Gliding Australia Training Manual

Trainer Guide

Unit 18

Spin / Spiral Dive Avoidance and Recovery

Spin / Spiral Dive Avoidance and Recovery

AIM

The aim of this unit is for the student to:

- Explain the aerodynamics of the spin manoeuvre.
- State the common causes of unintended spins and the ways to avoid them,
- Be capable of recognizing the symptoms of a spin and spiral dive.
- Be capable of efficient recovery of the aircraft from all phases of a spin or spiral dive.
- Verify that a glider is rated for spins

PREREQUISITE UNITS

- GPC Unit 12 Slow Flight, Stalling

COMPLEMENTARY UNITS

This unit has no complementary GPC Units.

COMPETENCY ELEMENTS AND PERFORMANCE STANDARDS

ELEMENT	PERFORMANCE STANDARDS
1. Knowledge of spins & spiral dives.	• **Describe:** ○ The actions that a pilot can take to prevent an accidental spin. ○ The phases of an aircraft spin noting the difference between the entry, incipient and fully developed phases. ○ The difference between a spin and a spiral dive. ○ The threats associated with: ● Spins and; ● Spiral dives. ○ The process of recovery (clearly identifying emergency actions without reference to checklists) from: ● The entry phase of a spin; ● The incipient and fully developed phases of a spin; and ● A spiral dive.
2. Ability to demonstrate recovery from spins & spiral dives.	• **Demonstrate:** ○ The use of internal and external references during recovery from spins and spiral dives. ○ The process of recovery (clearly identifying emergency actions) from: ● The entry phase of a spin; ● The incipient and fully developed phases of a spin; ○ Recovery from a spiral dive.

KEY MESSAGES

- Gliders spend a lot of their time at high angle-of-attack and therefore have a high potential for spin entry.
- Pilots must be trained to PREVENT spins, RECOGNISE when a spin is developing or occurring, and be able to RECOVER from any phase of a spin.
    - Pilots should first and foremost fly their aircraft in a manner that prevents spins. Maintain safe speed above ground when low, do not over rudder turns, do not thermal close to the ground.
    - Pilots need to recognize the precursors of a spin and take action to avoid progression into the spin by recovering early.
    - Every pilot needs to recognise & recover from spins & spiral dives.
- Whilst they may appear similar, Spins and Spiral Dives are different and have different recovery procedures. It is vital the pilot can recognise the difference and apply the appropriate recovery technique.
- Some aircraft may progress into a spiral dive from a developed spin.
- Recovery from spins is the same basic procedure (with some variations) for all aircraft but ALWAYS read the Aircraft Flight Manual (AFM) to ensure that the aircraft is rated for spinning and for any specific actions to use in the spin recovery.
- Spins & spiral dives consume considerable amounts of height and are dangerous below 1000' AGL.
- Spiral Dives can be dangerous at any height if the forces in the manoeuvre build up to a point where they exceed the aircraft's load limits.

LESSON PLANNING AND CONDUCT

Classroom Briefing

General

- While spin and spiral dive recovery are very important - because most spinning accidents occur too low for recovery, spin prevention is at least as important as recovery.
- Likely scenarios when spins might occur:
    - Mishandled (over-ruddered) turn
    - Attempt to stretch glide with low level turn
    - Attempt to turn a stalled glider (e.g., after winch cable break).
    - Not maintaining a safe speed above the ground when low
    - Thermaling too low.
- Describe pre-spin symptoms. In particular the loss of lateral damping leading to wing drop and how this can be overlooked by a pilot under stress or overloaded.
- Note that pre-stall buffet may not be felt due to turbulence missing the tail in the pre-spin period.

- Note that a key element that distinguishes a spin is the auto-rotation around the spin axis.
- Gliders certified to the EASA standard CS-22 must be able to be recovered from a spin in less than 1.5 additional turns regardless of configuration. If the aircraft is in a configuration approved for intentional spins, it must recover in one additional turn or less. Thus, all gliders designed to CS-22 must be recoverable.
- However, not all CS-22 aircraft are certified for deliberate spins and not all gliders are certificated to CS-22. Furthermore, some certified aircraft may not be approved for spinning in certain configurations. This means it is critical that the pilot understands the limitations (if any) put in place by the manufacturer regarding spinning the aircraft.
- Pilots must understand that the primary reference for spin approval to certified standards, or spin limitations, is the approved Aircraft Flight Manual or Pilot Operating Handbook (and applicable supplements).

Spin Phases

- A spin will not exist without both stall and yaw.
    - Note that the stall speed at any given moment varies with the load on the wing, which in turn depends on glider mass, angle of bank, use of airbrakes etc., therefore airspeed is only an indirect indication of an approaching stall.
    - If the aircraft is yawed, a roll will develop in the direction of yaw because the outer wing has increased airspeed, and therefore increased lift. The descending (inner) wing gains an increased angle of attack and if it is at or near the stall its lift will reduce. The effect of these differences in lift will be to produce an accelerating roll rate in the direction of the initial yaw.
    - The change in angles of attack will affect drag from each wing. The down-going wing with an increased angle of attack suffers increasing drag. The up-going wing gets a drag reduction. The difference causes even more yaw towards the down-going wing.
    - Explain how these forces create the rotation that the aircraft experiences as the spin develops.
- Note how yaw can be created in the aircraft:
    - Out of balance (uncoordinated flight) either unintentional or intentional (such as over-ruddering turns)
    - Wing drop at stall due to loss of lateral damping.
    - Application of aileron at the stall.
    - Gusts.
- Describe all four phases of a spin (entry, incipient, fully developed, recovery):
    - Spin entry characterised by departure from controlled flight at the stall and uncommanded wing drop. Recovery can be made by reducing the angle of attack and controlling yaw.
    - Incipient phase is the period of stalled flight between the commencement of rotation and the developed, stable or steady phase of autorotation. The aircraft's yaw is developing and accelerating and now requires full spin recovery control input.
    - Fully developed phase is where 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.

    - Recovery phase is where the pilot has initiated the spin recovery actions and the aircraft is no longer in autorotation and the aircraft can be recovered from the ensuing dive.
- Note that spin characteristics will vary, the pitch angle may be steep or flat.
- Spin entry, in-spin characteristics and responsiveness to recovery conditions will depend on the aircraft C of G position for that flight.
- There is a tendency for some aircraft to transition from the spin into spiral dive during the incipient phase. This will also be influenced by location of the aircraft's CoG.

Spin Recovery

- Pilots need to develop an acute detection of spin events and the ability to initiate an automatic recovery response.
- The best time to recover from a spin is at the entry phase (stall and wing drop).
- Use external references (ground, horizon, air-noise) to confirm spin and identify direction.
- Describe recovery technique from spin:
    - At the entry phase using stick forward and rudder to counter any yaw; and
    - From incipient and fully developed phase using the full spin recovery technique.
    - If in doubt about whether a spin is commencing, move the stick forward.
- Note that spin recovery process is the same basic procedure (with minor variations) for all aircraft but ALWAYS consult the Aircraft Flight Manual (AFM) for any specific actions to use in spin recovery.
- Explain that during the recovery phase, the nose attitude may steepen and the rate of rotation may momentarily increase as well, giving the impression that the spin is actually getting worse.
- Spin recovery may not be instantaneous. It may take up to several turns for the anti-spin control inputs to take effect.

Spin Avoidance

- Explain that preventing a spin is better than having to recover from one, by:
    - Avoiding skidding (over-ruddered) turns.
    - Maintaining safe speed when close to the ground.
    - Ensuring that after a launch failure, no attempt is made to turn without regaining safe speed.
    - If the desired landing area is looking out of reach but another option is available closer, chose the safer closer option to maintain airspeed.
    - Have a disciplined approach to break-off height when thermalling - know when to transition to landing pilot.
    - Being aware of false horizons in hilly terrain that may distort the pilot's perception of the aircraft's pitch & roll.

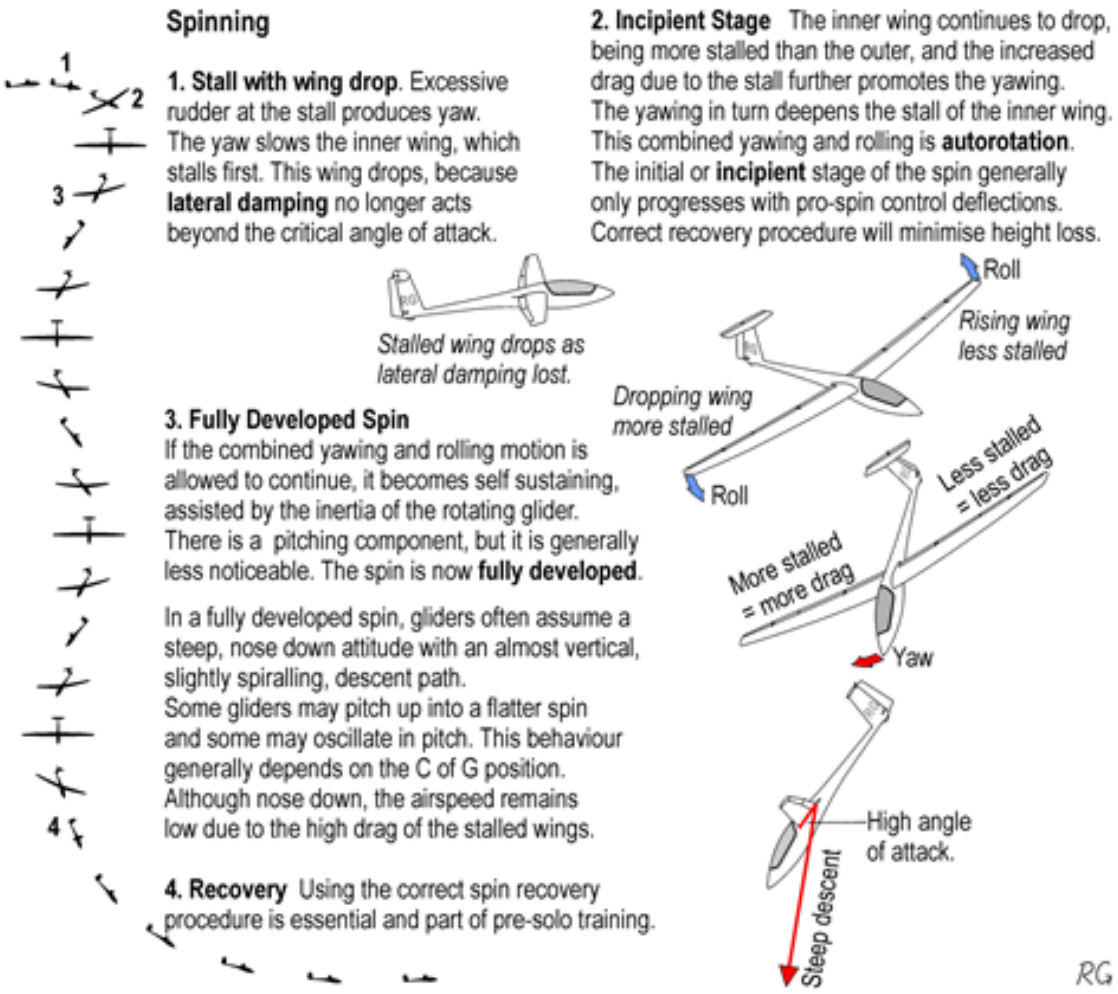
Spiral Dives

- Note that it is possible to confuse a spiral dive with a spin. Spiral Dives are steep, descending turns that become progressively tighter over time. They occur at lower angles of attack (the wing is not stalled) and display the same over-banking tendency common to all steep turns.

- Describe the events that could lead to a spiral dive.
- Describe symptoms of a spiral dive.
- Explain the different aerodynamics of the spin & spiral dive.
    - Spins result from a stall and yaw with auto-rotation about the lower wing.
    - Spiral dives are controlled flight in a descending spiral.

Spiral Dive Recovery

- Describe recovery from spiral dive.
- Explain why the airbrake should not be used.
- Discuss threats imposed by spins and spiral dives, particularly the potential for aircraft overstress.



Aids to Developed Spin/Spiral Dive Identification

Attribute	***In Developed Spin***	***In Spiral Dive***
Aircraft stalled	YES	NO
G Loading	Normal	Increasing
Load on controls	Light (unresponsive)	Effective and increasing control loads
Yaw string	Large deflection, pointing towards rudder for recovery	Generally normal flight position
ASI	Low or unreliable	Steady and increasing
Air sounds	Stable (but may vary on rotation)	Increasing

Recovery Techniques

This table is a guide only – the Aircraft Flight manual must be consulted for specific actions for any given airframe.

From Spin (Entry Phase)	***From Spin (Incipient & Fully Developed Phase)***	***From Spiral Dive***
Stick forward.	Full opposite rudder to spin rotation.	UNLOAD wings, move control column forward.
Rudder to correct yaw.	Aileron neutral.	ROLL wings level gently using aileron & rudder.
	Ease control column forward until rotation ceases.	Ease out of dive with elevator.
	Rudders neutral and ease out of dive with elevator.	
Adopt gliding position, re-orientate yourself, regain situational awareness with FULL SCAN.		

Human Factors

- Explain how a pilot may become progressively disorientated as the spin or spiral progresses.
- Explain how a pilot will be affected as the spin or spiral ceases.
- Explain the human aspects of startle and surprise and how pilots can build a defence against these responses.

PRE-FLIGHT BRIEFING

- Ensure pre-aerobatic check is completed.
- Note that motor-gliders have particular prohibitions regarding spins and the AFM/POH must be consulted.
- Explain how we use internal and external references (ASI, yaw string, ground rotation, compass movement).
- How spin entry phase and simple (push forward + rudder) recovery will be demonstrated.
- How the incipient and fully developed spin symptoms and full recovery sequence will be demonstrated.
- Emphasis on spin recovery using the forward movement of control column until aircraft returns to unstalled flight (entry phase) and rotation stops (incipient and fully developed spin phase).
- Describe the things the pilot should look for during spins and spiral dives that allow the pilot to discriminate between them (airspeed, g-force, rate of rotation).
- Emphasis on spiral dive recovery by unloading the wings by easing elevator forward (RELEASE) first, then rolling wings level (ROLL), prior to easing back on control column (PULL) to reduce airspeed.

- Describe the impact on spin entry & recovery of having flaps and airbrake deployed for the particular aircraft being used.
- Some use of rudder to create yaw may be required at the entry phase to assist a wing to drop and initiate the spin.

FLIGHT EXERCISES

Demonstrate spin entry at altitude from the four spin scenarios described earlier (mis-ruddered turn, extended glide, turn whilst stalled and low thermaling).

Entry Phase Spin Symptoms & Recovery

- Demonstrate entry phase spin symptoms and recovery.
- Explain recovery actions, stick, rudder, return to level flight.
- Note amount of control input and responsiveness of aircraft.

Incipient & Fully Developed Spin Symptoms & Recovery

- Demonstrate incipient & fully developed phase spin symptoms and recovery off simulated base turn (over-ruddered turn, nose slightly higher than normal).
- Point out ASI and yaw string indications.
- Refer to internal and external references to determine the direction of rotation.
- Note the aircraft is stable in the full spin phase, it generally will not recover by itself.
- Emphasise use of full rudder whilst moving stick forward to restore the aircraft to flying condition.
- Note: larger amount of control input and longer response from aircraft.

Spiral Dive Symptoms & Recovery

- Point out indicators of spiral dive and recovery technique. The earliest and most obvious symptom is the rate of rotation.
- Point out ASI and yaw string indications.
- Point out increasing G force – either through instrument or pilot sensation.
- Refer to internal and external references to determine the direction of rotation.
- Describe actions to recover to normal flight attitude:
    - RELEASE G force on wing by easing forward on stick
    - ROLL wings level
    - PULL back to recover from dive. Emphasise the need to keep within G limits.
- Where the aircraft has a tendency to migrate from a spin to a spiral dive ensure the student identifies the transition and applies the correct recovery technique as required.
- Repeat demonstration as many times as needed for the student to recognize the symptoms and undertake the effective recovery of spins/spiral drives. Repeat using different duration of spin.
- Ensure entry is demonstrated from straight and level and various angles of bank.

Student practice (under supervision)

- Student to practice recovery of entry, incipient phase and fully developed spins that have been initiated by the trainer.

- Recovery from fully developed spins may take longer to recover in some aircraft and the student should understand patience may be required for the recovery to take effect.
- Student to demonstrate spin entry, incipient phase first then the fully developed phase followed by recovery. Ensure exercise is commenced straight and level and various angles of bank.

Notes:

- Trainers must confirm that spin training is permitted in their aircraft. Refer to the AFM/POH.
- Ensure that specific procedures in the AFM/POH are followed for the recovery of the aircraft from a spin or spiral dive.
- Ensure that realistic nose attitudes are used on spin entry – i.e., do not allow the pilot to conclude that spins will only occur with high nose attitude.
- Ensure an adequate pre-aerobatic check is performed by the student prior to all flight exercises.
- Utilise the altimeter pre- and post- spin/dive exercise to illustrate how much height was lost and what this could mean if the upset occurred in the circuit.

COMMON PROBLEMS

Problem	Probable Cause
• Failure to conduct adequate pre-aerobatic check.	Student may forget or misremember checklist. Emphasise that spins are an aerobatic manoeuvre and require the pre-aerobatic check to be completed.
• Failure to identify the spin entry.	Student is not sensing the stall/yaw/nose drop symptoms. Utilise simulators if available to demonstrate the entry, spin and recovery sequence so that the student is aware of the visible attributes of the spin prior to flight exercises.
• Failure to identify the direction of rotation.	Student is not considering internal or external references. Utilise simulators if available to demonstrate the direction indicators of the spin.
• Failure to maintain forward stick until rotation stops.	Student is trying to recover too soon or may be pulling back as an instinctive reaction to the nose down attitude. Reinforce full recovery sequence, demonstrate in a variety of spins to allow student to gain familiarity with the spin sensations.
• Failure to use adequate (i.e., full) rudder during recovery from fully developed spin.	Student may find partial application of rudder does recover some aircraft types. Reinforce need to use full application of rudder as that may be needed in some circumstances.
• Inability to differentiate between spin and spiral dive	Student is misdiagnosing the spin/spiral symptoms. Re-brief the spin/spiral identification table.

Problem	Probable Cause
• Excessive use of controls during recovery	Student may have tight grip on control column or may be nervous about spin manoeuvres. Advise correct control column grip and expose student to spins gradually to encourage familiarity with the control inputs required.
• Student continues to hold rudder in after cessation of rotation or fails to centre ailerons	Student may not recognise cessation of rotation. Demonstrate recovery sequence with clear description of actions at each point.

THREAT AND ERROR MANAGEMENT

- Ensure a pre-aerobatic check is completed before spinning exercise.
- Low trainer currency in spinning in the aircraft type is a threat.
- Avoid confusion about what is happening, differentiate between symptoms of a spin/spiral dive – ASI, yaw string, noise.
- Recognise the direction of rotation.
- Poor height judgement can result in aircraft going below 1000’ AGL during manoeuvre (or 2000’ AGL near a registered airfield).
- A highly anxious pilot that has not experienced a spin manoeuvre previously can be a threat – use a simulator, video presentation or model to explain the manoeuvre 2or consider not flying the student.
- Poor aircraft handling can result in failure to recover from the spin or to recommence the spin in the opposite direction.
- Student confusion and disorientation. Student may be anxious about the spin sequence and sensitive to pitch and attitude changes during the manoeuvre.
- Aircraft that may require significant rearward C of G to spin easily but are normally operated in forward C of G position.

TRAINING MATERIALS AND REFERENCES

- GPC Unit 18 Pilot Guide
- Australian Gliding Knowledge pages 67-70
- CASA AC61-16 V1.0
- GPC Theory Lesson 6.