28 - AEROBATIC TRAINING

The majority of the aerobatics described in this chapter should only be done in a glider which has been designed to be fully aerobatic. The more advanced figures must be taught only by instructors who have an Advanced Aerobatic Instructor' rating. It would be the height of stupidity, not to mention extremely risky, to try and teach rolling manoeuvres, say, if your only experience of them was via the hit and miss of self teaching; or these days, in a computer flight simulator. Clearly, at some point, someone had to teach themselves the manoeuvres, but in those distant days - when aviation was bright and new - a high fatality rate was quite romantic. Not any longer.

Aims

☑ To improve glider pilots' handling and coordination skills.

☑ To improve their confidence in recovery from unusual attitudes.

☑ To enable them to safely undertake and enjoy simple aerobatics.

Scope

These notes are intended to help BGA instructors who do not have an aerobatic rating establish a basic teaching framework for aerobatics. The emphasis is on making sure that the manoeuvres listed below can be undertaken and enjoyed safely. Figures to be covered include:

- 45° up and down lines
- loops
- humpty bumps - canopy down
- stall turns using a 60° up line
- chandelles
- spins, with an exit onto a heading.

This chapter focuses on aerobatics as flown in competitions. Training for and taking part in this competitive aspect of the sport is a superb way for a pilot to develop his/her skills, although there are other sorts of aerobatics. All aerobatics, including the most basic, should be planned and well executed, and within the glider's particular limitations. Competition pilots have a disciplined approach to aerobatics which has much to commend it.

INITIAL AEROBATIC BRIEFING

Prior to aerobatic training flights the trainee should be fully conversant with the following:

Flight Manoeuvring Envelopes

Specific reference needs to be made to:

- the graphical pitch plane representation of glider strength (manoeuvring envelope)
- maximum manoeuvring speeds (V_A)
- velocity never exceed limits (V_{NE})
- effect on the manoeuvring envelope of using
  - the airbrakes
  - the ailerons
  - multiple axis control inputs (e.g. up elevator and right aileron together)
- load factor limits at different speeds
- the manoeuvring envelope of the glider to be used for training
- an appreciation of the relative strengths of different glider types.

Pre-flight HASSLL checks to be made immediately before each aerobatic session [chapter 4]. Particular attention should be paid to the following two important factors:

- that the check is a good moment to remind oneself of the glider's loading limitations, and the appropriate manoeuvring and V_{NE} speeds
- since the height band of the proposed aerobatic session is likely to be much greater than that usually covered by the stalling and spinning exercises, lookout needs to be especially vigilant. For example, looking for aircraft initially at a much lower altitude and still some distance away approaching the proposed aerobatics box. Aircraft directly below, etc.

Basic aerobatic disciplines

- always fly a preplanned Aresti sequence - e.g. 45° down line, loop, 45° up line - with suitable diagrams stuck to the trainee's and to the instructor's panel
- aerobatics should be performed along imaginary perpendicular axes orientated to, and referenced by, suitable ground features (aiming points)
- aerobatic flight lines should be vertical, 45° up or down, and horizontal. A 5° down line is allowed to maintain energy in horizontal flight
- sequences must consist of discrete individual figures. Each should be properly set up, flown, and completed before going onto the next. Emphasise the dangers of not doing this eg., G wind-up in continuous loops.

Safety considerations

Whilst these are, in the main, no different from those that might apply to any other flight, there are some which are specific to aerobatics. These include:

- adhering to preset altitude limits for aerobatics eg. from 4,000' to 1,200'
- avoiding conflict with local airfield traffic requirements
- maintaining an excellent lookout at all times, particularly during actual aerobatic manoeuvres
- tail slides must be avoided in gliders not specifically cleared to undertake them
- the need to:
  - immediately brace all controls against the stops if a tail slide seems likely. (The recommendation used to be to hold the stick rigidly central, but in practice this is impossible and almost invariably results in the controls slamming violently against the stops. This isn't very good for them and they are likely to fly off on their own after such treatment)
  - avoid 'pulling through' from inverted flight. The standard recovery technique to avoid excessive airspeed is to roll back to erect flight
  - avoid aerobatics in strongly thermic or turbulent air

- carefully prepare the glider before flight. A good DI, vacuuming the cockpit and cleaning the canopy - loose items can jam the controls and/or injure the pilot(s)
- before take-off, let other pilots know that it is an aerobatic flight - start height, approximate area and position of box etc. Get the permission of the appropriate authorities (e.g., the local CFI) if required.

A training syllabus and record card are essential. Ideally training should involve a mixture of dual flying and observed solo flights, with suitable feedback from each.

PREFLIGHT BRIEFING

Before each flight the routine to be flown should be planned, and an Aresti diagram drawn up for the trainee and the instructor. The following items should also be covered:

- target entry and exit speeds should be agreed and clearly annotated on the Aresti diagram. Ideally, the exit speed from one figure should approximate the entry speed for the next
- describe and discuss the method of flying each figure
- agree the proposed aerobatic box and the reference or aiming points to be used. Discuss the proposed interaction with local traffic and the local airfield requirements
- the characteristics of the glider to be used eg., how well does it spin. Identify any control weaknesses such as a small rudder or elevator etc
- the glider's flight limitations.

ADVICE TO INSTRUCTORS

Weather minima

Aerobatics need to be taught in smooth conditions so that the trainee can directly relate control inputs to the resulting motion of the glider. Turbulence can add significant and dangerous airframe loads to those already created by the manoeuvres. Ideally, aerobatics should be undertaken at the beginning and end of the day.

If there is extensive cloud, reference points can be difficult to see. These conditions may compromise good lookout during the course of manoeuvres, so it's a good idea to avoid them.

Demonstrations

Always demonstrate a proposed sequence before allowing the trainee to attempt it. This 'demonstration' is invaluable as it helps the trainee gain a feel for the figure(s), and gives him time to observe things which he might not notice when performing the sequence himself.

Trainee Physical Responses

The trainee's reaction to aerobatics may be quite different to your own. Watch for signs of mental overload, adverse reaction to g etc. When thing go wrong, the trainee's uncertainty may cause temporary paralysis of all useful mental functions. Be prepared to take over early if required. If the trainee shows signs of tiring, resort to simple figures.

Preparation

It is vital to brief the trainee before each flight, and to test his understanding of the pre-flight discussions. A properly annotated Aresti diagram encourages essential reference checks from an early stage. Never fly aerobatics without one.

Progress and approval status

It is important that the trainee aerobatic pilot is under no illusions as to exactly which aerobatic manoeuvres he is cleared to fly solo and unsupervised, and those he is not. The log book and training syllabus progress cards provide an excellent means for conveying this in an unambiguous manner. As always, log book entries should aim to provide the next instructor with a clear indication of any problem areas, and things to watch for.

Standard of competence for aerobatic training

Ideally, aerobatic training should begin when pilots are approaching Bronze standard. There is no reason why some aerobatic training should not be given to 'appropriate' pre-solo trainee pilots, to help them become accustomed to flight at higher speed regimes. Instructors should also recognise that aerobatic training provides solo pilots with an excellent, face-saving excuse to fly with an instructor to help sort out flying problems. Such cries for help do occur from time to time and it is important that instructors recognise and respond to them.

The Figures

Instructors should not teach aerobatic figures without having first achieved a reasonable degree of expertise themselves, so this section will not describe in detail how the manoeuvres are to be flown. The focus is on the key points to be briefed, observed, checked for and picked up during the course of demonstrations and trainee' attempts.

All trainee' attempts should be preceded by an instructor demonstration of the proposed sequence. During this the trainee gains both a feel for the figures to be flown, and an appreciation of the key points to be looked for and controlled in order for the figures to be flown correctly.

Such points include the following:

- aerobatic box axis aiming points both ahead and behind the glider, as well as on the horizon in the direction of the wing tips. A ground line feature such as a road, a railway or a runway provides the best axis reference of all
- load factors as measured on the installed G-meter, and as felt by the pilot
- airspeed indications on the ASI as well as the sound of the airflow
- the relative height of wing tips above the horizon
- attitude reference points for pitch control - ground, horizon or cloud features
- wing tip reference triangle properly aligned to longitudinal axis of glider to provide indication of horizontal, vertical and 45° lines
- position of the controls
- yaw string and wing roll angle relative to horizon.

As with all instructing, the eventual aim is to enable the trainee to analyse and improve the accuracy of his own performance.

45° down line

Commence from stalled level flight with the level wings and no yaw:

- use the wing tip reference to check the 45° down line
- use the forward aiming point to maintain constant attitude control
- pull out to horizontal flight at the correct (preselected) airspeed.

COMMON FAULTS

Dive too shallow. Ideally use a wing tip triangle and not the wing tip to judge.

Dive shallows-out as speed builds. Incorrect pitch control as stick forces vary.

Exit speed incorrect. Use a transition speed of, typically, 10kt less than the target speed - use pull out speed of 10kt less than target.

45° up line

- begin from level flight with the wings level and no yaw present
- use the wing tip reference to judge the 45° up line
- push over to achieve horizontal flight a little above stalling speed.

WARNING! Most gliders are very susceptible to spinning in this condition.

COMMON FAULTS

Climb angle too shallow/too steep/not constant - use attitude reference eg., clouds.

Incorrect exit speed - use the ASI to judge correct push over speed.

Pitch up to 45° not sharp enough - use the 3G load factor.

Exit speed too slow - push over at V_S + 20kt indicated airspeed.

The Loop

- begin from horizontal flight at the correct entry speed 2.5 x V_S
- at entry, the wings must be level and the glider must be free from yaw
- pull-up should be progressive, typically with 3G load applied in first quarter
- at the top of the loop
  - the wings should be level and no yaw present
  - the load factor should remain positive (0.25G)
  - the stick should be on rear stop
- at the vertical up/ down position, the wing tips should be equidistant above the horizon
- during the second half of the loop the elevator control must prevent initial over-tightening of the circle, whilst ensuring a horizontal exit at the same speed as the entry - or the selected target speed for the next figure.

COMMON FAULTS

Harsh pulling and/or pushing of the stick.

Tightening of the circle during the second half of the figure.

Entering the loop from a dive rather than from level flight.

Incorrect lines and glider orientations throughout manoeuvre.

Shape not circular. Segmented (angular sided).

Failure to finish in level flight by pulling up into a climb to reduce speed.

The Chandelle

- entry should be from horizontal flight at the chosen entry speed
- with level wings and no yaw present, the glider should be pulled up into a held 45° line
- a 180° direction change is effected via a 45° banked turn. Combined with the 45° up line this results in wings vertical after 90° change in heading
- a 45° held down line of equal length to the up line should precede a return to horizontal flight at the same speed as at entry to the figure.

COMMON FAULTS

45° lines too steep or too shallow with no check at the 45° line before commencing the turn.

Wings not horizontal/ vertical when required.

Axis orientation compromised.

Glider stalls rather than flies around the turn due to insufficient energy, ie. the manoeuvre becomes a shallow stall turn.

45° up and down lines of unequal length.

The canopy down Humpty Bump

This is an excellent figure for introducing trainees to vertical flight. Entry speed from horizontal is generally high, typically 2.5 x V_S plus 15kt. As this is well above V_A, care must be taken to limit the G during the pull-up.

- vertical lines must be vertical; ideally use a wing tip reference triangle
- the glider must not yaw or roll during the figure
- a 3G pull-up to the vertical line is required
- the pull over at the top should be effected whilst the glider still has sufficient (but not much) airspeed. The glider must fly, not fall over the top
- the vertical down line should be held briefly before a 3G pull out to horizontal flight at the target exit speed.

COMMON FAULTS

Vertical lines not vertical or of even length.

Entry and exit speeds substantially different.

Glider yawed in vertical line - check distance of each wing tip above horizon in both horizontal and vertical lines.

Glider falls off the top of figure as a result of pulling over when too slow.

Glider flies over top of figure at too high an airspeed so that vertical lines are not distinct, causing the figure to resemble an elliptical loop.

The Stall Turn (60° up line)

The entry conditions are similar to those used for the Humpty Bump although lower airspeed can be used with good effect on a 60° up line.

- to avoid the inherent dangers of a tail slide, this manoeuvre should only be taught at 'club' level from a 60° rather than a vertical up line
- the glider should yaw cleanly about the chosen wing tip, with no more than a single wingspan of lateral displacement.

COMMON FAULTS

Wings yawed and rolled once up line established

60° up line not held constant

Rudder kicked too early resulting in yawed upward flight and excessive lateral displacement

Rudder kicked too late, resulting in tail slide or 'fallen' figure

Up/ down lines of unequal length

Exit and entry speeds substantially different

Glider does not stop cleanly after yawing around to the down line (People grossly underestimate the difficulty of this figure in gliders!)

Spin and exit on a heading

Entry from horizontal flight at V_S plus 2kt with no discernible pitch-up:

- exit should be exactly on desired heading eg., one turn, one half turn etc
- exit dive should be momentarily vertical followed by transition to horizontal flight
- the recovery 'lead' angle must be clearly defined with regard to useable ground reference features eg., roads, railway lines, runways etc.

COMMON FAULTS

Entry not clean. Any amount of initial pitch up should be avoided.

Spin not maintained. Spiral dive develops.

Exit dive not on heading, and/ or not vertical and/or yawed.

Transition from vertical to horizontal flight too gentle.

