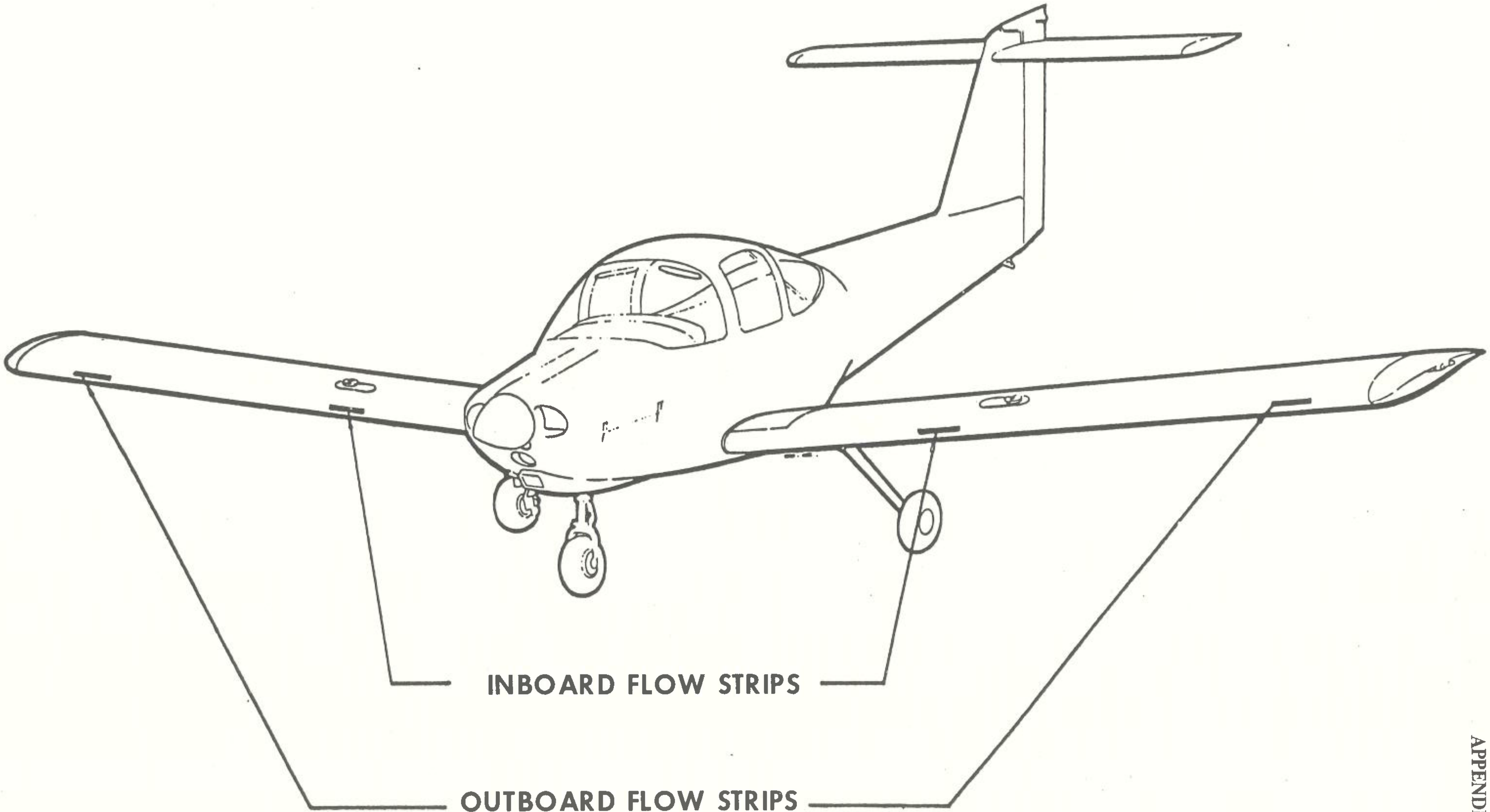
TOMAHAWK FLOW STRIPS



PA 38 FLIGHT TEST PROGRAMMES

1 Preliminary considerations

During the tests carried out by the CAA in 1978 for United Kingdom (UK) validation of the FAA certificate of airworthiness, the PA 38's flying qualities were considered to be free from dangerous features. Spin entry was found to be decisive with no tendency to enter a spiral dive. The spin was moderately fast and steep and the recovery was found to be positive, rarely taking as much as a turn. The only area of doubt concerned its behaviour following recovery from a spin, using the recovery drill recommended by the manufacturer in the POH. This drill differed in two respects from the spin recovery drill normally taught in the UK, namely:

(a) It omitted the pause after applying rudder opposite to the direction of the spin, which by allowing time for the reversed rudder to slow the aircraft's rotation, improves the potential effectiveness of the elevator when it is moved down;

(b) The Piper drill called for full down elevator as soon as the reversed rudder is fully applied, whereas the normal practice recognised in the UK is to move the control column progressively forward until the spin stops, which ensures that the nose-down pitch is no more extreme than is unavoidable whilst reducing the wing incidence sufficiently to stop the spin.

Oxford Air Training School consulted the CAA about the advisability of recommending less than full forward elevator control because, from the basically steep spin attitude, once the powerful elevator took effect the aircraft could easily achieve an attitude beyond the vertical in the ensuing recovery dive with some negative 'g' and considerable height loss before regaining level flight. Piper Aircraft Corporation (PAC) were, however, adamant that the wording contained in the POH should not be changed, their concern being that slower movement of the elevator might occasionally result in spin recoveries requiring more than the maximum of 1½ extra turns permitted by FAR Part 23. This position was accepted by the CAA who were confident that the consequence of the excessive down elevator during the recovery might be uncomforable but was in no sense dangerous in view of the POH instruction that 'the spin shall be initiated at an altitude which will result in full recovery above 3,000 feet agl'. This was the situation up to the time of the accident to G–BGGH.

2 Subsequent to the accident to G–BGGH the manufacturer made freely available to the CAA the Type Inspection Records covering two separate spinning programmes which were compiled at the time of the PA 38's type certification process in the United States of America.

A review of the records brought to light the following points related to the PAC spinning programmes:

(a) Control travel settings did not provide the most adverse combination of maximum pro-spin and minimum recovery authorities.

(b) On both test programmes, because of the number of variables, the investigations at aft cg were not comprehensive.

(c) Very few spins were made with full fuel and the combination of heavy fuel load and aft cg was not included.

(d) The effect of minimum longitudinal inertia (no anti-spin parachute) and maximum lateral inertia (full fuel), a normal load distribution, was not covered in the Lock Haven trials which represent the current production standard.

(e) The Lock Haven programme was biased towards spin to the left with in-spin aileron applied, because it had been concluded that this was the most adverse case.

(f) Long spins with out-spin aileron control had not been checked adequately – not at all in the original Vero Beach certification programme – and not to the right in the subsequent Lock Haven programme.

3 Further investigation of PA 38 spin characteristics

The CAA and the manufacturers agreed on a two-stage flight test programme; Stage 1 which was flown by PAC with satisfactory results, made good the omission of the certification tests and investigated credible variations in spin entry and recovery techniques. Stage 2, was flown by the CAA test pilot in order to check critical recovery cases and to investigate the effect of the standard spin recovery drill as taught in most UK flying training.

4 Results of CAA tests

The tests by the CAA were carried out in the United States on the same instrumented test aircraft previously used by the manufacturer. The CAA tests consisted of 32 confirmatory spins together with a further 17 demonstration spins on two other Tomahawks.

5 Further tests in the UK

By setting the flying controls to the limits of permissible travel most adverse to spin recovery, the most obvious source of variability between aircraft was covered during the tests in the United States. However, to investigate whether there were variations in spin and spin recovery characteristics between aircraft, the CAA carried out further spinning tests on the 6 aircraft in the UK on which reports of protracted spin recoveries were received in reply to the CAA's request to PA 38 operators (referred to in 1.16.2). The tests which followed were conducted by CAA Airworthiness Division) (AD) pilots who were also accompanied by instructor pilots who had reported the protracted recoveries.

6 Recovery methods used

Both POH and 'standard' recovery techniques were used during the tests which included non-standard procedures such as releasing the control wheel and deliberately maintaining full up-elevator following the application of spin recovery rudder.

7 Discussion

The CAA test pilot summarised his views as follows:

7.1 The Tomahawk is a safe spinning aeroplane and the Piper recommended recovery is not necessary as long as the ailerons are held neutral throughout.

7.2 The spin is steep, which can be disturbing, especially when coupled with a vigorous bunt on recovery, which pilots do not like. The standard recovery as recognised in the United Kingdom is totally effective.

7.3 There is a marked natural tendency for the ailerons to float about 1/8 full scale deflection so as to roll the aircraft in the direction of the spin. If this is not corrected by a conscious effort of the pilot, the number of apparent turns in recovery is increased. This is not the same as saying that the aircraft continues to spin for extra turns.

7.4 Ten out of ten Tomahawks recovered from spins in about one turn when the control wheel was released after applying full recovery rudder. These aircraft were all trimmed initially full nose-up, causing the elevator to float to neutral between 70 and 75 knots IAS, power-off.

7.5 During mishandled recoveries, power-off. two of the last five aeroplanes tested exhibited a fast disorientating and unnerving secondary spin mode which was most uncomfortable. The CAA AD pilot is convinced that this could well have been a contributory factor to the accident under consideration.

7.6 The tests revealed an initial lack of awareness, by 10 experienced flying instructors, of what was happening; all tended to be reluctant to apply sufficient down-elevator during recovery because of a natural apprehension of the ensuing pitch-down. However, this is no criticism of them but is more of a reflection on their lack of current practice in spinning, especially in the PA 38.

8 Recommendations

The following recommendations were made by the CAA pilot following the tests carried out in the United States of America and in the United Kingdom:

1 The Tomahawk is to be re-cleared for full spinning in the United Kingdom.

2 The POH is to have the agreed UK change sheet incorporated (this may be seen at Appendix 3 to this report).

3 All UK Tomahawk operators to be advised of the fitness of the aeroplane for spinning.

EXTRACTS FROM THE TOMAHAWK PA–38–112 PILOT'S OPERATING HANDBOOK

REVISED SECTION 4 NORMAL PROCEDURES

PIPER AIRCRAFT CORPORATION
PA–38–112, TOMAHAWK

SECTION 4
NORMAL PROCEDURES

4.43 SPINS

The airplane is approved for intentional spinning when the flaps are fully retracted.

BEFORE SPINNING

Carrying baggage during the spin is prohibited and the pilot should make sure that all loose items in the cockpit are removed or securely stowed including the second pilot's seat belts if the aircraft is flown solo. Seat belts and shoulder harnesses should be fastened securely and the seat belts adjusted first to hold the occupants firmly into the seats before the shoulder harness is tightened. With the seat belts and shoulder harnesses tight check that the position of the pilot's seats allow full rudder travels to be obtained and both full back and full forward control wheel movements. Finally check that the seats are securely locked in position. Spins should only be started at altitudes high enough to recover fully by at least 4,000 feet AGL, so as to provide an adequate margin of safety. A one-turn spin, properly executed, will require 1,000 to 1,500 feet to complete and a six-turn spin will require 2,500 to 3,000 feet to complete. The airplane should be trimmed in a power-off glide at approximately 75 knots before entering the stall prior to spinning. This trim airspeed assists in achieving a good balance between airspeed and 'g' loads in the recovery dive.

SPIN ENTRY

The spin should be entered from a power-off glide by reducing speed at about 1 kt/sec until the airplane stalls. Apply full aft control wheel and full rudder in the desired spin direction. This control configuration with the throttle closed should be held throughout the spin. The ailerons must remain neutral throughout the spin and recovery, since aileron application may alter the spin characteristics to the degree that the spin is broken prematurely or that recovery is delayed.

SPIN RECOVERY

(a) Apply and maintain full rudder opposite the direction of rotation.

(b) As the rudder hits the stop, rapidly move the control wheel full forward and be ready to relax the forward pressure as the stall is broken.

(c) As rotation stops, centralize the rudder and smoothly recover from the dive.

Normal recoveries may take up to 1-1/2 turns when proper technique is used: improper technique can increase the turns to recover and the resulting altitude loss.

FURTHER ADVICE ON SPINNING

SPIN ENTRY

Application of full aft control wheel and full rudder before the airplane stalls is not recommended as it results in large changes in pitch attitude during entry and the first turn of the spin. Consequently the initial 2-3 turns of the spin can be more oscillatory than when the spin is entered at the stall.

SPIN RECOVERY

The recommended procedure has been designed to minimize turns and height loss during recovery. If a modified recovery is employed (during which a pause of about 1 second – equivalent to about one half turn of the spin – is introduced between the rudder reaching the stop and moving the control column forward) spin recovery will be achieved with equal certainty. However the time taken for recovery will be delayed by the length of the pause, with corresponding increase in the height lost.

In all spin recoveries the control column should be moved forward briskly, continuing to the forward stop if necessary. This is vitally important because the steep spin attitude may inhibit pilots from moving the control column forward positively.

The immediate effect of applying normal recovery controls may be an appreciable steepening of the nose down attitude and an increase in rate of spin rotation. This characteristic indicates that the aircraft is recovering from the spin and it is essential to maintain full anti-spin rudder and to continue to move the control wheel forward and maintain it fully forward until the spin stops. The airplane will recover from any point in a spin in not more than one and one half additional turns after normal application of controls.

MISHANDLED RECOVERY

The airplane will recover from mishandled spin entries or recoveries provided the recommended spin recovery procedure is followed. Improper application of recovery controls can increase the number of turns to recover and the resulting altitude loss.

Delay of more than about 1-1/2 turns before moving the control wheel forward may result in the aircraft suddenly entering a very fast, steep spin mode which could disorient a pilot. Recovery will be achieved by briskly moving the control wheel fully forward and holding it there while maintaining full recovery rudder.

If such a spin mode is encountered, the increased rate of rotation may result in the recovery taking more turns than usual after the control column has been moved fully forward.

In certain cases the steep, fast spin mode can develop into a spiral dive in which the rapid rotation continues, but indicated airspeed increases slowly.. It is important to recognize this condition. The aircraft is no longer auto-rotating in a spin and the pilot must be ready to centralize the rudder so as to ensure that airspeed does not exceed 103 kt (V_A) with full rudder applied.

DIVE OUT

In most cases spin recovery will occur before the control wheel reaches the fully forward position. The aircraft pitches nose down quickly when the elevator takes effect and, depending on the control column position, it may be necessary to move the column partially back almost immediately to avoid an unnecessarily steep nose down attitude, possible negative 'g' forces and excessive loss of altitude.

Because the aircraft recovers from a spin in quite a steep nose down attitude, speed builds up quickly in the dive out. The rudder should be centralized as soon as the spin stops. Delay in centralizing the rudder may result in yaw and 'fish-tailing.' If the rudder is not centralized it would be possible to exceed the maximum maneouvre speed (V_A) of 103 kt with the surface fully deflected.

ENGINE

Normally the engine will continue to run during a spin, sometimes very slowly. If the engine stops, take normal spin recovery action, during which the propeller will probably windmill and restart the engine. If it does not, set-up a glide at 75 kt and restart using the starter motor.

SPINNING TRAINING – PSYCHOLOGICAL ASPECTS

Introduction

According to the RAF Institute of Aviation Medicine (IAM) it seems that very little scientific knowledge exists on the phenomenon known as 'freezing'; this is hardly surprising since there are ethical problems involved in frightening people for the purposes of a controlled study. What evidence exists is mainly confined to anecdotal accounts of incidents that have occurred, but there are few scientific facts. However, it seems clear that as the individuals who are likely to suffer cannot presently be predicted with any confidence, the circumstances to which all trainee pilots are exposed could benefit from review. The following note on the philosphy of spin training was prepared by a psychologist of the IAM Flight Skills Department.

Spinning training in the PPL syllabus

There can be little doubt that spinning is the most controversial exercise in the PPL syllabus. The USA deleted the spin requirement 31 years ago, but the question of whether it should be re-introduced in the USA is discussed in exactly the same way as the discussion of whether it should be dropped in the UK. This section reviews briefly, from a behavioural point of view, the arguments advanced for and against spin training for a PPL.

Defenders of spin training normally make the following points:

(a) That it is essential for a student pilot to be able to recognise and recover from an unintentional spin. In order to be able to do so the student must have experienced spinning and practised the recovery;

(b) that spinning gives the student confidence. It can be explained to the student that 'spinning' is the 'worst' control situation which can be encountered but, from which, it can be demonstrated that the student is perfectly capable of recovering.

It is, presumably, for these reasons that spinning is currently a part of the UK PPL syllabus. Since this is the status quo the arguments for removing spinning from the syllabus need to be strong and they are therefore examined below in some detail:

(a) It can be argued that the spin training given in the average PPL course prepares the student only for recovery from the sort of self induced spin which is likely to occur on the general flying test. It does nothing to prepare the student for the recovery from a spin entered accidently. The student does not need to acquire the perceptual skills and knowledge required to identify the direction of the spin because the direction of the intended spin is known, for example full right rudder has been applied to generate the spin. Recovery from the spin thus consists basically of 'changing feet' on the rudder and this is what is learned. There is anecdotal evidence to support this contention: An RAF Central Flying School Examiner was charged with demonstrating high rotation spins to extremely experienced Chief Flying Instructors of University Air Squadrons. If, in such a spin, recovery rudder is applied, but not accompanied by correct elevator control, the spin continues. The examiner instructed his subject to remove his hands and feet from the controls. He then initiated a high rotation spin, and when it was established he reversed the rudder control so that he gave the aircraft back for recovery with up elevator control and corrective rudder fully applied. Several of his experienced colleagues fell into the obvious trap of changing the sense of the rudder control already applied and thus attempted, hopelessly, to recover with full pro-spin rudder applied. Some of these claimed that had the examiner not taken control they would have been forced to abandon the aircraft as they were convinced that they were taking full corrective action. Thus, even such experienced pilots are not necessarily equipped properly to diagnose the nature of the spin and take appropriate recovery action; how much less able to do so is the 35 hour PPL?

(b) spin training does not give the student confidence. Presently, some spin training is given before the student flies solo or possibly before getting dual experience in the circuit. Thus the student pilot is exposed to spins, or introduced to spins, after only a small number of hours (say five) in the air. If a student is at all nervous about flying, then the probability of producing an extreme anxiety response, perhaps even 'freezing' must be maximised by placing spinning near the beginning of the course where the student has not had the opportunity to become 'at home' in the air even under normal circumstances. What is more, it is possible that the anxiety generated by spinning will generalise to more normal flying (ie the whole flying situation will become aversive) and lead to an overall reduction rather than an increase in the student's level of confidence.

The only argument which exists for giving spin training pre-solo is to enable the student to recover should a spin occur inadvertently whilst in the circuit. However, it is widely acknowledged that there is unlikely to be enough height available in the circuit to recover from a full spin, and furthermore, it is unlikely that the student would be sufficiently composed or skilled to recover.

The lack of necessity of spinning early in the course is underlined by the fact that the RAF does not do so in its basic flying training syllabus. In these cases, students are not given spinning until after the completion of the circuit consolidation phase which could be anything between 14 to 20 hours and prior to their introduction to aerobatics. While it is clearly prudent that a student learns how to spin and recover before undertaking aerobatics, the vast majority of civil private pilots will have no need or desire to perform aerobatics and the requirement for spin training is consequently reduced. What private pilots may, of course, encounter is an incipient spin and there can be no doubt that they should be prepared for this.