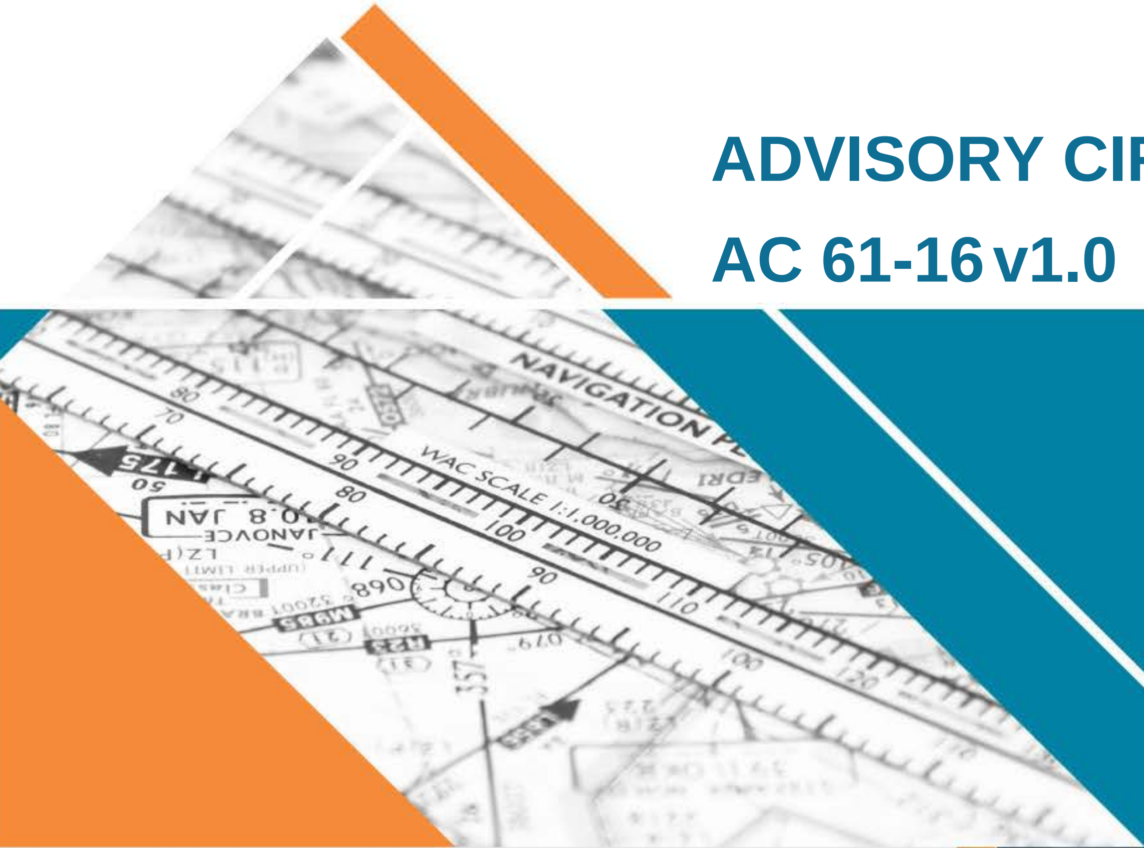
Australian Government
Civil Aviation Safety Authority



ADVISORY CIRCULAR
AC 61-16 v1.0

Spin avoidance and stall recovery training

Date April 2020

File ref D19/505522

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
- flight examiners
- Flight Training Operators and their Heads of Operations.

Purpose

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

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	April 2020	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, a. Section 4: Aircraft rating standards i A3.5 Control aeroplane at slow speeds ii A5.2 Aeroplane advanced manoeuvres iii G5 Glider advanced manoeuvres b. Section 5: Operational rating and endorsement standards i LL-A Aeroplane low-level operations c. Section 6: Flight activity endorsement standards i 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
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
Transport Canada TP 13747	Stall/Spin Awareness
Transport Canada TP13748E	An Evaluation of Stall/Spin Accidents in Canada
Aircraft Flight Manuals and Pilot Operating Handbooks	

2 Introduction

Stalling and spinning are aerodynamic phenomena which 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.[1]

Stall - spin related accidents continue to account for approximately one-quarter of all fatal general aviation accidents worldwide, including many during dual flight training. Most 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.

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.

Understanding of aircraft limitations at all times is essential, especially when conducting advanced stall with wing drop training, and training in recovery from a spin at the incipient phase. In particular, spinning must not be actively induced in aircraft not certified for intentional spinning with the intention of teaching recovery from 'incipient spin'.

This advisory circular (AC) provides important information regarding advanced stall training including:

- providing background to flight manual limitations, and where to find spin entry and recovery actions published for those aircraft that are certified for intentional spinning
- outlining the risks associated with advanced stall training when conducted in aircraft that are not certified for intentional spinning
- clarifying the difference between '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
- providing 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
- describing policy consistent with ICAO Standards and Recommended Practices and international aviation regulators regarding spin avoidance and stall recovery training standards for licensing and upset prevention and recovery training

2.1 Key messages

The key messages in this AC that are critical for the safe conduct of advanced stalling and spinning exercises, and that all pilots instructors, operators and flight examiners should be aware of are:

[1] Flight at critically slow airspeeds; spin avoidance; recognition of, and recovery from, incipient and full stalls is a flight instruction standard for the aeroplane category rating for the private and commercial pilot licence - ICAO Annex 1, 2.3.3.2 and 2.4.3.2

- A spin must not be induced in aircraft not certified or approved for intentional spinning
- A spin must not be induced without the pilot in command holding a spinning flight activity endorsement
- Aircraft flight manual limitations and any special procedures before conducting any exercise which may result in a spin
- The need to comply with aeroplane centre of gravity limits
- Wing drop at the stall for the purposes of spin avoidance training must not be induced by application of pro-spin rudder and the induction of a spin
- Training in spin avoidance must include the recognition of symptoms associated with slow flight and approach to the stall through to recovery from stall with a wing drop
- Recognise and manage changes in aircraft energy state
- Spin avoidance training where a wing may drop at the stall should be undertaken through scenario-based in-flight manoeuvres:
  - Approach configuration descending turns (base to final turn)
  - Go-around from approach configuration (significant change in trim state)
  - Climbing turns in departure configuration (trim changes during flap retraction and turns)
  - Engine failure after take-off (potential out of trim condition)
  - Turns in slow flight.

3 Background

Stall-spin accidents[2] 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 pro-spin rudder at the stall.
- Operators and flight instructors are not effectively managing the threats associated with advanced stall training.
- Inducing a spin in an aircraft not certified for intentional spinning is in contravention of the aircraft flight manual limitations and may consume the margins of safety provided by the aircraft's certification standards.

[2] 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 in icing conditions. 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, they 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 (Aeroplane) 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 investigations into fatalities resulting from accidents during stall and spin related training led to ICAO training and testing requirements changes from induction and recovery from spins to 'flight at critically slow airspeeds; spin avoidance; recognition of, and recovery from, incipient and full stalls'. More recently, ICAO recommends applicants for a commercial pilot aeroplane licence to complete in aircraft training in upset prevention and recovery.

5 Stall and wing drop

A stalled condition can exist at any attitude and airspeed. A wing may be stalled during:

- climbing or descending flight where lift is less than the weight of the aircraft
- level flight where lift is equal to the weight of the aircraft
- accelerated flight where the wing must provide more lift than in level flight, as occurs when turning or pulling up from a dive (the speed at which the wing stalls increases in accelerated flight, but the angle of attack at which it stalls is consistent).

For an aeroplane fitted with a stall warning system, the stall is recognised by a continuous stall warning indication (such as a sound or light) and 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 angle of attack
- 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, with roll being the main motion observed. At this point, 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 advanced stall training exercise, the likelihood of further stalling the down-going wing and inducing yaw may lead to a spin. When prompt action is taken to break the stall, normal lateral control is restored, and the wings may be levelled with balanced use of aileron. This is consistent with spin avoidance training.

Wing drop is tested under stalling certification standards. After the aeroplane 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 in an aeroplane, 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 which settles over a number of revolutions 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. For illustration of the phases of a spin see appendix A.

6.1.1 Entry phase

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

When entry is from a balanced flight condition — this can be level, accelerated or in an approach to land configuration — if the yaw produced following a wing drop at the stall is not arrested with sufficient opposite rudder, the aircraft will yaw towards the down-going wing and enter a spin. Use of the ailerons to pick up a 'dropped wing' is also likely to more deeply stall the down-going wing as the angle of attack of that wing is increased.

Deliberate entry from balanced flight at the point of stall — full rudder applied in the direction of the intended spin — will induce a yaw and secondary roll which, if the rudder and elevator backpressure are held, will rapidly accelerate to autorotation.

Uncountered wing drop or deliberate application of pro-spin rudder at the stall are both likely to cause the aircraft to enter a spin. As lift begins to decrease, drag increases rapidly on the down-going wing due to its higher angle of attack.

A spin can be avoided in the entry phase by breaking the stall restoring laminar flow with angle of attack reducing elevator control, then coordinated application of rudder and aileron bringing the aeroplane back to wings-level and finally, using elevator to recover to the desired flight attitude. Judicious use of power following recovery from the stall can reduce height loss.

6.1.2 Incipient phase

The incipient phase of the spin is the period of stalled flight between the commencement of rotation and the developed, stable or steady phase of autorotation. The incipient phase of a spin may 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 due to sideslip in the direction of roll.

The aeroplane has departed controlled flight and the accelerating yaw, pitch and roll will require prompt and positive 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. This requirement may determine the aircraft centre of gravity limits specified in the aircraft flight manual.

6.1.3 Developed or steady phase

In the developed or steady phase, aerodynamic forces created by the aircraft are balanced by gyroscopic forces due to the distributed mass of the rotating aircraft, causing a steady autorotational state. By this time the corkscrew flight path is vertical and oscillations in pitch, roll and yaw steadily repeat with each turn.

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 and positive 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, even where the wing is stalled, relatively low and the empennage and vertical stabiliser unstalled. This enables standard spin recovery control inputs to place the aircraft in a dive.

A rearward centre of gravity, use of aileron or application of power (or a combination of them) are likely to increase angle of attack, deepen the stall, and 'flatten' the spin. This 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 spin recovery actions, suitable for most aircraft, 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.

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

Any delay in power reduction after spin entry will result in delayed recovery and a greater loss of height.

Some aircraft require different timing and order of inputs as found through flight and certification testing. Any differences from the NACA standard recovery actions are published in the aircraft flight manual and pilot operating handbook.

Manoeuvre limitations and procedures for entry and recovery from spins are also listed in the aircraft flight manual.

Centre of gravity position limitations are also specified in the aircraft flight manual for aerobatic flight, and flight in the utility or normal category when spinning is to be undertaken.

Normal, utility or aerobatic aircraft certified for intentional spinning have been tested to be recoverable from a six-turn spin. This differs for light sport aircraft, which must have been tested to be recoverable from a three-turn spin, within one and a half turns of the recovery control application prescribed in the aircraft's flight manual. In these aircraft a recoverable spin may be safely induced from a slowly and deliberately entered level stall using 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

The terms 'incipient spin' and 'wing drop' have been used somewhat interchangeably over the years. This has led to an 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 substantial portion of a revolution of the incipient phase of a spin before spin recovery inputs are demonstrated.

Considering the definitions of the phases of spin outlined above, 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 uncorrected 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 is the deliberate induction of a spin, which is only permitted in aircraft approved for spinning.

Flight instructors are required to hold a spinning flight activity endorsement which provides them with the knowledge and skills to recover from a mishandled stall recovery should it develop past a wing drop into the incipient phase of a spin. Instructors are encouraged to refresh their knowledge and skills in spin recovery techniques.

7 Spin avoidance versus spin recovery

A wing drop at the stall may be recovered with proactive stall recovery control inputs, i.e. stall recovery and spin avoidance. Failure to recover from the wing drop at the stall may result in an entry to a spin.

By the incipient phase, a yaw has developed and would be accelerating. 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 spin recovery control inputs.

7.1 Spin avoidance training for the grant of a licence

ICAO documents (Annex 1 - Personnel licensing, and Doc10011 - 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 low aircraft energy state and potential upset.
- Recognition — timely action to recognise 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 describe practical slow flight and stalling exercises for pilot training with a focus on stall and spin avoidance and recommend distraction of the student during slow flight manoeuvres 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 flight activity- or spinning training endorsement.

The induction of a spin is not spin avoidance training. Spin avoidance training is part of the advanced stalling exercise where the aircraft is placed in the configurations most likely to cause a wing to drop. Elevator remains the primary control used to restore laminar flow or unstall the wing, and balanced aileron may be used to return the aircraft to the desired flight path once the wing is unstalled.

7.1.1 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, recognise and recover from approaching stall and full stall including wing drop at the stall and to manage aircraft energy in the recovery with and without the use of power.

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
  - distraction
  - turns
- Low flight
  - wind illusions
  - terrain avoidance manoeuvres
  - false visual horizons.

7.1.2 Distraction as a threat to be managed

Distraction is a threat that multiplies the risks when performing the above manoeuvres, 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.

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.

In some instances the application of power, when available, can induce a secondary stall or lead to an increased loss of height if applied too early in the recovery. Abrupt or aggressive use of elevator in the recovery also has the potential to induce a secondary or accelerated stall as a result of the increased load factor or 'G' loading.

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

A spinning flight activity endorsement is a prerequisite for the grant of a Grade 3 training endorsement (aeroplane). This ensures the holder of a flight instructor rating with a Grade 1, 2 or 3 training endorsement (aeroplane) has the ability to recover from the incipient phase of a spin which aligns with the aircraft certification margin of safety for a mishandled stall recovery.

Flight training operators should ensure flight instructors are competent to conduct higher risk training activities which should be reviewed periodically as part of the operator's recurrent training program or standardisation and proficiency checks.

7.1.5 What aircraft may be used for spin avoidance training

Aircraft approved for intentional spinning are recommended for spin avoidance training due to the greater margin of safety for recovery from a mishandled stall recovery.

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.

Accidents have shown that some normal category aircraft and light sport aircraft may not exhibit departure characteristics desirable for training purposes. Flight training operators should ensure any aircraft type used for spin avoidance training has proven to be recoverable from spins at least at the incipient phase.

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

Spin recovery training is highly recommended for pilots at any level of licence or experience and is worth revision at any stage of a pilot's career. Spinning training can give pilots confidence in recovery from an unusual attitude as a result of encountering an upset.

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 may be conducted for a spinning flight activity endorsement or 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 as it is considered an aerobatic manoeuvre.

7.2.1 Who may conduct spinning and spin recovery training

A flight instructor requires a spinning training endorsement for the conduct of spinning and spin recovery training.

A spinning flight activity endorsement is a prerequisite for the issue of a spinning training endorsement. A spinning training endorsement is not a prerequisite for a flight instructor rating Grade 3 Aeroplane training endorsement.

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

Spinning and spin recovery training must only 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 limited aerobatics which may include 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 and any other limitations that apply for conducting such manoeuvres. Aircraft must be operated in accordance with the flight manual to ensure a margin of safety is maintained when conducting spins.

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, depending on which standard is used for certification, are not required to be tested for spin recovery 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.

For illustration of certification testing requirements which show the margins of safety provided by each type of certification standard for each portion of the stall and spin flight activity see appendix B.

8.3 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 flight 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. They are to be activated when control of the aircraft is lost, generally in lieu of attempting to recover from a spin, and are intended to protect the occupants of the aircraft. Their use can result 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.

8.4 Spin severity

Stall and spin certification requirements call for abnormal control inputs such as pro-spin rudder and out-spin aileron at the stall to allow for the surprise response from the average pilot, and that a subsequent mishandled stall recovery which enters the incipient phase of a spin may be recovered from. However, these standards call for specific rates of deceleration approaching the stall, and deliberate (not abrupt) inputs at spin entry, which may not reflect the abruptness of 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. Centre of gravity margins are carefully proven to ensure the departure characteristics of the aircraft remain recoverable within certification limits.

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

Aircraft flight manuals for many aircraft used for flight training permit spinning when the aircraft is operated in the utility category (restricting the maximum take-off weight and 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

The following guidance is intended for pilots, instructors, flight training operators' 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 weight and balance and manoeuvre 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 of yourself coordinated flight 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 and go-arounds, to simulate the situations that typically lead to stalls.
  - If low on the approach to land, pitching up to regain the desired flightpath without the use of power may result in a loss of airspeed.

  - Adding power during a baulked landing or missed approach may result in the nose of the aircraft pitching higher than desired.
  - 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

- A number of accidents have occurred when conducting stalling and spin avoidance training. It is a higher risk training activity that requires instructors to manage threats and errors effectively.
- 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.
- Ensure the aircraft is operated in accordance with the aircraft flight manual limitations and entry and recovery procedures for manoeuvres including stalling and spinning.
- Even if the aeroplane you are flying 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.
- Spin avoidance training includes the recognition of symptoms of slow flight and approaching to the stall through to recovery from stall with a wing drop
- Spin avoidance training where a wing may drop at the stall is best achieved through the following scenario based flight situations:
  - Approach configuration descending turns (base to final turn)
  - Go-around from approach configuration (significant change in trim state)
  - Climbing turns in departure configuration (trim changes, flap retraction and turns)
  - Engine failure after take-off (potential out of trim condition)
  - Slow flying
    - Turns
    - Distractions
- 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 the stall is broken and 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.
- Be familiar with the handling characteristics when using a light sport aircraft for the steep turn, stalling, wing drop or spinning exercises as the safety margins may be reduced.

- 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. Multi-engine aircraft are certified to the point of stall recovery but are not certified to enter a spin.
- Recognise and avoid the potential for negative training with a clear understanding of what the desired training outcome is for the lesson. The latent effects of negative training can stay with a pilot throughout their career.
- Emphasise the importance of unstalling the wing as the priority in any stall recovery.

10.3 Heads of Operations of flight training operators

- Heads of Operations for operators approved to conduct flight 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 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 consult with the manufacturer if there in any doubt.
- Operators should ensure the aircraft used in flight training are appropriate and suitable to achieve the desired training outcomes.
- If utilising light sport aircraft for the steep turn, stalling, stall with a wing drop or spinning exercises determine the suitability of the aircraft in consultation with the manufacturer.
- Recognise and manage the risks associated with flight training activities. Operators must ensure flight instructors are competent to conduct their assigned duties through use of standardisation and proficiency checks and recurrent training and checking.

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 where it is called for in Part 61 MOS.
- Emphasis should be on correct technique rather than the achievement of minimum height loss.

11 Conclusion

This AC introduces the concept of spin avoidance and stall recovery training in line with international standards and practices. It deliberately concentrates on the knowledge and skills associated with recovery from stall with a wing drop which demonstrates the edge-of-envelope departure characteristics in scenarios consistent with inadvertent stall in a variety of flight regimes serves two functions in the context of this AC.

- It prevents aircraft not certified for intentional spinning being induced to spin but allows them to be used for the advanced stalling exercise, including a stall with a wing drop, which leaves a margin of safety for mishandled recovery.
- It aligns Australian flight training with ICAO and international pilot licence training practice and UPRT policy.

In addition, this AC provides some background into flight training and aircraft certification information in order to assist understanding regarding the change in policy. In the interests of brevity and the restriction of scope to general characteristics of aircraft behaviour and standard departure recovery techniques not all relevant information is necessarily presented. Readers are encouraged to consult the References, aircraft flight manuals and other authoritative publications for a fuller understanding of the topic.

The AC also highlights the responsibilities for operators and flight instructors to manage threats than can add to the risks associated with spin avoidance and stall recovery training and minimise the potential for negative training, that can have longer term consequences for a student.

Appendix A

Illustration of the phases of a spin

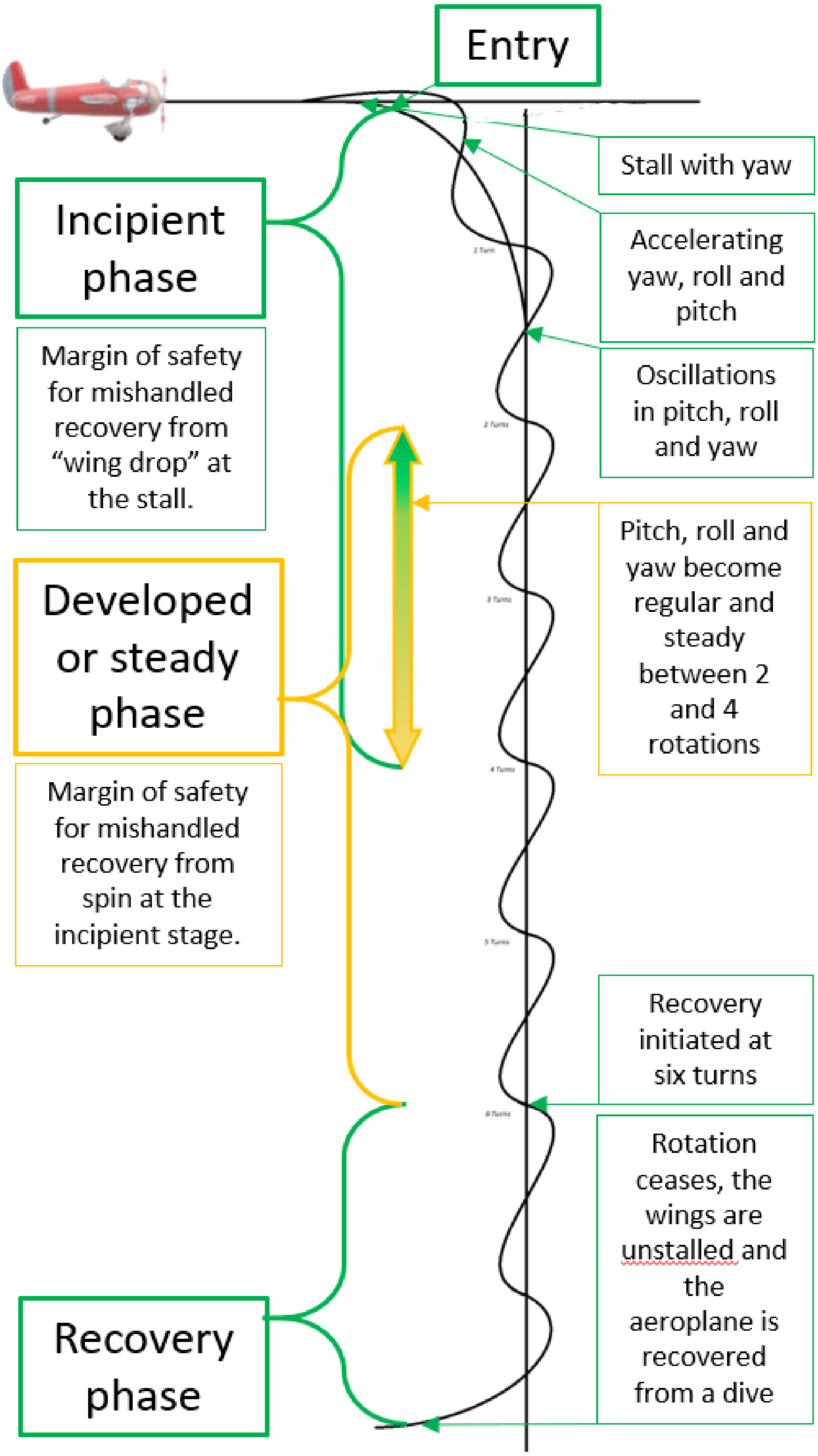


Figure 1: Phases of a spin

Appendix B

Illustration of stall and spin certification requirements

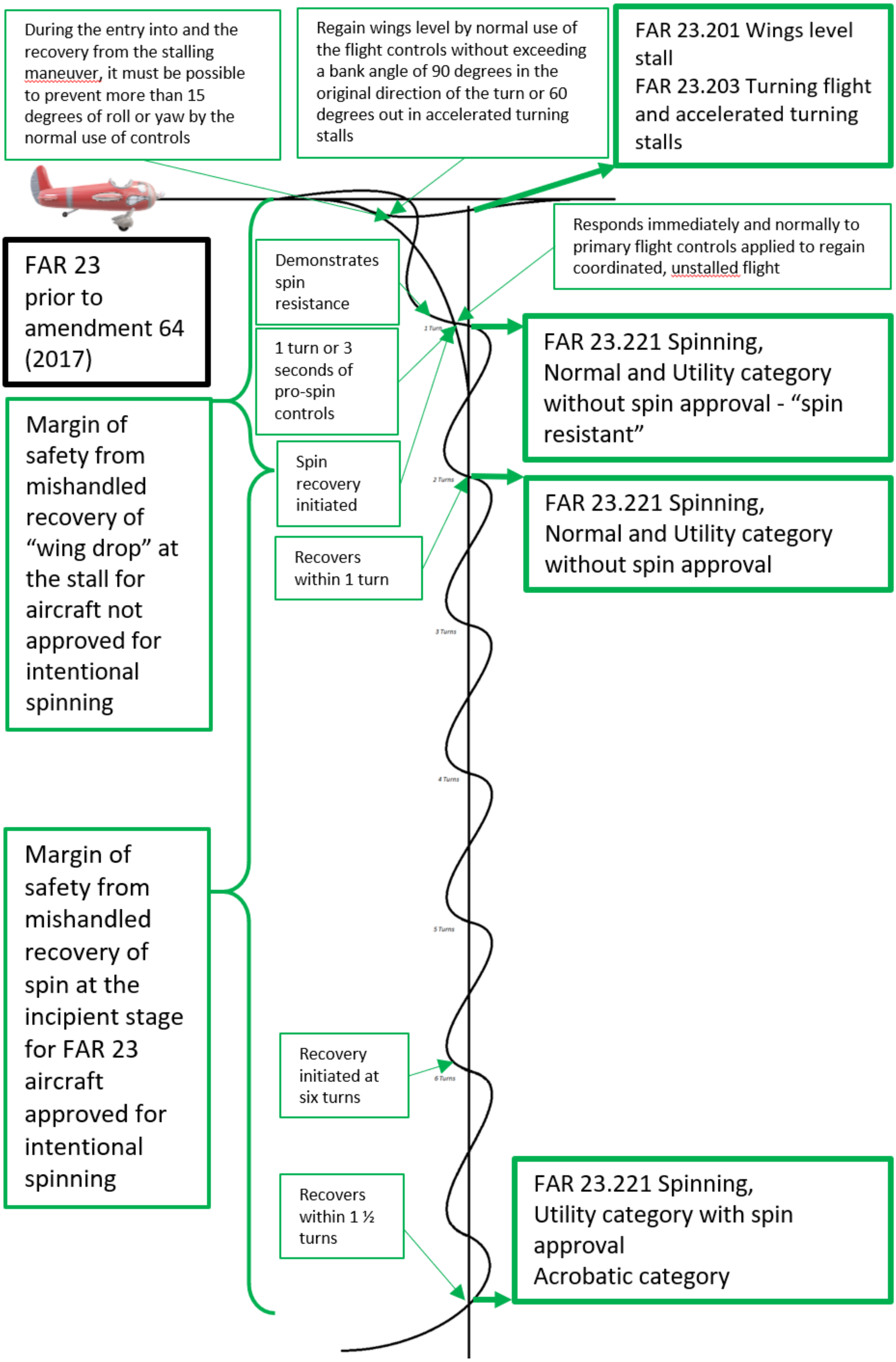


Figure 2: US FAA Part 23 Normal, Utility and Aerobatic

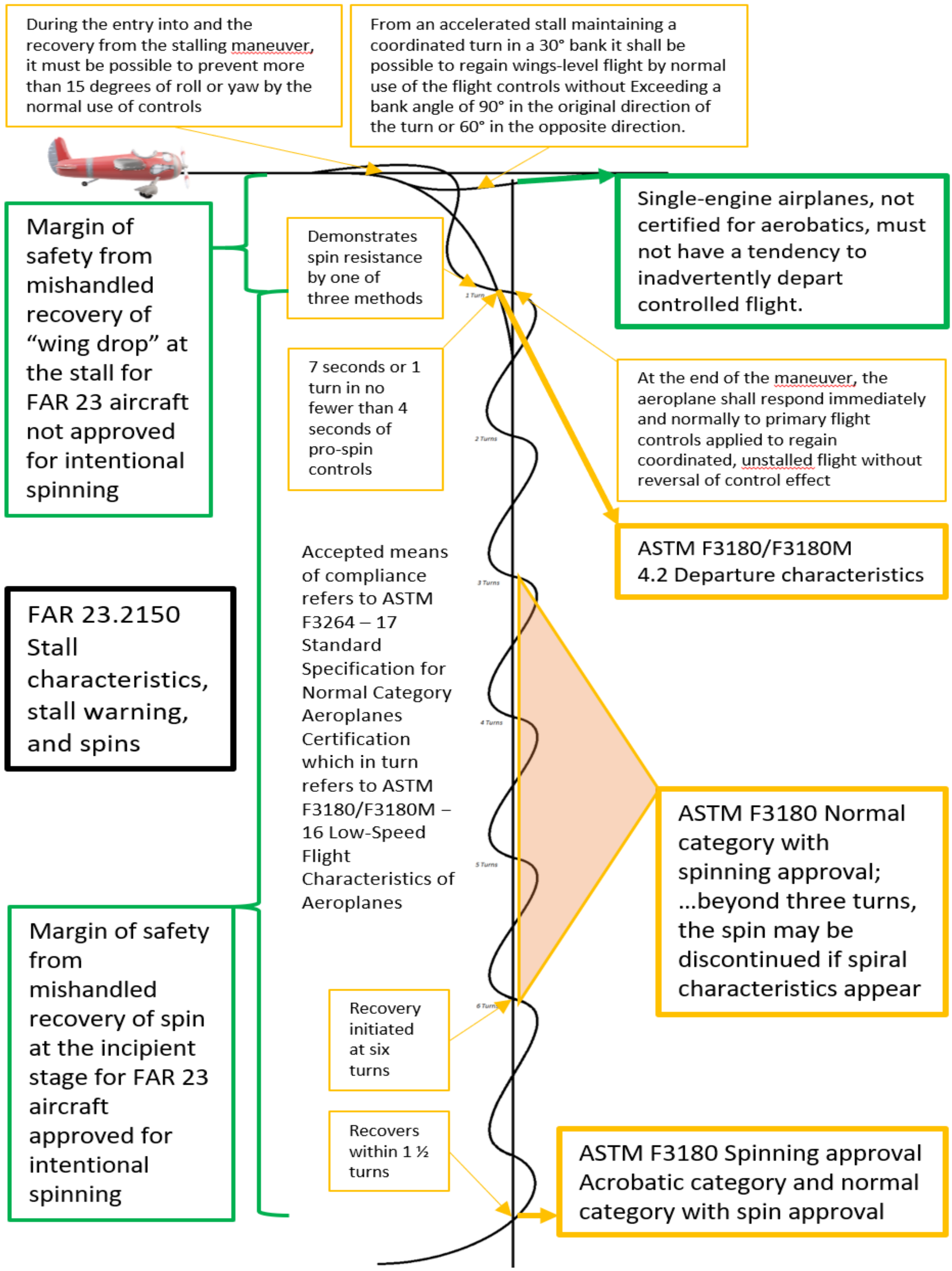


Figure 3: FAA Part 23 (post-amendment 64) Normal and Aerobatic

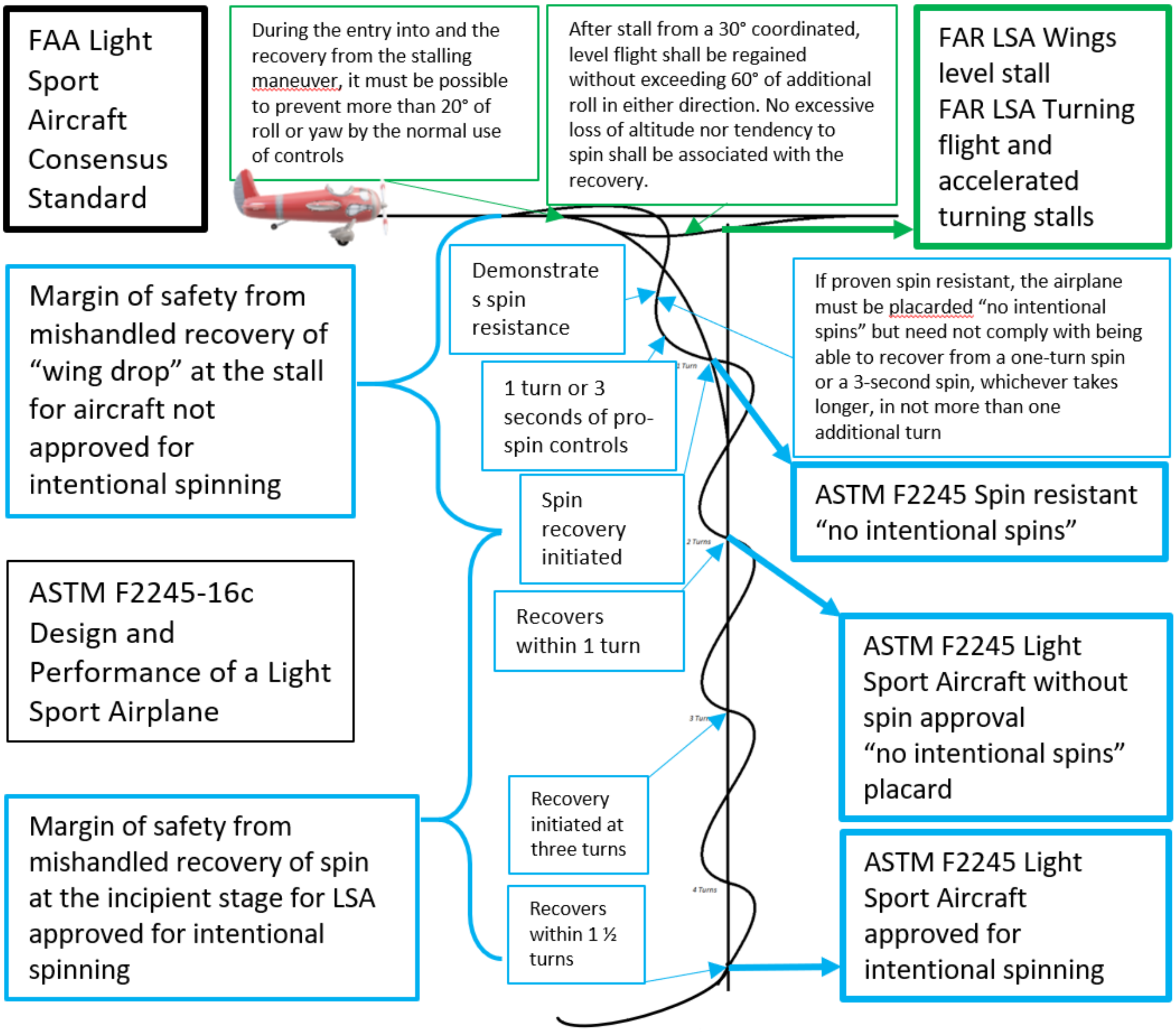


Figure 4: FAA Light Sport Aircraft