Spin Training Issues

Background

- There is a long history of fatal spin accidents and reports of delayed spin recoveries in types approved for intentional spinning. Even more concerning is that these accidents and incidents have involved instructors who have been authorised to teach spins!
- This CASA magazine article mentions “a cesspit of misinformation, half-baked truths and misshapen facts”. https://www.flightsafetyaustralia.com/2017/12/the-unreachables-are-they-unteachable/
- That statement is certainly true! This note discusses the evidence for that comment.
- “Throughout aviation history situations have arisen wherein half truths and rumours relating to the characteristics of a particular aircraft type have engendered uneasiness and doubt as to its true performance, often to a stage where safety is seriously compromised. Where this has happened confidence has only been restored after the issue of competent judgement based on indisputable facts.” From the Chipmunk article in 1960 below.
- It is long overdue for those indisputable facts to be imbedded in flight instructor training guidance material.
- Improvements in the training of spin instructors’ knowledge is indicated so this notes makes some specific recommendations on this.
- We should start with the definition of a spin and the only one that really matters is this one from Reference 14 because this is the

definition used by those who write the text about spinning in the AFM/POH.

(1) *Spin*. A spin is a sustained autorotation at angles-of-attack above stall. The rotary motions of the spin may have oscillations in pitch, roll, and yaw superimposed upon them. The fully developed spin is attained when the trajectory has become vertical and the spin characteristics are approximately repeatable from turn to turn. Some airplanes can autorotate for several turns, repeating the body motions at some interval, and never stabilize. Most airplanes will not attain a fully developed spin in one turn.

- Note there is no mention of an incipient spin anywhere in Reference 14.
- Only the first line is the definition and the last part is superfluous so: ***a spin is a sustained autorotation***!

Some History

- Decathlon VH-ERB Spin Accident 21/8/78

6. RELEVANT EVENTS

The pilot was an experienced flying instructor and aerobatic pilot and held a general authorisation to conduct aerobatic flying below 3000 feet but not below 500 feet above ground level. He was also authorised to conduct an aerobatic display at Newman down to a height of 500 feet on the day before the accident. On that day, he flew the aircraft from Port Hedland to Newman and, after completing his aerobatic display, which commenced with a spin, he commented that the spin had been made with engine power on and more height had been lost during this manoeuvre than he had intended.

On the next morning, the pilot telephoned the Port Hedland Briefing Office and submitted flight plan details for a return flight from Newman to Port Hedland. The aircraft was refuelled to capacity and the pilot carried out a pre-flight inspection. He indicated that he would do a couple of "simple manoeuvres" after take-off before setting course for Port Hedland.

The surface wind was from 080° at three knots, there was no low cloud and visibility was unrestricted. After a normal engine start and warm-up period, the aircraft took off into the north-east and climbed in a left circuit pattern until it was again heading north-easterly, parallel to and to the south-east of the runway. During this period, the pilot broadcast by radio his intention to "carry out aerial work" in the vicinity of the aerodrome for three minutes before departure. At a height variously estimated from 2000 to 4500 feet above ground level, the aircraft made a steep turn in each direction and then resumed a north-easterly heading in a nose-up attitude. Engine power was then heard to decrease and the aircraft entered a spin, probably to the left although one of several witnesses believed it was to the right. As the spin progressed, the nose attitude appeared to steepen to the near vertical. After making four complete turns, and after the fifth turn commenced, the aircraft struck the ground some 600 metres south-east of the aerodrome terminal building. There was no fire.

Detailed examination of the aircraft wreckage indicated that it had struck the ground in a nose down attitude of some 60° to 70° below the horizontal. At the time of impact, it was not rotating about the vertical axis to any degree which suggests that the pilot had initiated partially successful action to recover from the manoeuvre. There was no evidence of any defect or malfunction which might have contributed to the accident.

Back then we didn't know as much about spinning as we do now:

- Before the internet it was much harder to gain information
- NASA has done much research into spinning of GA aircraft however the Decathlon AFM, even for current production aircraft (apart from the new Xtreme Decathlon) has not been updated with new relevant information. Specifically, consideration of action to avoid an accelerated spin with the resultant delayed recovery.
- In any case, back then all aircraft were required to have an Australian-specific AFM which had different, often scant information compared to the original.
- Additionally, flight schools were required to develop their own "Handling Notes" for aircraft and pilots used these rather than the

original documents that came with the aeroplane. Different flight schools had different content for the same aeroplane.

- Zlin VH-ILZ Spin Accident 14/5/91

Aircraft Details: Moravan Zlin-Z326
Registration: VH-ILZ
Serial Number: 304
Operation Type: Private
Damage Level: Destroyed
Departure Point: Moorabbin VIC
Departure Time: 1303
Destination: Moorabbin VIC

Approved for Release: 14th May 1991

Circumstances:

A ground witness heard the aircraft's engine power increase and observed the aircraft pull up, roll over and enter a spin to the right. He estimated the aircraft was about 3000 feet above the ground. The aircraft spun six to eight turns to the right and at about 600 feet above ground level the right spin ceased before the aircraft entered a spin to the left. The left spin stopped after about one turn and the aircraft appeared to be recovering from the dive when it hit the ground in a wings level, 45 degrees nosedown attitude. The pilot-in-command, who occupied the rear seat, held a low level aerobatic approval to operate down to 1000 feet above ground level. He had often spun the aircraft but is reported to have normally recovered after two turns. The other pilot who occupied the front seat, held an aerobatic endorsement but this was his first flight in a Zlin. It is not known which of the pilots was at the controls when the aircraft entered the right spin, however, the aircraft was normally commanded from the front cockpit. Injuries sustained by the pilot-in-command indicate that he was at the controls at the moment of ground impact. The normal technique prior to the entry of an intentional spin in the Zlin is to reduce power to idle. Considering the report that engine power was increased prior to the spin, it is possible that the spin entry was unintentional. It is the recommended practice in the Zlin to recover from a spin after two to three turns. Why the pilot(s) failed to recover from the right spin after two to three turns could not be determined. An examination of the wreckage and associated aircraft documentation did not reveal any fault that may have contributed to the accident. The prevailing weather was not considered a factor.

  - This was in the time when the Australian-specific AFM was in use. I haven’t compared that with the original AFM however just noting that the Zlin had a very specific spin recovery method which was quite different from that applicable to the other types that the experienced aerobatic pilot was familiar with.

Chipmunk

- Extracts from Reference 17 in 1960. The complete document is reproduced in Reference 2 apart from the foreword below:

On examining the material for this issue of the Digest, it seemed appropriate that the article entitled "The Chipmunk Spin" should be given the prominence of first place. The subject has been of considerable concern to the Department and has been under very close scrutiny over a lengthy period. Controversial viewpoints have been held in this matter and the widespread interest that has been aroused fully justifies the attention now given to it in this article.

Throughout aviation history situations have arisen wherein half truths and rumours relating to the characteristics of a particular aircraft type have engendered uneasiness and doubt as to its true performance, often to a stage where safety is seriously compromised. Where this has happened confidence has only been restored after the issue of competent judgment based upon indisputable facts. I believe the point now reached in relation to the Chipmunk spin calls for such action.

My purpose in writing these few words is to express my personal faith in the judgment underlying the confidence expressed in the article. I hope that it will not only be of general interest to instructor and student alike but will achieve the purpose of convincing all concerned that there is no justification for a belief that the Chipmunk is in any way unsuitable or unsafe for both dual and solo training in spinning exercises.

D.G. Anderson

Director-General of Civil Aviation

The first De Havilland report on Chipmunk spinning was issued in 1956 and summarised the experience of pilots who had spun something like 1,000 Chipmunk aircraft, before delivery, in normal and extreme conditions of centre of gravity. The report stressed the need to differentiate between the spin and the spiral and emphasised the importance of using correct entry and recovery procedures. It was pointed out that in most cases the aircraft will first spiral from the stall and as many as three turns may result before the spin proper is entered. This report also

After considering these reports and the results of tests conducted in Australia, the Department decided that each and every Chipmunk should be spin-tested at maximum all-up-weight and with the centre-of-gravity fully aft, fully forward and neutral. In the case of each aircraft on the Australian register its behaviour was found to be normal, in that the spin characteristics and responses to controls were safe and within the performance envelope described by the manufacturer. The temporary spin limitations were then removed.

The aircraft was then instrumented for the spinning tests. The edges of the perspex panels in the canopy were indexed so that, in the spin, an observer could note and record where the horizon cut the canopy on both sides. From these records the angle of the mean chord of the aircraft above or below the horizon could then be measured with the aircraft in the rigging position. An accelerometer was rigidly mounted on the coaming between the cockpits and the ball of the turn and bank indicator was indexed to facilitate precise measurements. Finally, a stop watch was used to record the time per revolution in the spin.

The spin evaluation programme then started in earnest and almost 100 spins were carried out as well as many experiments in respect of flying control and engine power settings in order to determine the effectiveness of these factors in altering the spin characteristics of the aircraft. Before any spin measurements were taken the circumstances of the incident were simulated to see whether the aircraft's reported behaviour could be easily reproduced using a normal entry technique. Although four spins in both directions, including one of 13½ turns, were carried out, recovery was at all times positive with the stick reaching approximately the neutral position.

knots. It was found that this aircraft had three distinct spinning modes characterised by angles of the mean wing chord below the horizon of 24 degrees, 35 degrees and 43 degrees. Each of these angles were achieved on several occasions and in almost all cases it was apparent that a state of equilibrium had been reached. It is interesting to note that the spinning mode most commonly achieved was the flattest of the three observed (i.e. mean chord 24 degrees below the horizon) and that it was almost the inevitable result of a spin entry using the prescribed standard technique.

sideslip. The tests did not reveal any simple correlation between entry techniques and the spinning mode but, nevertheless, factors such as an aft centre of gravity position, applications of power, use of full back stick and full rudder from a low nose position at entry all tended to flatten the spin attitude. There is an interaction of so many variable factors in spin initiation that the spin characteristics may appear to be unpredictable, but it is considered that this is a false impression and that the aircraft wil repeat a spinning mode without exception if a consistent entry method can be repeated with sufficient precision.

(f) Recovery from the spiral using the standard spin recovery method is quick and, in fact, the aircraft will stop spiralling if the controls are released.

(g) The aircraft will not recover from the spin proper by releasing the controls and proper spin recovery action must be taken.

(h) The aircraft may not always adopt the same spinning mode or even a steady spin pattern. Variations in respect of attitude, spin radius, speed of rotation and rate of descent must be expected because of the inevitable small variations in entry technique.

(i) *The proper recovery technique requires full opposite rudder and the stick must be moved progressively forward until the rotation stops* — in some cases full forward stick may be necessary and care must be taken to ensure that the harness adjustment will enable this position to be reached.

(j) The number of turns from recovery initiation to actual recovery can be as many as 3½ turns and full spin recovery control must be maintained until the rotation is stopped — *interruption of this control application will only delay the recovery.*

(k) In all cases application of spin recovery control will tend to lower the nose and speed up the spin rotation — *this is a sure sign that the recovery process has begun and full recovery will eventuate.*

(l) Frequently the resistance encountered as the stick moves forward will be high and this could be confused with the stick having reached the forward limit of travel. A conscious effort is necessary to avoid this confusion.

(m) Despite many reports, there has been no confirmed case of a Chipmunk failing to recover from a spin if the standard recovery technique is applied *and held on* — nor is there any confirmed evidence which would cast doubt on the aircraft's spin recovery ability.

- That was over forty years ago but there are some lessons from this. Reports of aircraft not recovering from a spin or abnormal behaviour in the recovery. "… half truths and rumours …." according to the Director-General of Civil Aviation. That sounds very familiar now?
- Chipmunk VH-UPD Spin Accident 29/6/14 from Reference 2.

"The flight instructor …. did not teach the method to recover from a developed spin that was appropriate ...

The spin recovery methods taught by the flying school were inconsistent across instructors and training material, and were not always appropriate for the Chipmunk aircraft type used by the school. The approval for the accident aircraft's flight manual had been revoked, and the flight manual in use lacked the spin recovery instructions."

  - That same Australian-specific AFM was an issue – it had been in the aeroplane for over 50 years but CASA had withdrawn its approval in 1999. But why didn't it have the correct spin recovery procedures in it anyway?

    - Why didn't the instructor know the correct method for the Chipmunk? If he had done another turn or two of a spin himself he would've found out that he had it wrong.
    - This was a clear warning that instructor spin training was deficient however the ATSB did not issue a Safety Advisory Notice to alert others of the general problem.

- There is more information publicly available about spinning the Chipmunk than there is about any other type. There is the report from production spin tests of 1000 examples. Australia conducted spin tests on every Chipmunk on the register as well as comprehensive instrumented spin tests on one example.
    - When you read documents for other types compare the scope of information with that of the Chipmunk regarding the range of CGs and different entry techniques.
    - Certification spin tests are also very comprehensive however are generally not made public. I'm aware of the content of such spin tests for several model Pitts as I was Vice-President Engineering and a production test pilot at the factory.

Cessna and FAA in the 1970s

- From Ref 8 page 81 “In the early 1970s …. a couple of flight instructors reported difficulty in recovering from spins. A representative from the FAA subsequently flew many different 150s with Cessna test pilots. No problems were found with the airplanes. The FAA representative then went into the field to address questions about the 150’s spin characteristics. The representative was met with considerable misunderstanding about spins in general and the Cessna 150 in particular. ….. The instructors responsible for launching this investigation apparently did not know the effect of aileron inputs during spins. Nor did they understand the importance of proper recovery control sequencing. Recognizing this problem, the FAA published an eight-page Flight Instructor Bulletin devoted to spinning. The FAA also sponsored a prototype stall/spin clinic and Cessna published a supplementary pamphlet … “ - see References 4 & 16.
- The NTSB wrote “Detailed investigation by the FAA, however, disclosed that problems were related to operational vagaries or anomalies, inadequate knowledge regarding the precise spin recovery procedures for the airplane, improper application or misapplication of recovery controls, apprehension, and confusion.”
- Similar story to the Chipmunk back in 1960.

Cessna Spin Information

- The Cessna document, Reference 4, on the spin characteristics for various single engine models is readily available however not promoted and it seems that few are aware of it. However, reference 7 includes the relevant information and should be the textbook for instructors teaching spins and aerobatics in the Cessna 150 or 152. It is readily available.
- So why do we see Australasian flight schools publish stuff like this:
    - Incipient spin recovery method contrary to Cessna recommendations – I wouldn't argue if it was at the immediate stage and it occurred during aerobatics – but to say it will work "before the spin has stabilised" is misleading. "If the spin becomes fully developed and the incipient recovery actions are ineffective, carry out the Standard Spin Recovery. (See below)."
    - "Regardless of how the spin is entered or for how many turns it is sustained, the following recovery technique is to be used:
        - Check that the ailerons are neutral and the throttle is fully closed;
        - Check the direction of spin on the turn coordinator;
        - Apply and maintain full opposite rudder;
        - Move the control column ***progressively*** and centrally forward far enough to break the stall;
        - Immediately rotation ceases:
            - Centralise all controls;
            - Level the wings; and
            - Ease out of the dive.
- Why teach the above contrary to the POH?

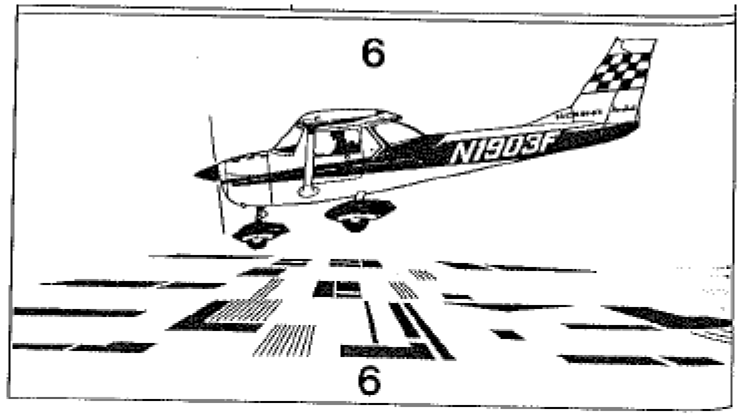


Fig. 3-9. Steps recommended for spin recovery in the Aerobat. (1) Close the throttle. (2) Neutralize the ailerons. (3) Get the flaps up (if they are down in an inadvertent spin). (4) Apply full rudder opposite to the rotation. (5) Apply brisk forward motion on the wheel. (6) Neutralize the rudder and pull out of the dive. (More details about various models later in the chapter.)

- What do you do if it doesn't recover – a very important question?
- The instructions from this flight school are dangerous:
  - Having done what is believed to be the correct control inputs then simply checking is inadequate. If the elevator was moved prior to the rudder or if the elevator was not moved briskly per the POH then thinking back to what the pilot thought had been done and looking at where the controls are misses a lot.
  - Give it enough time to work first. Return to the "known condition" is the principle. Move the yoke back. Then run through the correct spin recovery actions per the POH. Guaranteed to work.
  - Recall that the ailerons will want to trail inspin and may require significant force to hold the yoke neutral otherwise recovery will be delayed.
  - The emergency recovery procedure described below is Beggs-Mueller which we know will not work in the Cessna! Both Beggs and Kershner have confirmed that – albeit for only two specific spin modes.

Delayed Spin Recovery

If the spin continues after carrying out the **Standard Spin Recovery** technique, confirm:

- That the throttle is closed;
- The direction of spin as indicated on the turn coordinator/needle;
- That the correct control inputs have been made; and
- That the flap has not inadvertently been applied.

When the above actions have been completed the **Emergency Spin Recovery** may be attempted. This is a characteristic of **most** aircraft types.

For the C152 Aerobat the **Emergency Spin Recovery** technique is to apply full opposite rudder and release the control column.

The varying airflow will cause the control column to settle in such a position that the balance of aerodynamic and inertial forces is broken. When the spin has stopped, reapply control and ease out of the dive.

Failure to recover is highly unlikely with modern light aircraft. However if experienced, attempt to recover by rocking the aircraft with power applications coordinated with elevator control. Pushing with full power and pulling with throttle closed. Coordinated flap application is considered to be worth trying.

If recovery has not been successful and parachutes are worn, abandon the aircraft by 3000ft AGL.

- In Reference 7, Kershner describes this exercise which suggests that a Cessna will recover "hands off":

Hands-off recovery. As indicated earlier, a good demonstration of *recovery* would be to set up a power-off, wings-level spin entry and at one to two turns quickly remove hands and feet from the controls. (Count the turns and let go at "TWO" or "NOW.") The response of one airplane, hands off, at two turns in a left spin is a movement of the control wheel to the left (the airplane gives itself left aileron) and then a recentering of the wheel as it moves forward and the spin recovery is completed. As noted, if the airplane is trimmed slightly nose-up before the spin, it will pull out of the following dive by itself after the recovery. You'll then adjust power and trim for cruise, climb, etc. It's a good confidence builder if done properly and shows

- In 1978, Cessna's test pilot mentioned that demonstration of a "hands off" recovery after two turns in a 150 and stated that it took much longer than the POH method. He went on to say that there was no certification requirement to test a "hands-off" recovery. Just because it worked from a normal spin after two turns does not mean after that or that it will work from other spin modes.
- Kershner unfortunately doesn't expand on that in Reference 7 however he does so in Reference 21!

In N7557L (3693 spins) a 2-turn hands-off recovery was demonstrated starting the *left* spin with full power, closing the throttle at 1 turn and at 2 turns releasing the wheel and getting off the rudder. The airplane was trimmed nose-up before the entry for "show business" purposes (this was always explained to the trainee) so that the airplane would pull out of the dive after the spin was stopped (still hands off) without an excessive loss of altitude. If there was a delay of more than ¼ turn of closing the throttle *or* releasing the prospin controls, the airplane would not recover on its own but the wheel would turn left into the spin and ride back slightly, requiring the recovery steps for a developed spin unless the back pressure had been relaxed during the entry process and a spiral had started to develop.

The airplane (N7557L) had a tendency to pitch down at 4 turns with a temporary increase in rotation rate at 5 turns. The hands-off recovery at 2 turns was demonstrated once, followed by trainee practice. The airplane would *not* recover hands off from 2¼ to 3½ turns, but if the trainee delayed releasing the controls until 4 turns, in many cases the airplane would drop its nose and recover, leaving the writer to reexplain that in the incipient spin (0–2 turns) the airplane would recover hands-off and at the 4-turn point *for this airplane* it would *sometimes* recover but at no other point in the developed spin.

In developed left spins in N7557L, opposite (right) rudder *alone* would not alter the rate of rotation or start a recovery. Making sure that the throttle was closed and *releasing the wheel* while holding full opposite rudder resulted in a faster rotation because the ailerons, when freed, would move to a prospin condition. The C-152 ailerons were still effective in the spin and the "automatic" prospin deflection increased the roll rate in extended left spins. The control wheel also tended to move slightly rearward, but there was never a problem in recovery.

Some of the C-150s spun better to the right than to the left (see Fig. 21-13 again) whereas the C-152s spun by the writer entered and spun well to the left, but tended to spiral out in a right entry. This was noted by an increasing airspeed. An immediate recovery from the spiral was accomplished.

It was found that closing the throttle alone just as an inadvertent spin starts was as effective as applying opposite rudder alone (though you should do both in that case).

- As for "rocking the aircraft with power applications coordinated with elevator control". That is also in CASA's FIM, Reference 10. I was told many years ago that someone tried that in a Tiger Moth, or perhaps it was a Chipmunk, and it worked so the technique has stuck but, it seems to me, it is not much better than a rumour. What is the source data for this? We need "competent judgement based on indisputable facts" as we have from the manufacturer's certification spin tests. We need data as Beggs has given us or an engineering analysis based on proper spin dynamics.
    - Certified aircraft approved for intentional spins undergo rigorous and extensive testing. The recovery procedure in the AFM/POH (also on a cockpit placard) is guaranteed to work unless there is a relevant fault with the aircraft. Stick with what is known to work! Reset and check as above if required but give it time.

Use of Parachutes

- That last extract prompts this discussion. If you are going to wear a parachute you need adequate training in its use plus the discipline of using it as briefed. Egress procedures must be rehearsed every flight.
- To avoid jumping out of a perfectly good aeroplane then you would need to do the training exercises high enough above your hard deck. Hard deck consideration needs to consider the type of aircraft and the time required for two people to get out.
- Read the article at Reference 19.
- In a Decathlon the instructor has to get the student to eject the door, student to get out first and then the instructor - that can use up a lot of altitude. I am aware of two fatal accidents where parachutes have been used - in both cases only one person got out and the other did not.
- In something like a Pitts my briefing is something like: I will say "bail out" three times and on the third time I won't be there. I am aware of fatal accidents where there had been sufficient height but the pilot left the decision too late.
- Another consideration is weight and CG. Most aerobatic aircraft are fairly tight for useful load and some can be tight for loading within the allowable CG range.
- Further guidance on the use of parachutes is in References 20 and 21.

Cessna A150 Spin Accident 23/6/21 Discussion

- Reference 1 mentions the possibility of a flat spin. NASA defines a flat spin as 0-25^O below the horizon and a moderately flat one as 25-45^O below. Cessna notes that the 150M, at aft cg loadings, the nose may raise to 45-50^O below after about 2½ to 3 turns. So moderately flat is not abnormal.
- Video #1 shows a flat spin to the left in a Cessna 152 with full inspin aileron with prompt recovery.
- Ref 5 explains the behaviour of the Pitts in detail. Some books on spinning are written by those who are familiar with the Pitts and other advanced aerobatic airplanes and so describe the effect of ailerons in those types and present it as general behaviour applicable to all types.
- Even Ref 9 goes down this path with a detailed explanation of the effects of aileron in a spin "One of the easiest ways to flatten a spin and make it unrecoverable in some airplanes is to use aileron opposite the spin." The author does however recognise that it is not general behaviour for all types.
- Effect of ailerons in the C150 is opposite to the effect of ailerons in the Pitts and Decathlon. Reference 11 states "The use of inspin aileron in a Cessna 150/152 Aerobat has the opposite effect to what you would expect. Inspin aileron causes the spin to go flat." Reference 4, and repeated in Reference 7, only goes as far as stating "Typically even a slight inadvertent aileron deflection in the direction of the spin will speed up rotation and delay recoveries."
- Reference 6 goes further: "… regarding the use of ailerons in the Cessna 150. I found that in spins both to the right and left, the use of full opposite aileron (outspin aileron), would always produce a recovery from the spin! This is completely backwards to the results obtained in all other aircraft that I have flown. … In the Cessna 150,

the use of "in-spin" aileron always increased the rate of rotation and steepened the pitch attitude …"

- Reference 10 states "The effect of the ailerons will vary between aeroplanes. Putting the control column (or control wheel) in the forward corner (i.e. in-spin aileron) opposite to the rudder will probably have the best effect" so even CASA provides advice contrary to the behaviour of the Cessna 150.
- Some books promote the Beggs-Mueller emergency spin recovery technique as being generally applicable. Reference 6 clearly states that it is not applicable to a number of types, including the Cessna 150.
- A spin instructor trained on other types who does not read beyond the POH would likely be unaware that it behaves differently in aggravated spins.
- We know from Reference 22 that the aircraft moments of inertia are significant in the spin and recovery characteristics of aircraft.

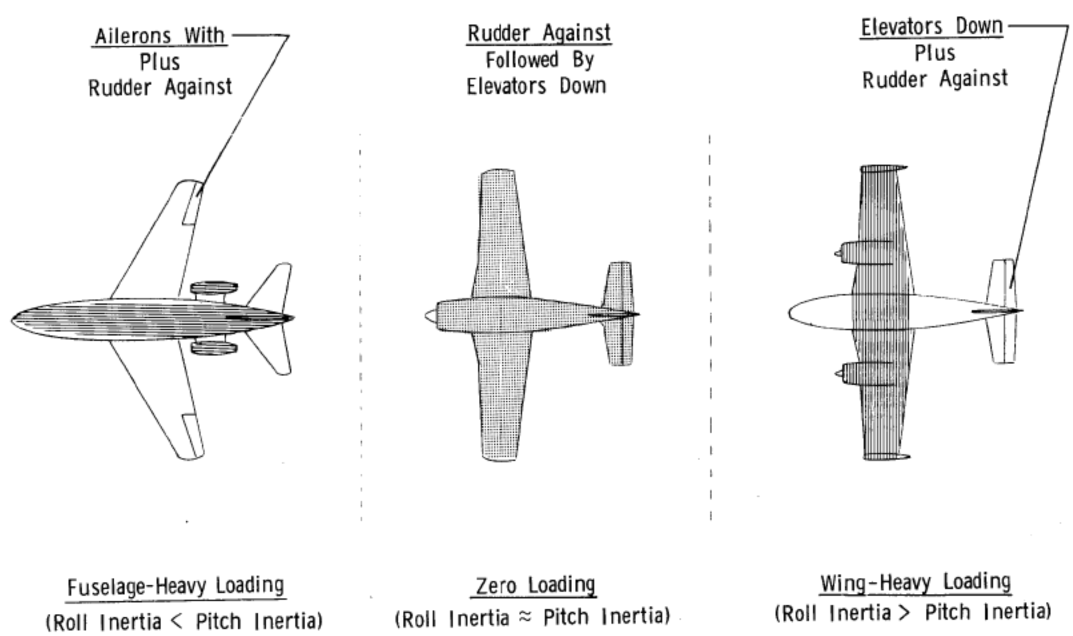


Figure 4.- Primary recovery controls as determined by mass distribution.

- Video #2 illustrates the airflow over the tail of a Cessna 152 in a spin. Catherine Cavagnaro makes the point that the elevator is the primary control for spin recovery in the Cessna.
- The ATSB report mentioned an earlier incident in 1995 with delayed recovery in a spin. Two fairly heavy crew with the seats in the aft position and a substantial fuel load. It was attributed to a rear CG. "the instructor believed … had entered a flat spin". Reference 4 or 7 provide adequate guidance on a more likely scenario:
    - "… 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." See reference 18 for an explanation. Consider the extra fuel in the wings as that is more significant in increasing inertia than the crew.
    - "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."
    - "The effect of leaving power on during a spin may lengthen recoveries on some airplanes."
    - The comment below on the ATSB's Facebook page is interesting and it would be good to discuss these comments with that person.

> I have questions. I knew the instructor reasonably well and worked with him at another flight school.
>
> I specifically remember discussing our experiences teaching spin recovery on that schools (non aerobatic) C-152s. Specifically how each aircraft seemed to behave differently with the same recovery technique applied, and how reluctant we were to push these airframes, which were ageing and in poor condition. For this reason I believe he had spinning experience on a very similar type.
>
> That said, I don't recall the C152 spin recovery ever requiring moving the control column forward briskly. Quite the opposite, just "relaxation" of the back pressure was taught. Generally, the nose was so low after two rotations that you were more worried about the rising airspeed and recovery from the dive.
> For this reason, he may have thought the Mueller/Beggs method would also be effective in the A150 and was lulled into a false sense of security.
>
> I also trained in the Pitts but that is the only aircraft I would have considered applying it in. I also wonder, given the previous incident in CYO, if there was some peculiarity with this aircraft or is there a common tendency for A150s to spin flat/recover slowly?

- Did they have References 4 and/or 7 as guidance?
- Why teach a method contrary to the POH anyway? After all, that is a CASA requirement, apart from the logic of adhering to guidance from the manufacture following testing of aggravated spin modes.
- There is indeed “a common tendency for A150s to spin flat/recover slowly”! That information is readily available and those instructors should have known about it and how to avoid the situation.

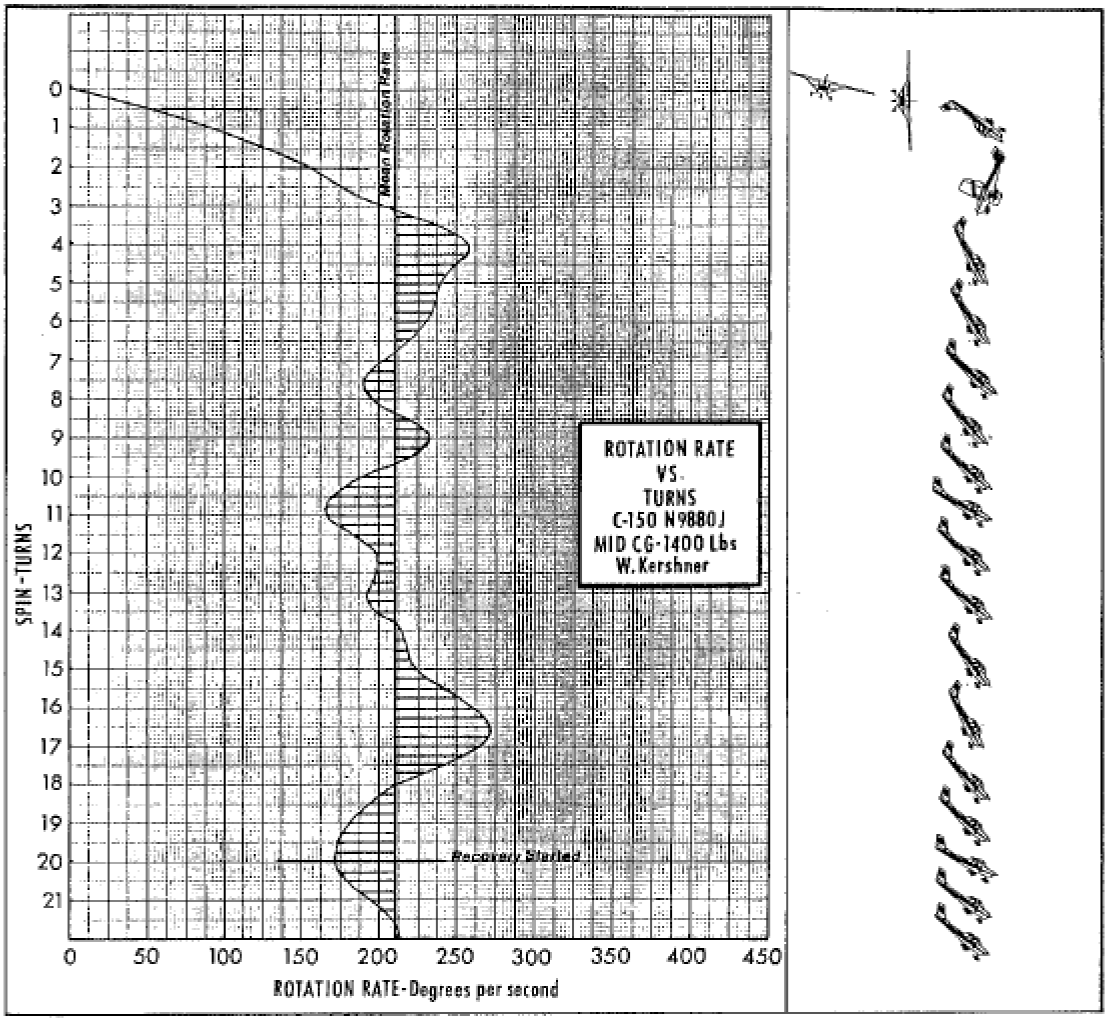


Fig. 3-4. Rotation rate versus turns for a spin in a Cessna 150 Aerobat. The airplanes on the right side of the illustration show the approximate pitch attitudes at the various turns and rotation rates. Note that for this airplane the higher the pitch attitude, the slower the rate of rotation. Figures 3-4, 3-5, and 3-6 were done as research for this book and show the reactions of a *particular* airplane. Again, it's suggested that you limit your spins to six turns or less – *your* airplane may have different spin and recovery reactions.

- Were they using the spin entry procedure described in the POH for a positive entry to the spin? When I did my flight instructor course I trained on a Cessna 152 and a PA-28 Warrior II. I was instructed on the application of the positive entry method in the POH and further described in References 4 and 7. The aggressive entry results in a motion as shown in this diagram below by Kershner – inverted at the first ½ turn of the spin.

- Incidentally, when coaching competition aerobatics in the Cessna A152 I use an entry technique which minimises the points reduction from the judges however I still enter with some power on and aggressive elevator movement lagging the rudder input. See Video #3.

Decathlon Spin Issues

- I occasionally hear from flight instructors who have experienced delayed recoveries and I ask what they did. My response is invariably that they were lucky to survive with that action.
- I failed one candidate for a spin training endorsement because his spin recovery method was contrary to that in the AFM and did not work – we eventually flew together and I suggested that he try his method and he saw why I had failed him. It just kept spinning.
- To see something like this in a current book based on flying the Decathlon is troubling:

> **Letting go of the controls**
>
> Most modern airplanes will eventually recover from an inside spin on its own if you let go of the stick and rudder controls (see research done by German pilot Eric Müller and American pilot Gene Beggs). This lesson, however, describes an assertive recovery procedure that minimizes altitude loss. You want an effective, reflexive skill-set in place in case a spin ever takes you by surprise.

- Nope, neither Mueller nor Beggs stated that! Furthermore, Beggs stated that the Decathlon is one of the types for which the Beggs-Mueller method does not work for some spin modes.
- The trainee survived the Decathlon accident of Reference 23 when the instructor persisted with demonstration of the Beggs-Mueller technique in an inverted spin. Quite similar to the recent Cessna A150 accident however illustrates the benefit of a parachute.
  - It also highlights the importance of a practical hard deck and the discipline associated with the use of parachutes.

Current Issues

- Reference 10 has a number of deficiencies with spinning, depending on the type that a pilot is flying. References 12 and 15 are better. Specific instructions on the use of elevator appropriate to the particular type is vital.
- Reference 10 states "…. full opposite rudder. After a brief pause ease the control column forward progressively until the spinning stops." That is incorrect for most types used in spin training in Australia. For example, Reference 14 states "Recoveries should consist of throttle reduced to idle, ailerons neutralized, full opposite rudder, followed by forward elevator control as required to get the wing out of stall and recover to level flight. For acrobatic category spins, the manufacturer may establish additional recovery procedures …" There is no "pause".
- CASA stealthily withdrew CAAP 155-1, Aerobatics, in December 2021 and is intended to be replaced by AC 61-18 Aerobatics.
- Per the accident report, Reference 1, and much training material the CG is described as having an effect on spin and recovery behaviour. That is true however the moments of inertia are more significant parameters. Certainly, add mass away from the CG and the CG will move however the pitch and yaw inertia also change. Add fuel in the wing results in increased roll and yaw inertia with little change in CG yet noticeable changes in spin behaviour.
- The above information was introduced in Cessna's spin document.
- I have provided a more technical overview of the effect of inertia in Reference 18.
- CG is a function of the first moment whereas these inertias are second moments – distance squared multiplied by the mass. Recall the Beagle Pup where a mass ballast had to be added to the tail for spinning.

- Sure, the CG was further aft but a more significant effect was the increase in yaw and pitch moments of inertia. From the table below, that decreases B/A, the ratio of pitch to roll moments, so it changes the spin behaviour from spiral tending towards flat.

2.12 Effects on Type of Spin of Changing Aircraft Parameters

The type of characteristics of the spin can often be changed by changing the control setting, inertias, CG position, etc, and a general indication of the effects of these changes is given in the following paragraphs.

Using the notation:

a = Spiral dive
b = Oscillatory spin
c = Normal smooth spin
d=Flat spin

And where a→d represents a change of an oscillatory spin to a normal smooth spin, or a normal spin to a flat spin, etc (d→a indicates changes in the reverse direction). The type of spin obtained from any given change obviously depends upon the initial conditions but the trend is indicated below:

1	Increasing B/A	d→a
2	Decreasing B/A	a→d
3	Increasing AUW the effect is small but tendency is	d→a
4	Moving Co aft the effect is small on most types of Aircraft in a and b class but aircraft with spins of Type c and d are very sensitive to Co positions.	a→d
5	Increasing wing span	a→d
6	Increasing fin size	d→a
7	Increasing body damping (Fitting strakes or changing body section)	d→a

- It also has the effect of making inspin aileron less anti-spin, perhaps even to pro-spin as shown in the diagram below.
- Ailerons will tend to float inspin during a spin because of the local airflow and the loads generated on the aileron. When the aileron effect is anti-spin then one might expect that type of aircraft to be a candidate for successful use of Beggs-Mueller.

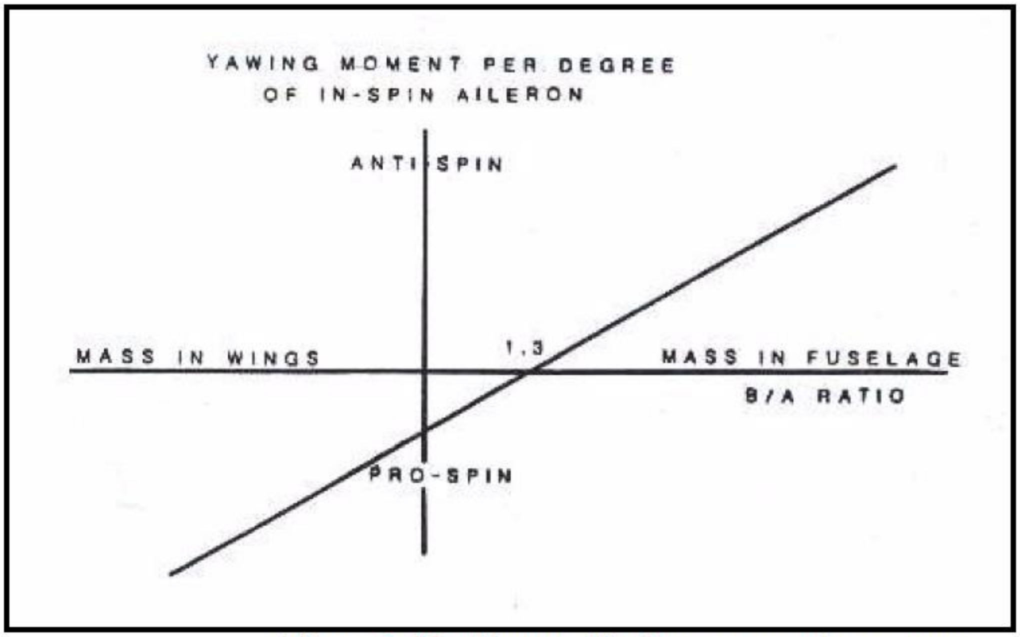


Figure 2-15: Aileron effectiveness on spin recovery

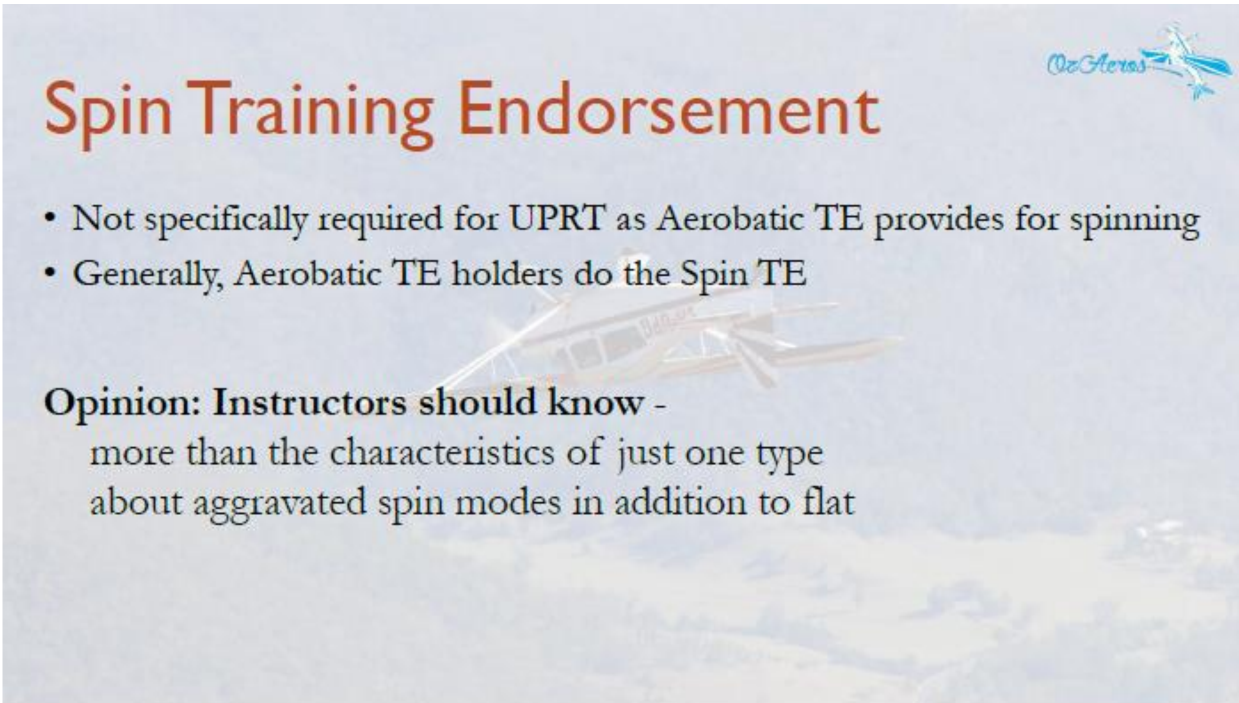
- As Kershner notes there will be differences between individual aircraft. Even more so with older aircraft as changes in rigging, cable tension and repairs to wing leading edges may contribute.
    - In aircraft like the Decathlon a change in wing rigging will significantly change the stall behaviour and spin entry.
    - The Piper PA-38 Tomahawk can have a significantly different behaviour between one example and another as described in Reference 8.
    - Pilots should be vigilant in the awareness of a different behaviour being experienced and ensure that maintenance action is taken.
- CASA does not require that a flight instructor with a spin training endorsement know any more than is required to gain a spin endorsement on just one type of aircraft.
- References 1 & 2 illustrate what can go wrong with the current regime.
- By comparison, EASA requires additional spin knowledge and experience for flight instructors teaching their advanced UPRT per

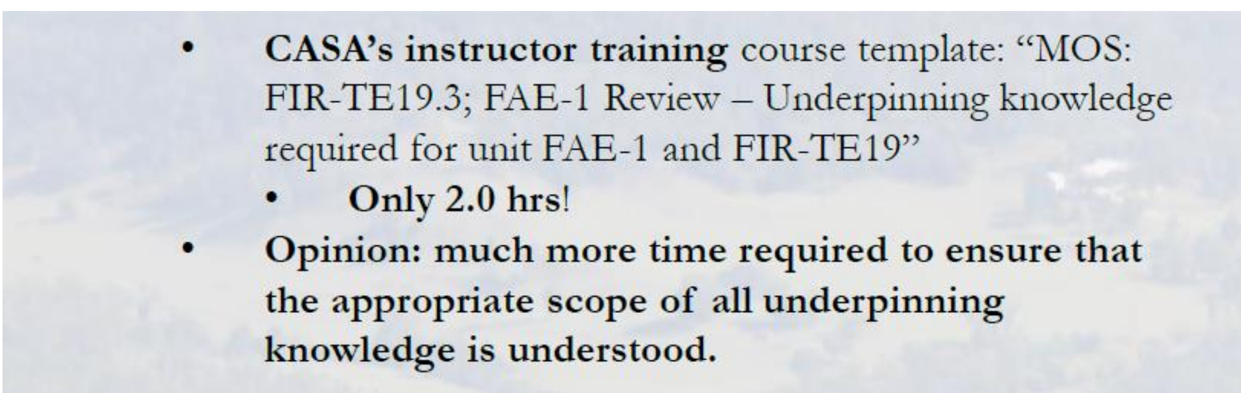
AMC1 FCL.745.A (even though advanced UPRT does not require teaching of spins beyond CASA's requirement for a spin endorsement) per Reference 13: "Even in a case where an aeroplane is not certified for intentional flat or aggravated or inverted spins, it does not mean that mishandled student recovery avoids placing the aeroplane in such a situation. Some student inputs will take the aeroplane uncontrolled far beyond the normal scope of the aerobatic rating as defined in point FCL.800. Those situations might also have the potential to draw the aeroplane outside its certified flight envelope (e.g. overloads, snap-roll departures above limit speed, spin or inverted spin when not certified for, flat spins, etc.). Most importantly, those resulting situations could startle the instructor. ….. instructors should … demonstrate their ability to recover from all spin types, not only from spins entered intentionally, but from spins of unannounced direction of autorotation, and from all potential spin variations, including: (i) normal (non-aggravated) spins; (ii) flat spins; (iii) accelerated spins; and (iv) transition spins (incorrect recovery resulting in reversal of rotation)." My view is that just the knowledge of the above is required by a spin instructor.

- Rich Stowell's comment on page 81 of his excellent book Stall/Spin Awareness, Reference 8, is particularly relevant:
  - "Red flags have indeed been visible – and have gone unheeded – for years. The degradation of stall/spin awareness over successive generations of instructors has undoubtedly been cumulative."

UPRT Providers Conference 1 August 2022

- I presented these recommendations on improvements for the spin training endorsement:





- The spin training endorsement course template is similar – MOS reference FIR-TE18; FIR-TE18.3; FAE-8 – 2 hours.
- I give trainees a list of reading material in advance of starting the course as well as some further recommended reading. Invariably they do very little study of the required underpinning knowledge

in advance and none of the further reading. Generally, it seems they must be spoon fed. There are exceptions!

- I have encountered more than one at the test for the training endorsement who have admitted to not having read the AFM/POH for the aeroplane. I require completion of the Single Engine Endorsement Questionnaire for my own trainees which requires trainees to read the manuals – many instructors do not.
- I have developed this theory that pilots never read placards in the cockpit. How many know what is written about spin recovery right in front of them?
- More time is required in the classroom to effectively provide the required underpinning knowledge and ensure that the trainee understands it.

ATSB SAN 10 August 2022

ATSB – AO-2021-025

Safety action

Safety advisory notice

Safety advisory notice to aerobatic pilots and instructors

SAN number:	AO-2021-025-SAN-001

The ATSB strongly encourages all aerobatic pilots and aerobatics flight instructors to be aware:

- the Mueller/Beggs method of spin recovery does not recover all aircraft types from a spin
- the Mueller/Beggs spin recovery method limitations should be emphasised during spin theory training
- the Mueller/Beggs method of spin recovery will not recover a Cessna A150 Aerobat or similar variants from a spin in some circumstances
- they should review the pilot's operating handbook of the aircraft type that they intend to operate for the recommended spin recovery technique
- prior to doing spins in any model aircraft, they should obtain instruction and/or advice in spins from an instructor who is fully qualified and current in spinning that model.

It seems to me that effective action in response to this must be:

- the CASA Manual of Standards for the spin endorsement must be amended to include this in the underpinning knowledge requirements.
- Requirements for the instructor spin training endorsement must include knowledge of the different spin and recovery characteristics of different aircraft.
- Related to that last point – that necessitates knowledge of all of the typical aggravated spin modes.
- The changes must be delivered to existing pilots and instructors through the series of AvSafety pilot seminars and Flight Instructor Safety Seminars. Also online through email and social media etc. It must be retained in a dedicated AC.

Conclusions and Recommendations

- We are no further advanced than the FAA back in the 1970s.
- Nope, we are no further advanced than we were back in the 1950s!
- From Reference 16: "The subject of airplane spinning is a complex one, which is often over-simplified during hangar-flying sessions. ….. This has resulted in some confusion and misunderstanding over the behaviour of airplanes in spinning flight, and it appears this lack of understanding may have contributed to some serious accidents. … 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 procedure for this particular type of airplane."
- CAAP 155-1, Aerobatics is to be replaced by AC 61-18 Aerobatics with updated and revised content.
- I now recommend that a separate AC on spinning be developed, leaving the other AC to focus on recreational, competition and display aerobatic pilots.
- The spinning AC would focus on the flight instructor spin training endorsement.
    - An industry working group (as there was for CAAP 155-1 15+ years ago and the first draft aerobatics AC 91-15 30+ years ago) should advise CASA on the content. There are others with significant spin training experience who should contribute.
- My specific input at this stage follows.
    - It must outline the effect of parameters discussed in this note.
    - It should refer to Reference 8 as the source of information for spin theory training.

- It should include Reference 7 specifically for instructors flying the Cessna 150 and 152.
- It should include my book, Reference 3, specifically for instructors flying the Decathlon series.
- It should include Reference 6 specifically for instructors in Pitts aircraft and for advanced spinning general. Note that not all types with the Pitts name will recover using the Beggs-Mueller method!
- It should include my book, Reference 18, for an overview on the importance of moments of inertia.
- It should include References 19 and 20 for consideration of the use of parachutes.
- The spin accidents above should be included as case studies to emphasis the importance of the above matters.
- It should include guidance for training in Experimental amateur-built aircraft and Limited category aircraft.
- It should include guidance on types not approved for intentional spinning regarding the limitations (see the definition of a spin above) and the importance of immediately applying the recovery technique per the POH.

- I generally endorse Kershner’s views on spin training in Reference 21.
- CASA’s Part 61 MOS FAE-8 for the spinning flight activity endorsement should be amended with additional underpinning knowledge requirements.
- CASA’s Part 61 MOS for the Flight Instructor Rating should include a section on the expanded knowledge requirements for a spin training endorsement.

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21 August 2022

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3. Spin Not Stjepan Nikolic https://youtu.be/XQ1QmCPOt1s