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## **1 INTRODUCTION**

a) Aerobatics, whether in a glider or a powered aircraft, provide an opportunity for pilots to learn and participate in a new facet of sporting aviation. It is, however, vital to keep safety in mind, since **a reckless or careless attitude can result in serious injury or death**. Almost every year accidents occur where the height available proves insufficient to recover from an intentional or, more usually, a badly executed aerobatic manoeuvre.

b) The motivation to acquire aerobatic skills is usually a desire to experience the pleasure of being able

to control the aircraft while precisely drawing a defined manoeuvre in the sky. A side benefit is that it also adds to the pilot's ability to cope with unusual attitudes and unexpected upsets, such as wake turbulence, in a safe manner.

c) Only a limited range of aircraft attitudes will have been encountered during a pilot's training towards a private licence. Learning aerobatics will extend the pilot's knowledge of the aircraft's performance envelope, while emphasising the need to co-ordinate use of the flying and engine controls to achieve the desired manoeuvre.

## 2 AIRCRAFT SUITABILITY

a) The particular aircraft which you propose to use **must** be cleared for the aerobatic manoeuvres intended, so a review of the Certificate of Airworthiness/Permit to Fly and the Flight Manual/Pilot's Operating Handbook, including all Supplements, is essential before flight. These will detail the permitted speeds (e.g.  $V_A$  – manoeuvring speed, the maximum speed at which controls can be fully deflected under normal circumstances), as well as the permitted manoeuvres and load factors, which may vary between two outwardly identical aircraft. The aircraft should, ideally, be fitted with a 'g' meter to confirm that it has been flown within its permitted 'g' envelope. In addition, try to avoid sudden large control movements at any speed, especially when reversing direction.

b) On most aircraft the maximum weight and centre of gravity (cg) position permitted for aerobatics is restricted. Fuel and oil system design may also limit manoeuvres which are possible, duration of inverted flight etc.

c) Aircraft with fixed-pitch propellers need particular care to ensure rpm limits are not exceeded at high speed.



d) Know your aircraft. The variable-pitch propellers of many aerobatic aeroplanes are designed to move to 'coarse' rather than 'fine' in the event of oil pressure failure. This prevents transient over-speeding, but a total pressure failure is likely to result in limited power being available.

e) If the aircraft is fitted with a Turn Co-ordinator, be warned that it can give incorrect indications in an inverted spin, whereas a conventional Turn and Slip indicator will always indicate the correct yaw direction.



f) For aerobatics the aircraft must have a full harness, but a lap strap and diagonal is permitted for spinning. Be sure that you understand the restraint system – some aerobatic aircraft have two separate, independent restraints.

g) A serviceable transponder can be used to warn air traffic radar units that you are carrying out aerobatics. Select 7004 (with ALTitude if fitted) a few minutes before starting your practice.



h) If there are any aspects concerning the aircraft or its suitability that you do not fully understand, seek advice from a suitable and knowledgeable person.

### **3 PHYSIOLOGICAL ASPECTS**

a) Aerobic manoeuvres involving changes of aircraft attitude cause marked effects on the balance apparatus of the inner ear. Without good visual cues, erroneous messages from this to the brain can lead to disorientation, so a good horizon and good visibility are essential. Even in perfect conditions, the mismatch between balance cues (which have an in-built time lag) and visual cues (which are instantaneous) can cause motion sickness, although experience and practice will usually overcome this.

b) Non-pilot occupants, or non-aerobic pilots, will be more prone to this feeling and should be warned that it might happen, and that it is a normal physiological response. Any attempt to continue aerobic flight after the other occupant has gone pale and quiet will inevitably lead to a messy cockpit unless a sick bag is readily available.

c) During aerobatics, 'g' loading causes shifts of blood within the body. Positive 'g' moves blood toward the feet and away from the brain. At about +3½ to +4 'g' a relaxed human being will suffer vision changes, initially loss of colour and peripheral detail (greyout), and then a complete loss of sight (blackout). If the 'g' load increases, loss of consciousness will occur ("g-loc"). Tensing the stomach and leg muscles and grunting will help prevent this sequence (guidance should be sought from a pilot who is familiar with the technique).

d) Other occupants should be advised to carry out the technique when approaching positive 'g' manoeuvres of this magnitude (the natural muscle tensing of the aerobic passenger may help). They should also keep their head still during application of 'g' to minimise the risk of neck injuries and reduce the likelihood of disorientation.

e) Negative 'g' manoeuvres cause blood to accumulate in the head, and the increased blood pressure can occasionally cause damage. Little can be done to mitigate the effects of negative 'g', which is poorly tolerated and more uncomfortable than positive 'g'.

f) A person's tolerance to 'g' tends to increase with exposure and reduce with age. Because aerobic flight places extra stresses on the body you should seek medical advice from your AME (Authorised Medical Examiner) or airport medical advisor about the wisdom of performing aerobatics if you are over 60 years of age or suffer from any possibly relevant medical condition.

g) Aerobic pilots need to be able to see and identify any collision threats which may fly into their intended flight path. If you have any ailment or injury which restricts your ability to look all round, consider cancelling the aerobatics.

#### **4 PERSONAL EQUIPMENT/CLOTHING**

Whilst there are no requirements to wear or use specific garments or equipment, the following items are strongly recommended.

- Gloves help to protect against fire and abrasion in an accident. They also absorb perspiration, improving grip.
- Overalls made from natural fibres, with zippered pockets and close-fitting ankles, collar and wrists, also give protection, as do leather flying boots.
- Particularly in open cockpits, a lightweight helmet gives protection while minimising discomfort under increased 'g' loadings.
- In some aircraft for physical or weight and balance reasons it may not be possible or practicable to wear a parachute. However, in the event of failure to recover from a manoeuvre a parachute may be the only alternative to a fatal accident, although the time and height lost while exiting the aircraft (and while the canopy opens) must be considered. A static line deployment system might save vital seconds. A parachute should be comfortable and well fitting with surplus webbing tucked away before flight, and maintained in accordance with manufacturer's recommendations. Know, and regularly rehearse, how to get out of the aircraft and use it, and remember the height required to abandon your aircraft when deciding the minimum recovery height for your manoeuvres.
- Don't carry any potential loose articles, e.g. coins, keys.

#### **5 INSTRUCTION**

a) To carry out aerobatics in an EASA aeroplane, a pilot with a Part-FCL licence must hold an Aerobatic Rating, obtainable by completing a course at an Approved Training Organisation. To fly aerobatics in non-EASA aircraft, pilots are strongly recommended to complete a training course with a similar syllabus. [Instructors who wish to teach for the Aerobatic Rating on EASA aircraft are required to extend their Instructor Certificate privileges by completing a training course at an Approved Training Organisation and applying to the CAA.](#)

b) As with any other aspect of aviation, the acquisition of skill and knowledge is most effective and enjoyable with high quality instruction. Effective pre-flight briefing is essential to gain full benefit from any course of training. Initially, keep the flight lessons as short as possible, concentrating on simple, positive 'g' manoeuvres, such as loops and barrel rolls, to start with. Make the post-flight analysis and discussion session a worthwhile contribution towards the next training flight.

c) The Aircraft Owners and Pilots Association (AOPA) have published syllabi for three different standards of aerobatic qualification, which (although not specific for the Part-FCL Aerobatic Rating) are available at several flying clubs. Other training courses will have similar syllabi. The handling skills acquired during PPL training must be thoroughly revised before learning basic aerobatic manoeuvres. Training in recovery from unusual attitudes

and incorrectly executed manoeuvres is essential. Since the PPL syllabus now only includes incipient spinning, you **must** now become familiar with entry to and recovery from a fully developed spin since a poorly executed aerobatic manoeuvre can result in an unintentional spin. On completion of the AOPA Aerobatic Course a pilot should be capable of flying a simple sequence of manoeuvres in a safe manner, and also of recovering from inadvertent spins.

d) Know the spin characteristics of the aircraft you are flying even though you may have no intention of entering a spin. Know also the different symptoms of erect and inverted spins and the appropriate recovery drills for each type of spin.

e) Ensure you learn the safest way of recovering from each manoeuvre if it goes wrong **and be prepared to use it in the future**. Continuing to pull is usually less safe than rolling to the nearest horizon.

f) Novices should not attempt new manoeuvres without proper qualified instruction; the result could be an over-stressed aircraft or an accident.

## **6 AIRCRAFT CHECKS**

a) Maintain a close liaison with the person/organisation responsible for maintenance so that the maintenance schedule may be interpreted to its best effect when taking into account the particular needs of an aerobatic aircraft. Homebuilt and other 'Permit' aircraft are not subject to a formal Maintenance Schedule, thus the engineer who maintains the aircraft should be familiar with the type and the critical areas to inspect.

b) The pre-flight inspection needs to be carried out with extra care, since the aircraft will be flown nearer to its performance and structural limits than usual. Ask other owners/users of the specific aircraft type about items which need particular scrutiny.

c) Check that items of cockpit equipment, such as seat cushions and the fire extinguisher, are properly secured and check **VERY** carefully for any loose objects which might be present. Even the most insignificant item could lodge in such a manner as to restrict control movement. Dust and dirt from the floor, under negative 'g' situations, can get in the pilot's eyes.



d) Make sure that there is sufficient fuel for the flight whilst still remaining within the **aerobatic** weight and cg envelope.

## **7 PREPARATION FOR FLIGHT**

a) Make sure you all are tightly strapped in, yet still able to move the controls to their full travel without difficulty. It is essential that you feel part of the aircraft and not a loose object within it. Tuck away the surplus harness adjustment.

b) Check that the rudder, which on the ground may be restricted by nosewheel steering or braking, does have **FULL** travel.

## **8 PRE-AEROBATICS VITAL ACTIONS**

a) Weather conditions must be suitable. There must be good visibility, a clear horizon all round and space to remain clear of cloud under VFR.

b) Allow plenty of height from ground to cloud base. Recognition and recovery from an inadvertent spin and the subsequent dive may require many hundreds of feet (e.g. a Chipmunk requires 250 feet per turn and 1,200 feet for the dive recovery). In an aircraft with a low power-to-weight ratio, remember to allow sufficient height to complete an aerobatic sequence before reaching the base height.

c) Be considerate to those on the ground. Do not always use a particular area for aerobatic practice to the annoyance of those who desire peace and quiet. Avoid also regular VFR routes and areas well known to have frequent traffic, e.g. PPL training areas.

d) The standard HASELL check needs to be carried out with particular vigilance:

- **H**eight - depends on experience of pilot, but novices should commence at no less than 5,000 ft above ground level and all manoeuvres should be completed by 3,000 ft agl.
- **A**irframe - flaps up, brakes off (in some aircraft brake application restricts rudder movement), wheels up, etc. to suit your particular aircraft.
- **S**ecurity - all harnesses fastened, canopy/doors secure and no loose articles.

- **E**ngine - all engine instruments reading normally, mixture rich, carb heat check, adequate fuel selected and electric fuel pump on if applicable.
- **L**ocation - clear of congested areas and outside or remaining below any controlled airspace (unless appropriate permission from the controlling ATC unit has been given). An area offering good forced landing options in the event of engine problems is wise. Note a good landmark to assist orientation.
- **L**ook-out - clearing turns in both directions and check above and particularly below.
  - e) Look-out needs to be comprehensive at all times, checking between manoeuvres and sequences, to avoid any risk of conflict with other aircraft.

## **9 SPORTING AND COMPETITION ASPECTS**

a) Once the basic skills have been mastered, many pilots are quite content with the occasional aerobatic flight in a club aircraft to enhance their pleasures of aviation.

b) However, some pilots enter competitions to measure their ability against others at a similar level of attainment.

c) Competition aerobatics is an international sport under the Federation Aeronautique Internationale. The relevant sporting regulations have been prepared by the International Aerobatics Committee who sanction both World and Continental championships. The Royal Aero Club of the United Kingdom have recognised the British Aerobatic Association\* as the sport's representative body to foster its development and to organise national competitions.

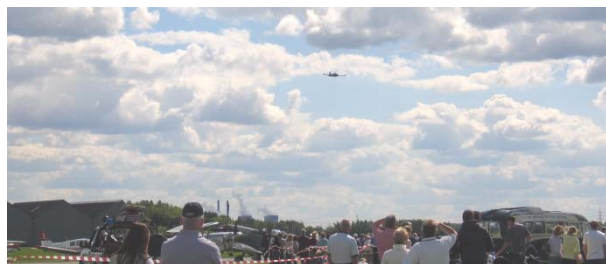
d) Contests are held at a number of venues each year at the various levels of pilot skill. These are Beginners, Standard, Intermediate, Advanced and Unlimited. Aircraft performance is a major factor in progression up through the system; however, a well-flown sequence in a basic aircraft can be just as competitive.

\*Address:

BAeA  
White Waltham Airfield  
Nr Maidenhead  
Berks.  
SL6 3NJ

Website: [www.aerobatics.org.uk](http://www.aerobatics.org.uk).

## **10 AIR DISPLAYS AND PUBLIC EVENTS**



Before a pilot can perform at an Air Display or public events, he/she MUST have a Display Authorisation permitting aerobatics issued by the CAA (see [CAP 403](#) – *Flying Displays and Special Events: a Guide to Safety and Administrative Arrangements* for details).

## 11 **SUMMARY**

- **Get dual instruction before attempting aerobatics.**
- Check that the aircraft is cleared for aerobatics and know both the aircraft and your own limitations.
- Be proficient with recoveries from spinning and unusual attitudes.
- Start with sufficient height to give plenty of margin if things go wrong.
- Maintain a good look-out and monitor your height constantly.
- Do not exceed the 'g' limits, or use large control movements near or above maximum manoeuvring speed  $V_A$ . Do not exceed  $V_{NE}$ , the never exceed speed.
- Do not exceed maximum engine RPM or manifold pressure limitations.
- Ensure you know the escape route for each manoeuvre if it goes wrong – and use it when necessary.
- **Never be tempted to show off with low aerobatics or beat-ups.**