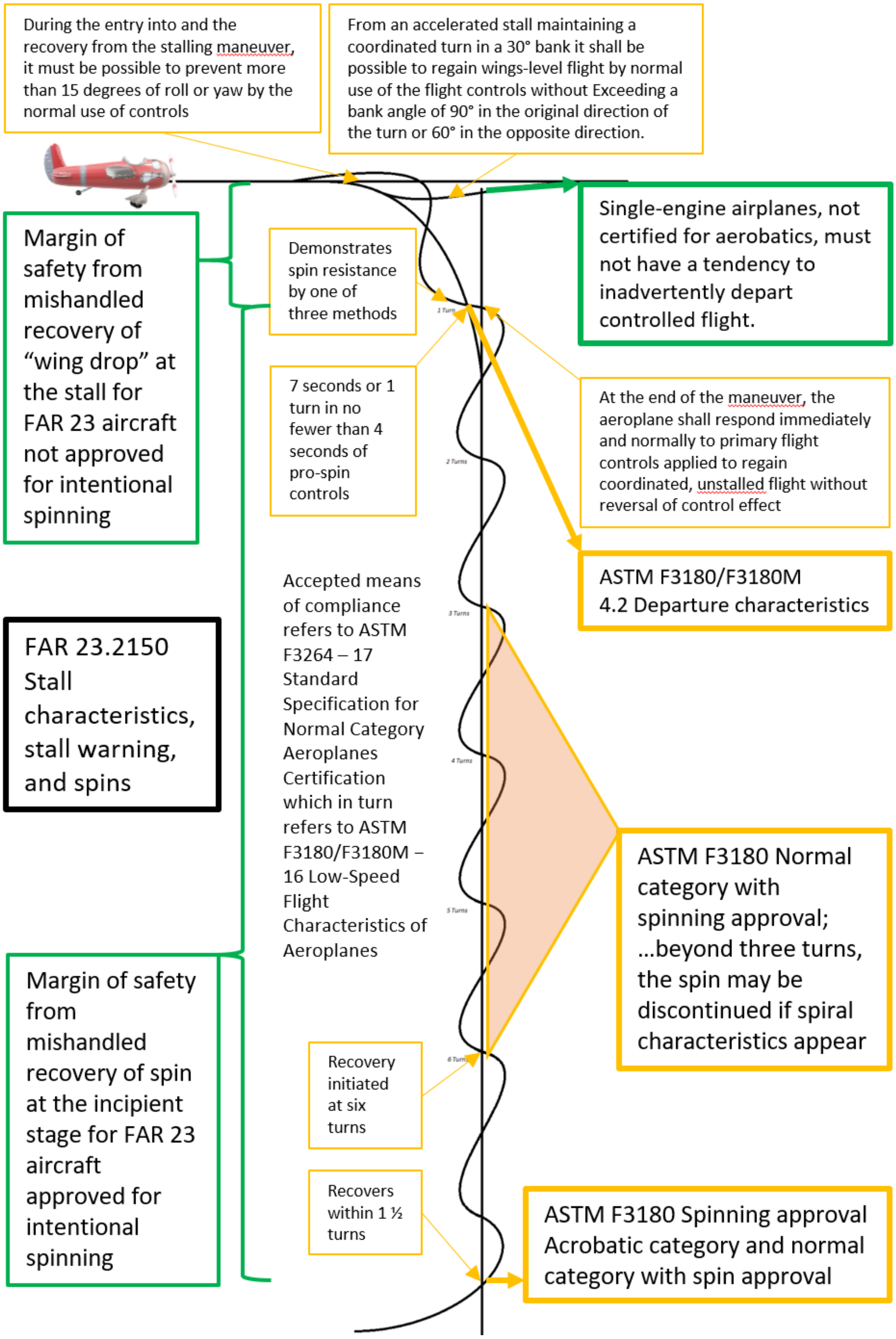
- Normal category aircraft certified after 2017 may be certified for intentional spinning - refer to the aircraft flight manual
- Light Sport Aircraft approved for spinning are required to be recoverable from a three-turn spin within one and a half turns. While a light sport aircraft may be certified for intentional spinning careful attention must be paid to flight manual requirements with respect to the entry and recovery technique and timing.

- Ultralight aircraft are not approved for intentional spinning and are not required to be tested for spinning during certification.
- Multi-engine aircraft are not approved for intentional spinning. The departure characteristics of a multi-engine aircraft from a developed stall are not as predictable or recoverable as single engine aircraft.

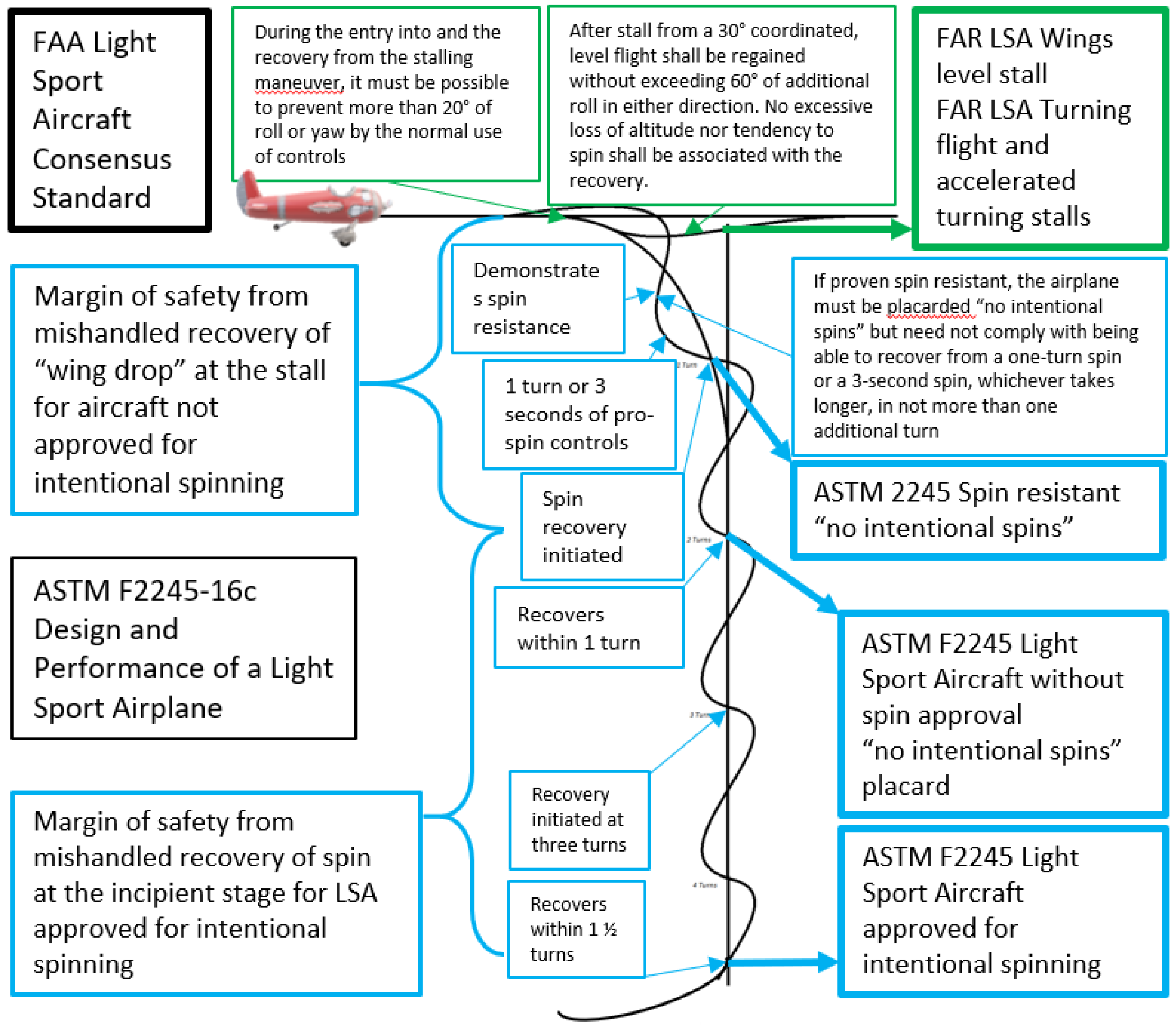
8.3 Diagrams of stall and spin certification requirements



US FAA Part 23 Normal, Utility and Aerobatic



FAA Part 23 (post-amendment 64) Normal and Aerobatic



FAA Light Sport Aircraft

8.4 Spin resistance

Light aircraft manufacturers have since the late 1970s been concentrating on the development of aircraft which exhibit high controllability at the stall and resistance to entering a spin through the use of aerodynamic features such as leading edge discontinuity, leading edge droop on the outboard sections of the wing, and slotted ailerons, in addition to the washout conventionally built into the wing. Many popular modern designs in use at schools worldwide exhibit some or all of these features.

Research and experience are revealing that 'features in this design intended to make the aircraft spin resistant are detrimental to spin recovery, to the extent that aircraft may not meet the original requirements which only deal with spin recovery.

'Based on limited evidence to date, the spin resistance and spin recovery itself appear to be mutually exclusive; good characteristics in one or the other can be achieved, but not both at the same time' (EASA 2008).

Ballistic parachutes that reduce vertical speed to survivable rates are also becoming a certified spin recovery feature of recently manufactured aircraft. Their use results in significant damage to the aircraft on deployment and on impact with the ground. Use of the ballistic parachute will be described in the aircraft flight manual.

8.5 Spin severity

Stall and spin certification requirements call for specific rates of deceleration approaching the stall and deliberate (not abrupt) inputs at spin entry, which may not reflect actual inputs during inadvertent entry, particularly with respect to elevator and aileron application by a surprised pilot. A spin entered with abrupt inputs or from an accelerated state; for example, from a steep turn, may result in a mode of spin not tested and potentially unrecoverable.

For this reason, and the above observation regarding spin resistant characteristics in some aircraft, a spin achieved in an aircraft with spin-resistant characteristics is much less likely to be recoverable.

Although the downward pitch angle during a spin may vary between aircraft types and be influenced by many factors, pilots generally discuss one of two modes of spin: nose down, which is usually recoverable; or with a higher nose attitude commonly called 'flat', which is more difficult, or impossible, to recover from. Historically, training aircraft have been designed to exhibit nose down spin characteristics. The many airframe, load, manoeuvre and control input variables which determine which mode of spin an aircraft will enter on departure from controlled flight require significant time and budget to test. A utility category aircraft approved for intentional spinning will likely have been spun during certification in many different flight regimes and in each direction, amounting to hundreds of spins during design, construction and certification.

Light Sport Aircraft standards have been made simpler and less costly to comply with by reducing the amount of testing specified before a manufacturer may bring a new aircraft to market at a lower price point than more thoroughly tested normal and utility category certified aircraft. Despite the requirement for an aircraft to not exhibit an uncontrollable tendency to spin after the aeroplane has stalled, some light sport aircraft may demonstrate stall characteristics in which a wing drop can rapidly and unpredictably result in an unrecoverable spin entry, particularly in accelerated stalls.

Before selecting an aircraft for stalling or spinning training, consult with the manufacturer and other users to establish what manoeuvres are safe to conduct, including steep turns, stalls, stalls with a wing drop and spinning.

9 Flight manual manoeuvre limitations for training aircraft in use in Australia

Flight manuals for many older training aircraft permit spinning when the aircraft is operated in the utility category (restricting the centre of gravity to a lighter, shorter and more forward range), while others expressly prohibit intentional spinning.

It should be noted that aircraft flight manuals indicate manoeuvre limitations in different formats. Some may appear to be silent on spins in the manoeuvre limitations section but state the prohibition on placards which may appear at other locations in the manual, rather than in the limited or permitted manoeuvres list.

Some aircraft have been prohibited from spinning later in their service lives. The warning may be placarded in the cabin of later models by the manufacturer or during maintenance in operational aircraft via Airworthiness Directive. These warnings may not appear on the same page in the flight manual as the manoeuvre limitations.

Placards may sometimes fail to be present in older aircraft due to wear and tear, or may not have been retrofitted as new limitations are placed on existing aircraft (eg AD/PA-28/54 Spin Prohibition Placard 2/75 and AD/AA-1/13 Stall and Spin Placards - Installation 8/73).

Where aircraft equipment has been replaced or modified the position of the new centre of gravity may cause difficulty when loading the aircraft to remain within the utility category limits to assure recoverability from a spin at the incipient stage. Flight Manual supplements should also be consulted, and modifications and their effects noted, before undertaking spinning activities, or when choosing an aircraft for flight training.

Some newer generation normal category and light sport aircraft used for training have not been evaluated to meet intentional spin recovery requirements and are not certified for spinning. Flight manuals for these aircraft will contain statements indicating spinning is prohibited.

If a light sport aircraft is certified for limited aerobatics including intentional spins, the flight manual should contain very specific limitations and instructions regarding spin entry and recovery.

Some aircraft are permitted to spin only with an approved 'spin kit' installed, which may include wheel spats, tail strakes, stall strips, vortex generators, additional ballast placement and other requirements. Pre-flight inspection should include a check of all 'spin kit' provisions before spinning is conducted.

10 Guidance for specified personnel providing training

The following guidance is intended for pilots, instructors, flying training organisation key personnel, and flight examiners to safely operate training aircraft in slow flight and at the stall for the purposes of satisfying courses of training and licence testing in spin avoidance and stall recovery.

10.1 Pilots

- Only induce spin (including the incipient stage) in aircraft certified for intentional spinning.
- Only practice stalls using slow deceleration to the stalling or minimum steady flight speed.
- Wing drop may accompany stalls and is permissible in aircraft not certified for intentional spinning, but wing drop should not be confused with spin induced with pro-spin application of rudder at the stall.
- Recovery from a stall with a wing drop prevents the aircraft from entering a spin. It is spin avoidance.
- Prior to spinning any aircraft:
  - Comply with aircraft flight manual limitations, placards and, if provided, procedures and advice for each intended manoeuvre.
  - Check the aircraft weight and balance to be sure you are within the approved envelope for stalls or spins.
  - Obtain thorough instruction in spins from an instructor fully qualified and current in spinning that model.
  - Conduct clearing (HASELL) checks.
  - Enter each spin at a high altitude. Plan recoveries to be completed well above the minimum legal altitude.
  - Conduct all spin entries and recoveries in accordance with the procedures recommended by the manufacturer.
- Avoid unintentional spinning
  - Practice slow flight and the transition between airspeeds, ensuring control of angle of attack, and that the aircraft is trimmed as quickly as possible after the desired speed is reached.
  - Maintain rudder coordination at all times (unless intentionally slipping in a crosswind or to lose altitude at a constant speed). If you demand coordinated flight from yourself at all times, you'll instinctively apply the proper rudder to remain coordinated at high angles of attack.
  - Practice stalls regularly with a qualified instructor to be more likely to detect impending stalls during distracting situations. This includes realistic presentation of stalls from power-off glides and last-minute baulked landings/go-arounds, to simulate the situations that typically lead to stalls.
  - If you find yourself low on glidepath, add power to reduce the rate of descent, instead of raising the nose to try to 'stretch' your glide.

   - Add power before raising the nose during a baulked landing or missed approach and be aware of prior trim setting causing pitch up.
   - In all procedures, employ precise power and pitch attitude control to avoid high angle of attack conditions.
   - Use slightly lower pitch attitude targets at high aircraft weights and/or high density altitudes.

10.2 Instructors

- Do not apply rudder to induce a wing drop at the stall - adopt a configuration which promotes the aircraft's tendency to drop a wing at the stall.
- Only induce spin (including the incipient stage) in aircraft certified for intentional spinning.
- Always consult the aircraft flight manual for manoeuvre limitations and entry and recovery procedures for manoeuvres including stalling and spinning.
- Even if the particular aeroplane normally does not 'drop a wing' during the stall the correct stall recovery technique should be taught from the start.
- Before commencing the stalling exercise, finesse trimmed, balanced slow flight at less than minimum drag speed in each configuration.
- The Civil Aviation Authority of New Zealand's Flight Instructor Guide offers some methods to encourage the wing drop in the advanced stalling exercise:
   - 'At the stall, altitude is lost, the nose pitches down, and one wing may drop. If the aeroplane is reluctant to drop a wing at the stall, alter the power and flap combination (refer CFI) and relax rudder pressure to simulate the pilot’s failure to maintain directional control.
   - Alternatively, a gentle turn may be required (5 degrees angle of bank).
   - There is nothing underhand about these techniques, as permitting the aeroplane to yaw or stall in the turn are possible causes of a wing drop stall'.
- To recover from a stall with a wing drop:
   - Apply forward movement of the control column to unstall the wing.
   - Apply rudder to prevent the nose of the aeroplane yawing into the direction of the dropped wing.
   - The ailerons should be held neutral until control is regained, when the wings should be levelled using coordinated inputs.
   - Apply power and adopt an attitude to minimise further height loss. With experience, power may be introduced earlier in the recovery sequence.
- Use of light sport aircraft for the steep turn, stalling, wing drop or spinning exercises should be approached with extreme caution.
- For the stalling exercise in multi-engine aircraft, the aircraft should be recovered from the stall before power is applied to ensure yaw and roll are controllable with normal and coordinated inputs. Stall training should never be done with asymmetric power.

10.3 Heads of operations

- Heads of Operations for operators approved to conduct flying training under CASR part 141 or 142 are required to ensure the proper allocation and deployment of aircraft and personnel for use in the training
  - Ensure aircraft are appropriate for the training task.
  - Ensure standardisation of instructors and their capabilities for each training task.
- Spin entry and recovery training must be conducted:
  - in aircraft certified for intentional spinning
  - by instructors with a spinning training flight activity endorsement.
- Stalling may be conducted in normal, utility category and light sport aircraft as permitted in the aircraft flight manual.
- Stalls with a wing drop are permitted in most normal category aircraft, but confirm with the manufacturer.
- Use of light sport aircraft for the steep turn, stalling, wing drop or spinning exercises should be approached with extreme caution.

10.4 Examiners

- Spin induced with pro-spin application of rudder may only be conducted in aircraft certified for intentional spinning.
- Recovery from stall with a wing drop is an acceptable means of testing spin avoidance and recovery from spin at the incipient phase.
- Emphasis should be on correct technique rather than the achievement of minimum height loss.