

Gliding Australia Training Manual

Trainer Guide



Unit 6

Aileron Drag & Rudder Coordination

Unit 6 - Aileron Drag & Rudder Coordination

AIM

The aim of this unit is for the student to:

- learn how aileron drag is generated whilst applying aileron;
- describe and demonstrate how aileron drag affects the aircraft;
- be able to use controls to counter the effects of aileron drag resulting in coordinated flight at an angle of bank; and
- describe and demonstrate the secondary effect of rudder.

PREREQUISITE UNITS

- GPC Unit 5 Primary Effects of Controls

COMPLEMENTARY UNITS

There are no complementary units for this GPC Unit

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COMPETENCY ELEMENTS AND PERFORMANCE STANDARDS

ELEMENT	PERFORMANCE STANDARDS
1. Knowledge of Aerodynamics of Control Surfaces	<ul style="list-style-type: none"> • Describe: <ul style="list-style-type: none"> ○ How aileron drag is created. ○ How aileron drag affects the aircraft. ○ The proportional use of rudder and aileron to overcome aileron drag. ○ Develop the ability to recognise uncoordinated flight by feel so that focus can be maintained outside the cockpit on lookout etc. ○ The meaning of the yaw string indications. ○ The risks associated with uncoordinated flight (either too little or too much application of rudder).
2. Conduct coordinated flight	<ul style="list-style-type: none"> • Describe: <ul style="list-style-type: none"> ○ The difference between a slip and skid and how each can arise. • Demonstrate: <ul style="list-style-type: none"> ○ The effect of aileron drag/adverse yaw. ○ Achievement of coordinated flight through coordination of rudder and aileron at different rates of roll in both directions. ○ Centralising rudder when ailerons are neutral. ○ Rolling the glider on a point.
3. Use of the secondary effect of rudder	<ul style="list-style-type: none"> • Describe: <ul style="list-style-type: none"> ○ How the secondary effect of rudder is created. • Demonstrate: <ul style="list-style-type: none"> ○ Secondary effect of rudder in flight.

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KEY MESSAGES

- Explain the use of the yaw string.
- Describe the feel that the glider slipping or skidding indicates that the rudder is uncoordinated. The aircraft is flying in a coordinated manner when there is no yaw on the aircraft (yaw string is centred).
- Aileron drag is produced whenever the ailerons are used, producing uncoordinated flight if it is not corrected.
- Rudder is used to counter aileron drag and maintain coordinated flight.
- Coordination in a glider by feel is easy and important so that the pilot can focus outside the cockpit on lookout and other aspects of the flight path essential to efficiency and safety.

LESSON PLANNING AND CONDUCT

Classroom Briefing

General

- Lookout (targeted scan) is essential – particularly in direction of roll.
- Aim is to maintain coordinated (clean) airflow over the aircraft, this is efficient flying by understanding how aileron drag impacts coordination and how the pilot counters this.

Use of Ailerons Creates Aileron Drag

- Review use of ailerons to roll aircraft so that we create an angle of bank which creates a turning force (primary effect of aileron).
- Use of ailerons creates additional lift at the upgoing wingtip.
- Additional lift also causes additional drag at the upgoing wingtip.
- Drag on the upgoing wingtip causes yaw towards that wingtip, opposite to the direction the stick moved (i.e. adverse yaw).
- Adverse yaw creates side slip towards the lower wing.
- The yaw will be indicated by movement of the yaw string.
- Induced drag (and effect) will be greater at lower airspeeds.

Issues with Uncoordinated Flight

- Too much rudder results in a skid, too little results in a slip.
- Reduced efficiency of aircraft (reduced glide angle).
- Increased potential for aircraft to enter spin at low airspeeds.

Countering Aileron Drag

- Use of rudder in the same direction of turn to overcome the adverse yaw – introduced simultaneously with movement of the stick.
- Stick moved to left side – use left rudder; stick moved to right side - use right rudder. Centre rudder when stick is centred.

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- Proportionate use of rudder required. Large aileron movement requires large rudder movement. Ensure sufficient force is applied on the pedal to counter adverse yaw, but no more.
- Yaw string indicates when coordination is achieved. Coordination indicator; the yaw string points down to the rudder pedal to use to overcome the yaw.

Rolling on a Point

- A good exercise to develop coordinated use of aileron and rudder.
- Emphasise the need to commence this exercise from the stable platform and start with small amounts of roll in each direction, increasing this as skill increases. Return to the stable platform if the aircraft becomes uncoordinated.

Secondary Effect of Rudder

- Describe how the use of rudder to create yaw will also create a rolling force on the aircraft.
- The roll is caused by the outer wing having to fly faster, which produces more speed and therefore more lift.
- Left rudder, right wing flies faster, right wing goes up. Glider banks to the left.
Right rudder, left wing flies faster, left wing goes up. Glider banks to the right.
- Direct student to look ahead and then apply left rudder. Ask student to describe whether the left wing or the right wing goes down when the rudder is applied. Ask them to hold the aileron central as they apply the left rudder. Apply a lot of rudder and wait some time to spot the effect.
- You can then have the student pick up a wing by using opposite rudder, without using aileron. Instructor applies a aileron to lower the wing and then asks the student to pick it up by using the opposite rudder alone.

Pre-flight Briefing

- Cover instruments if required and brief student to maintain their view outside the cockpit.
- Explain that increased lift creates increased drag, so the upgoing wing will drag backwards. This is adverse yaw.
- You will feel this yaw, and you can observe the nose of the aircraft moving on the horizon.
- Describe that the adverse yaw can be countered by rudder in the direction of the roll. Left aileron results in the right wing being dragged backwards, so left rudder is required to overcome this drag.
- Large aileron movement causes more drag and therefore requires more rudder to counteract the drag.
- Emphasis on the same direction of movement of the stick & rudder pedals (left stick left rudder, right stick right rudder).
- Emphasis on use of controls simultaneously to maintain coordination.
- Review why uncoordinated flight introduces additional threats.

FLIGHT EXERCISES

Ensure that all exercises start and finish at the stable platform.

Demonstration of Aileron Drag

- Conduct targeted scan to maintain situational awareness.

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- Start at stable platform. Note attitude using horizon. Select a point on the horizon as yaw reference. Demonstrate at low minimum sink speed for greater effect.
- Advise that we will create aileron drag by moving the stick sideways without rudder input. See the movement of the aircraft nose against the horizon opposite to the direction of bank.
- Feel the aircraft yawing.
- Hear the air noise associated with a yawed state & observe yaw string deflect from the centreline indicating yaw.
- Return to stable platform through use of rudder and wings level with aileron, repeat in opposite direction.

Suggested Patter:

- SEE that the nose is pointing towards [reference point] and that the yaw string is pointing along the canopy centreline.
- Follow me through on the stick and rudder. I will apply left aileron.
- SEE that the left wing goes down when I move the stick to the left, but also see and feel the nose of the glider swing to the right on the horizon.
- SEE that the yaw string moves to the right, showing yaw to the right.
- HEAR the sound of the disturbed airflow.
- SEE that when I move the stick to the right I can bring the wings level, but the nose swings in the opposite direction.
- Repeat demonstration as many times as needed in both directions for the student to recognize the effect. Repeat using different amounts of lateral stick force to create differing amounts of adverse yaw.

Student practice (under supervision)

- Students can predict movement of the aircraft nose when the instructor nominates the use of aileron to roll left or right. Student confirms movement naturally when roll is commenced.

Conducting Coordinated Flight by Countering Aileron Drag

- Brief the need to fly coordinated and therefore the need to remove the effect of aileron drag when we use the stick from side to side to control the ailerons.
- Conduct targeted scan to maintain situational awareness.
- Start by noting the attitude using horizon.
- Move the stick as before – and now counter the aileron drag with rudder applied in the same direction as the aileron. Feel the use of rudder and aileron simultaneously.
- Based on what you observe, you can apply more or less rudder so that no yaw occurs as indicated by the yaw string.
- Observe no movement of nose against horizon indicating no yaw to right/left and hear no change to air noise and note the yaw string remains centred indicating coordinated flight.
- Roll back to wings level using the same technique with rudder to emphasise its use whenever the stick needs to be moved left or right, to maintain coordination.

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- Large aileron movement requires large rudder movement. No aileron movement, no rudder movement.
- Emphasis on when the stick is centralised (and ailerons are brought to neutral position) the rudder pedals are centralised. Ensure the student understands that in this context (overcoming aileron drag when banking) that when sideways stick movement is used – rudder is also used.
- The instructor should demonstrate poor coordination through under or overuse of rudder – with the student following on controls. Demonstrate which rudder to use, how much force is applied and when it is used to correct the yaw.

Suggested Patter:

- SEE that the nose is pointing towards [reference point] and that the yaw string is pointing along the canopy centreline.
 - Follow me through on the stick and rudder. I will apply left aileron, but I will also apply left rudder to stop the adverse yaw.
 - SEE that the left wing goes down when I move the stick to the left, and this time the nose does not swing and the yaw string stays in the centre.
 - HEAR the sound of normal airflow.
 - If we have a small swing of the nose, I can use more or less rudder to keep it coordinated.
 - When I bring the wings level with right aileron, FEEL that I also use right rudder.
 - Repeat demonstration as many times as needed in both directions for the student to recognize the effect. Repeat using different amounts of stick force to create differing amounts of adverse yaw.
- Repeat demonstration to the right and repeat as many times as needed for the student.
 - Demonstrate the different force used on the rudder pedals at different airspeeds and roll rates.
 - Demonstrate removal of force from pedals when the stick is centred.
 - Demonstrate roll from left bank to right bank (i.e. through wings level).

Student practice

- Instructor nominates direction to bank.
- Crew conducts FULL SCAN and TARGETED SCAN
- Student introduces roll and counters adverse yaw with rudder.
- Student removes force on rudder when aileron force is removed.
- Critique use of rudder (selected pedal, timing, force) and if necessary, re-demonstrate.
- Return to stable platform between practice.
- Practice at slow and fast airspeeds.

Rolling on a Point Exercise

This exercise is useful practice for students to improve the simultaneous use of controls.

- Point the nose towards a conspicuous feature on the horizon (hill, cloud, prominent building etc) in a stable platform around best L/D speed.

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- Start to roll slowly with coordinated aileron and rudder up to 10 degrees of bank in both directions and reverse the roll before the glider turns. The nose should remain pointing at the feature throughout the exercise.
- Demonstrate what happens to the nose if not enough and too much rudder is applied, then re-demonstrate the use of coordinated aileron and rudder.
- Hand over and have the student fly the exercise.
- The first aim of this exercise is to practice the timing of applying and centralizing the aileron and rudder simultaneously. The second aim is to develop a feel for how much rudder is required to balance the aileron input. The student may take a few attempts to achieve these aims. Encourage the student to be smooth on the controls and take over to re-demonstrate if the student continues to have difficulty.
- As student proficiency increases get them to increase the rate of roll and bank angle in each reversal. Have the student repeat the exercise at circuit speed and note the difference with the more powerful rudder at higher speed.
- For maximum use of airborne time, this exercise can be flown any time the glider is flying in a straight line e.g. on the downwind leg of the circuit before the student is ready to learn circuits.

Notes:

- The student must have a relaxed grip on the stick and controls adjusted correctly for reach during flight.
- During student flight exercises the student may feel that they are pressing on the rudder pedal harder than they actually are. The instructor may need to assist by demonstrating the required force but if this is done, ensure the student is aware that the instructor is assisting.
- Ensure lookout is maintained by all aircrew. Cover instruments in the student's view if necessary to discourage looking inside the cockpit.
- Be very careful with terminology and clarity of language. Make it clear when discussing control surfaces and control inputs (elevator, aileron, rudder), their effects in terms of motion (pitch, roll and yaw) and their effects in terms of attitude and flight path (attitude, bank angle, yaw angle or slip-skid angle).
- Precision with terminology must be synchronised with demonstrations in flight. Patter must be concise and careful. Feedback from the student must be sought. "What did you see when...?"
- If the flights are to be short (such as winch-launched sorties on a non-soaring day) do not attempt to include all elements of this module. It is better to allow the student time for a good demonstration and opportunity for practice on a single learning outcome.
- Focus attention on the horizon during initial demonstrations to ensure the student identifies the yaw occurring and in what direction.
- Ensure that the student has been briefed on the correct hand-over/take-over procedure and their expected action and verbal response to each. There must be no confusion about terminology for transfer of control.
- Remove all distractions from the exercise, for instance mute audio variometers.
- Do not reference changes to flight instruments – at this stage of learning the student must learn with reference to external cues.

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COMMON PROBLEMS

Problem	Probable Cause
<ul style="list-style-type: none"> Insufficient rudder utilised to overcome aileron drag. 	<p>Student may tend not to push hard on the rudder as it may feel harder to use than stick forces. Encourage the student to utilise correct force, demonstrate with them shadowing instructor inputs.</p> <p>Student may be applying too much aileron and generating a large amount of aileron drag for their skill level. Encourage use of aileron for lower angles of bank.</p>
<ul style="list-style-type: none"> Excessive use of rudder or perhaps late use followed by excessive rudder 	<p>Excessive use of rudder dangerous. Nose must not screw into turn. Risk of spinning at low speeds.</p>
<ul style="list-style-type: none"> Rudder is maintained when stick is centred. 	<p>Student may forget to remove rudder inputs due to workload or distraction. Encourage workflow of 'use stick, use rudder' to encourage the student to make movements in both controls when necessary.</p>
<ul style="list-style-type: none"> When rolling on a point, coordination is not maintained. 	<p>May be caused by late or insufficient application of rudder by student. Encourage simultaneous input of controls with sufficient rudder input.</p> <p>May be caused by student attempting large bank angles on the rolls. Have the student start with very low angles of bank (5 degrees) and work up as their skill level improves.</p>

THREAT AND ERROR MANAGEMENT

The threats and errors that can apply to this unit are:

- Misunderstanding of use of rudder simultaneously with aileron.
- Left-handed student may have difficulty in controlling ailerons with non-dominant hand.
- Higher force required to operate rudder relative to lateral stick movement.
- Loss of SA during exercises when focussing on coordination.
- Potential for loss of controlled flight if airspeed reduces towards stall in yawed configuration.
- Loss of height during conduct of exercises away from the landing area – maintain SA with relation to the airfield.
- Ineffective communication between student & instructor (including distractions, hearing difficulties or English as a second language).

TRAINING MATERIALS AND REFERENCES

- GPC Pilot Guide Unit 6
- Theory Lesson 2
- Model Glider