Cessna

Spin

CHARACTERISTICS of CESSNA MODELS 150, A150, 152, A152, 172, R172 & 177

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The subject of airplane spinning is a complex one, which is often over-simplified during hangar-flying sessions. There are increasing numbers of pilots, including flight instructors, who, because of the structure of present pilot certification requirements, have had little or no training in spins and spin recovery. This has resulted in some confusion and misunderstanding over the behavior of airplanes in spinning flight, and it appears that this lack of understanding may have contributed to some serious accidents. In the interest of expanding each pilot's knowledge and increasing the safety of his operations, we will discuss some factors influencing spin behavior as it pertains to the Cessna Models 150, A150, 152, A152, 172, R172 and 177 which are approved for intentional spins.

The following list summarizes important safety points relative to the performance of intentional spins.

BASIC GUIDELINES FOR INTENTIONAL SPINS

(1) KNOW YOUR AIRCRAFT THOROUGHLY.

(2) PRIOR TO DOING SPINS IN ANY MODEL AIRCRAFT, OBTAIN THOROUGH INSTRUCTION IN SPINS FROM AN INSTRUCTOR FULLY QUALIFIED AND CURRENT IN SPINNING THAT MODEL.

(3) BE FAMILIAR WITH THE PARACHUTE, AIRSPACE AND WEATHER REQUIREMENTS OF FAR 91.15 AND 91.71 AS THEY AFFECT YOUR FLIGHT.

(4) CHECK THE AIRCRAFT WEIGHT AND BALANCE TO BE SURE YOU ARE WITHIN THE APPROVED ENVELOPE FOR SPINS.

(5) SECURE OR REMOVE ALL LOOSE COCKPIT EQUIPMENT PRIOR TO TAKEOFF.

(6) BE SURE THE AREA TO BE USED IS SUITABLE FOR SPINS AND IS CLEAR OF OTHER TRAFFIC.

(7) ENTER EACH SPIN AT A HIGH ALTITUDE. PLAN RECOVERIES TO BE COMPLETED WELL ABOVE THE MINIMUM LEGAL ALTITUDE OF 1500 FEET ABOVE THE SURFACE.

(8) CONDUCT ALL ENTRIES IN ACCORDANCE WITH THE PROCEDURES RECOMMENDED BY THE MANUFACTURER.

(9) LIMIT YOURSELF TO 2-TURN SPINS UNTIL COMPLETELY FAMILIAR WITH THE CHARACTERISTICS OF YOUR AIRPLANE.

(10) USE THE FOLLOWING RECOVERY PROCEDURES FOR THE CESSNA MODELS 150, A150, 152, A152, 172, R172, AND 177:

(a) VERIFY THAT AILERONS ARE NEUTRAL AND THROTTLE IS IN IDLE POSITION.

(b) APPLY AND HOLD FULL RUDDER OPPOSITE TO THE DIRECTION OF ROTATION.

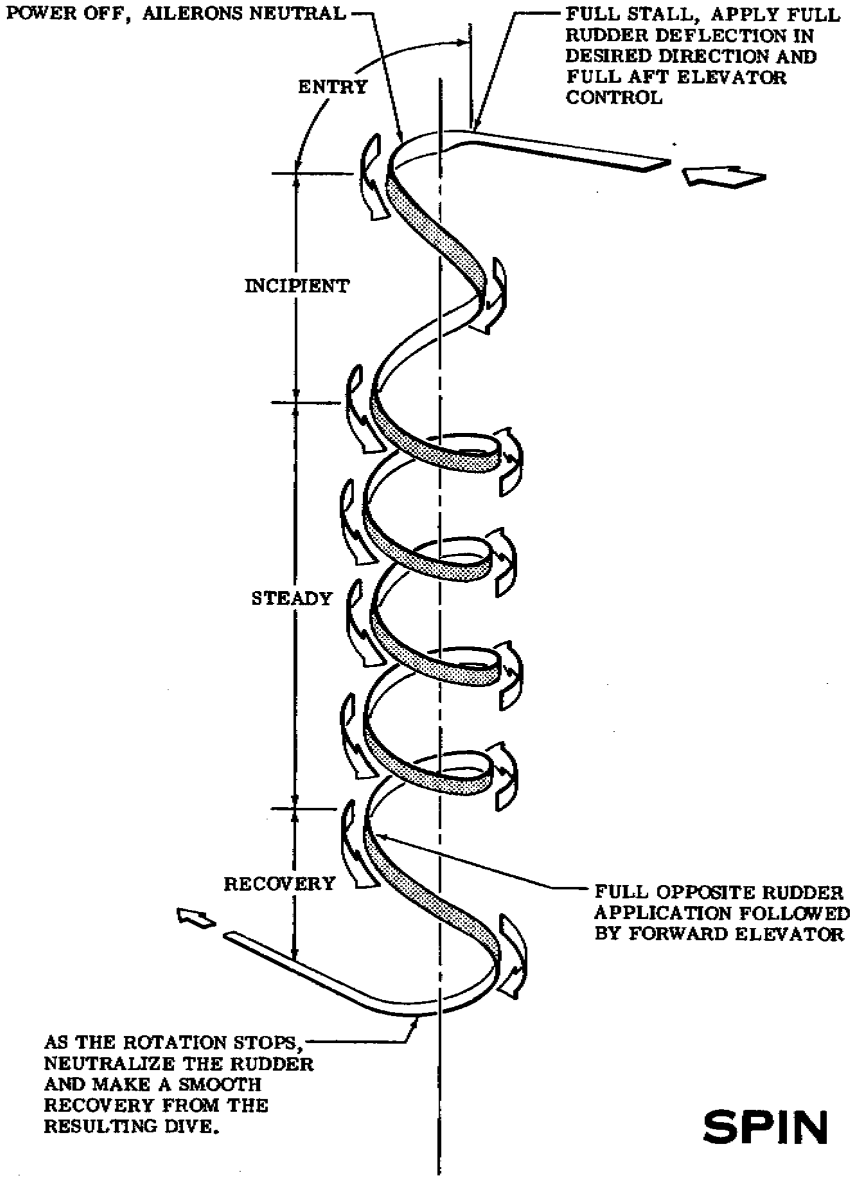
(c) JUST AFTER THE RUDDER REACHES THE STOP, MOVE THE CONTROL WHEEL BRISKLY FORWARD FAR ENOUGH TO BREAK THE STALL. Full down elevator may be required at aft center of gravity loadings in some airplane models to assure optimum recoveries.

(d) HOLD THESE CONTROL INPUTS UNTIL ROTATION STOPS. Premature relaxation of the control inputs may extend the recovery.

(e) AS THE ROTATION STOPS NEUTRALIZE RUDDER AND MAKE A SMOOTH RECOVERY FROM THE RESULTING DIVE.

For the purpose of this discussion, we will divide the spin into three distinct phases. These are the entry, incipient, and steady phases. These are illustrated in the figure. The basic cause of a spin is a difference in lift and drag between the two wings with the airplane operating in essentially stalled flight. Entry to this condition is initiated, intentionally or otherwise, when the airplane is stalled in uncoordinated flight. This causes one wing to reach a higher angle of attack than the other. Beyond stall angles of attack, lift begins decreasing while drag rises rapidly. This causes a sustained autorotation to begin because of the decreased lift and increased drag of one wing half as compared to the other.

Here, in the entry phase, recovery from or prevention of the spin is as simple as normal stall recovery since, in fact, at this point that's all we are really faced with. Coordinated use of rudder and aileron to oppose any tendency to roll should be applied with emphasis on the rudder due to its generally more powerful influence at this point. This should be accompanied by relaxation of elevator back pressure to reduce the angle of attack below that of the stall. Coordinated use of all controls should then be applied to return to normal level flight. During this entry phase re-


POWER OFF, AILERONS NEUTRAL
FULL STALL, APPLY FULL RUDDER DEFLECTION IN DESIRED DIRECTION AND FULL AFT ELEVATOR CONTROL
ENTRY
INCIPIENT
STEADY
RECOVERY
FULL OPPOSITE RUDDER APPLICATION FOLLOWED BY FORWARD ELEVATOR
AS THE ROTATION STOPS, NEUTRALIZE THE RUDDER AND MAKE A SMOOTH RECOVERY FROM THE RESULTING DIVE.

SPIN

covery of control (or prevention of loss of control) will normally be instantaneous for all practical purposes as soon as the stall is broken.

The second or incipient phase covers that period of time from the spin entry to the fully stabilized spin. During this period the yaw being produced by a deflected rudder while the airplane is stalled is supplemented by the differences in lift and drag between the two wing panels. These parameters cause the rotating motion of the airplane to begin to increase.

During this incipient phase, spin recoveries in those airplanes approved for intentional spins are usually rapid, and, in some airplanes, may occur merely by relaxing the pro-spin rudder and elevator deflections. However, positive spin recovery control inputs should be used regardless of the phase of the spin during which recovery is initiated. Briefly, these control inputs should be 1) neutral ailerons and power off, 2) full rudder opposite to the direction of rotation, 3) just after the rudder reaches the stop, elevator briskly forward to break the stall, and 4) as rotation stops, neutralize the controls and recover from the resulting dive. Using these procedures, recoveries are typically accomplished in from 1/8 to 1/2 turn during the incipient phase.

The final phase is the fully developed "steady" phase. Here, a more-or-less steady state spin results where the autorotational aerodynamic forces (yaw due to rudder deflection, lift and drag differences across stalled wing) are balanced by the centrifugal and gyroscopic forces on the airframe produced by the rotating motion. Due to the attitude of the airplane in a spin the total motion is made up of rolling and usually pitching motions as well as the predominate yawing motions. Movement of the airplane flight controls affects the rate of motion about one of the axes. Because of the strong gyroscopic influences in the spin, improper aerodynamic control inputs can have an adverse affect on the spin motion.

Aileron variations from neutral can cause a different balance between the aerodynamic, inertia and gyroscopic forces and cause some delay in recoveries. Typically even a slight inadvertent aileron deflection in the direction of the spin will speed up rotation and delay recoveries. Moving the elevator control forward while maintaining pro-spin rudder deflection may not provide a recovery with some airplanes. In fact, reversing the sequence of rudder-elevator inputs or even just slow, rather than brisk, inputs may lengthen recoveries. Finally, it is important, particularly in this steady spin phase, in addition to using the correct control application and proper sequence of control application, to HOLD THIS APPLICATION UNTIL THE RECOVERIES OCCUR. In extreme cases, this may require a full turn or more with full down elevator deflection.

The proper recovery control inputs to obtain optimum recovery characteristics in Cessna single engine airplanes approved for spins are repeated here and amplified somewhat from those listed under the incipient phase.

(1) VERIFY THAT AILERONS ARE NEUTRAL AND THROTTLE IS IN IDLE POSITION.

(2) APPLY AND HOLD FULL RUDDER OPPOSITE TO THE DIRECTION OF ROTATION.

(3) JUST AFTER THE RUDDER REACHES THE STOP, MOVE THE CONTROL WHEEL BRISKLY FORWARD FAR ENOUGH TO BREAK THE STALL. Full down elevator may be required at aft center of gravity loadings in some airplane models to assure optimum recoveries.

(4) HOLD THESE CONTROL INPUTS UNTIL ROTATION STOPS. Premature relaxation of the control inputs may extend the recovery.

(5) AS THE ROTATION STOPS NEUTRALIZE RUDDER AND MAKE A SMOOTH RECOVERY FROM THE RESULTING DIVE.

The emphasis added to these steps differentiates the steady phase from the incipient phase. The most important difference in the steady phase is an increase in the length of recoveries in this phase for some airplanes, and to a lesser extent the amount of control input needed. Up to a full turn or more to recover is not unusual in this phase. Full down elevator deflection will sometimes be needed to assure optimum recoveries at aft loadings in some airplanes. Therefore IT IS VERY IMPORTANT TO APPLY THE RECOVERY CONTROLS IN THE PROPER SEQUENCE AND THEN HOLD THEM UNTIL RECOVERY OCCURS.

Some of the additional factors which have (or may have) an effect on spin behavior and spin recovery characteristics are aircraft loading (distribution, center of gravity and weight), altitude, power, and rigging.

Distribution of the weight of the airplane can have a significant effect on spin behavior. The addition of weight at any distance from the center of gravity of the airplane will increase its moment of inertia about two axes. This increased inertia independent of the center of gravity location or weight will tend to promote a less steep spin attitude and more sluggish recoveries. Forward location of the c.g. will usually make it more difficult to obtain a pure spin due to the reduced elevator effectiveness. If a spiral is encountered as evidenced by a steady increase in airspeed and

"G" loads on the airplane, recovery should be accomplished quickly by leveling the wings and recovering from the resulting dive. Conversely, extremely aft c. g. locations will tend to promote lengthened recoveries since a more complete stall can be achieved. Changes in airplane gross weight as well as its distribution can have an affect on spin behavior since increases in gross weight will increase inertia. Higher weights may extend recoveries slightly.

High altitudes will tend to lengthen recoveries since the less dense air provides less "bite" for the controls to oppose the spin. However, this does <u>not</u> suggest the use of low altitudes for spin practice.

Airplane rigging can have a strong influence on spin characteristics. Improper elevator and rudder deflection stops can alter the depth of entry into a spin and also can alter the amount of recovery control available. Low cable tensions can alter the amount of travel available at the control surface and may thus reduce the control power available for either entry to an intentional spin or recovery.

Power can affect the spinning attitude. If power is carried in the spin the airplane attitude may be less nose down. In addition the propeller will tend to add some gyroscopic inputs which will be reversed between left and right spins. The effect of leaving power on during a spin may lengthen recoveries on some airplanes.

The foregoing areas have been considered in the design and certification of an airplane. If the airplane is maintained and operated within manufacturers approved limitations, then spin characteristics and recoveries will be acceptable although the trends mentioned above may be evident.

The next several paragraphs will briefly describe the typical spin characteristics of recent Cessna models approved for spins.

<u>150F through 150L</u>
<u>A150K through A150L</u>

Entries at an aft c. g. will be positive from a power off unaccelerated stall. At more forward c. g. locations, a slightly higher deceleration rate may be necessary.

The incipient phase rotation will be rapid and the nose will progress to an average 60° to 70° nose down attitude in the vicinity of two turns.

150F through 150L
A150K through A150L (cont)

At aft c.g. loadings at 2 1/2 to 3 turns as the airplane enters the steady phase, there may be evident some change in character of the spin. The nose attitude may become less steep and rise to approximately 45° to 50° below the horizon. In addition some change in sideslip will be felt and rotation rates will change some. As the c.g. is moved forward this tendency to change character will disappear and spiral tendencies may appear.

Recoveries during the entry and incipient phases will vary from 1/4 to 1/2 turn typically at aft c.g. loadings to practically instantaneous at forward c.g. loadings. Recoveries from extended spins will vary from in excess of a full turn at aft c.g. to 1/2 turn typically at forward c.g. locations.

150M
A150M

Spin characteristics for this model are similar to those of the earlier models except as follows. Entries at forward c.g. loadings will be more difficult to accomplish without more rapid deceleration.

The incipient phase will be almost the same as for the older models but the character change upon entering the stable phase will be subdued but still evident at aft c.g. loadings. The nose attitude change may not be evident at all, although some variation in rotation rate and sideslip may be noted.

Recoveries will be similar to those of the earlier models from all phases although a slight reduction in recovery turns (1/8 to 1/4) may be evident.

152
A152

Positive entries can be made from all c.g. locations by leading with full rudder in the desired spin direction just prior to full up elevator application.

152
A152 (cont)

In incipient phase, nose attitude may cycle beyond vertical during the first turn. The rotation rate accelerates quite rapidly during the first two turns, and the nose progresses to an average 65 to 75° nose down attitude in the vicinity of two turns.

A change in turn rate may be noted in some spins beyond two turns with an approximate frequency of one cycle per turn (speeds up and slows down once each turn). The increase in turn rate is sometimes accompanied by aileron control forces in the direction of the spin (5 to 10 pounds). It is important that the pilot counteract these forces by holding the aileron control in the neutral position. Even small amounts of aileron deflection with the spin may increase the rotation rate and prolong the recovery.

Loads felt during extended spins beyond two turns are generally higher than 1 G. Typically, the "G" loads range from approximately 2.0 "G's" at forward c.g., gross weight conditions to 3.0 G's during light weight, solo occupancy conditions. Spiral tendencies may be evident at the forward c.g. loadings as noted by light elevator buffet, an increase in airspeed beyond 80 KIAS, and a steadily increasing "G" load.

Recoveries during the first two turns may take somewhat more than 1/2 turn typically at aft c.g. loadings to 1/4 turn or less at forward c.g. loadings. Recoveries from extended spins will vary from in excess of a full turn at aft c.g. to 1 turn or less at forward c.g. locations.

172H through 172L (1971)
Utility Category Only

Entries at an aft c.g. (utility aft) will be positive. At forward c.g. locations, more rapid deceleration or some power will be necessary to obtain an entry.

172H through 172L (1971) Utility Category Only (cont)

The airplane will pass rapidly through the incipient phase into the steady phase with little change to note.

Recoveries in the entry and incipient phases will be up to 1/8 of a turn at aft c. g. locations to almost instantaneous at forward c. g. 's. The steady phase recoveries will take up to 1/2 turn at aft c. g. and to about 1/8 turn at forward c. g. locations.

172L (1972) through 172P (Utility Category Only)

Entries at all utility loadings will be difficult to obtain unless some power and a slight amount of aileron toward the desired spin direction are applied.

Throughout the incipient phase, spiral tendencies will be evident and the airplane will usually spiral out of the spin by 2-1/2 to 3-1/2 turns even at aft c. g. loadings (utility aft).

There is no real steady phase with this model. Recoveries initiated at any point in the spin at any loading will result in practically instantaneous recoveries.

R172K (Utility Category Only)

Entries at all utility loadings will be difficult to obtain unless some power and a slight amount of aileron toward the desired spin direction are applied.

Throughout the incipient phase, spiral tendencies will be evident and the airplane will usually spiral out of the spin by 2-1/2 to 3-1/2 turns even at aft c. g. loadings (utility aft).

There is no real steady phase with this model. Recoveries initiated at any point in the spin at any loading will result in practically instantaneous recoveries.

177 through 177B
(Utility Category Only)

Entries are positive although some added deceleration or power may be necessary at forward loadings.

In incipient phase, nose attitude may cycle beyond vertical during the first 2 turns.

In the steady phase spiraling tendencies will be evident especially at forward loadings. Nose attitude will be in the area of 60° nose down.

Recoveries during the entry and incipient phases will take no more than 1/4 turn and during the steady phase up to 3/4 turn regardless of loading.

For the purpose of training in spins and spin recoveries, a one or two turn spin will normally provide all that is necessary. All of the characteristic motions and control inputs required will have been experienced. Longer spins, while acceptable as a maneuver in appropriately certified airplanes, provide little additional insight to a student in the area of spin recovery since the prime reason for conducting a spin is to learn how to avoid an inadvertent entry in the first place and then how to recover if one should develop.

It is recommended that, where feasible, entries be accomplished at altitudes high enough to complete recoveries 4000 feet or more above ground level. At least 1000 feet of altitude loss should be allowed for a 1 turn spin and recovery, while a 6 turn spin and recovery may require somewhat more than twice that amount for the Cessna Models 150, A150, 152, A152, 172, R172 and 177. For example, the recommended entry altitude for a 6 turn spin would be 6000 feet above ground level. In any case, entries should be planned so that recoveries are completed well above the minimum 1500 feet above ground level required by FAR 91.71.

Another reason for using high altitudes for practicing spins is that a greater field of view is provided which will assist in maintaining pilot orientation. However, if disorientation does occur and precludes a visual determination of the direction of rotation, the symbolic airplane of the turn coordinator or the needle of the turn and bank indicator (not the ball) may be referred to for this information.

Finally, a pilot planning to spin a new model for the first time or after a long absence from this type of maneuver should first fly with a qualified instructor pilot who can point out key points in the spin and recovery process for this particular type of airplane. The weight and balance should be checked carefully to assure that the spins will be conducted at an approved loading. As previously stated, plenty of altitude should be maintained at all times. Owner's Manual procedures for the spin and spin recovery should be rigorously followed for the optimum and most repeatable characteristics.

Understanding of the information provided in this bulletin and adherence to the recommendations will assure each pilot the utmost safety of his flight.