DEPARTMENT OF THE AIR FORCE
94th Flying Training Squadron (USAFA)
USAF Academy CO 80840

Flying

TG-9A AEROBATICS TECHNIQUES GUIDE

This Techniques Guide (TG) outlines the training required to fly and instruct aerobatic maneuvers in the TG-9A. It prescribes the overall plan of instruction, specific instructions for each maneuver, and basic/advanced aerobatic training programs.

SUMMARY OF REVISIONS

This revision incorporates the newest changes in formatting, incorporates separate basic and advanced qualifications, and refines techniques. It also incorporates new maneuvers designed to allow competitive aerobatic training.

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1. TG-9A Aerobatics.

1.1. Introduction. This study guide is for use as a training aid. It is by no means conclusive. Prior to beginning aerobatic training, the student must be familiar with all soaring operating procedures outlined in the Advanced Syllabus, 34OG OI 11-206 Vol I, Aircraft Technical Order, Flight Crew Checklist, and In-Flight Guide. The student must also meet all prerequisites stated in the Advanced Sailplane Syllabus.

1.2. Sailplane Aerobatics. Most sailplanes are not particularly well suited for aerobatics. The sailplane's relatively long wings result in a very poor roll rate. The comparatively low drag characteristics of the sailplanes can result in excessive airspeed any time the nose is below the horizon. The most hazardous aerobatics are poorly executed maneuvers. Poorly executed maneuvers may result in an unusual attitudes and could lead to an overspeed or over G situation. Accordingly, all sailplane aerobatics will be taught by an experienced rated instructor pilot and will be performed only after the pilot is totally familiar with the aircraft flight characteristics, including G to stick force relationships and unusual attitude recoveries.

1.3. Approved Maneuvers. Authorized aerobatic maneuvers are contained in this techniques guide and are limited to those not demanding extraordinary pilot skills while minimizing the possibility of aircraft damage.

1.3.1. The following maneuvers will be flown in the Basic Aerobatic Program: Chandelle, Lazy Eight, Loop, Cloverleaf, and High Speed Pass.

1.3.2. The following maneuvers will be flown in the Advanced Aerobatic Program: Slow Roll, Split-S, Immelmann, Cuban Eight, Hammerhead (Stall Turn), Barrel Roll, and Inverted Flight.

1.4. Prohibited Maneuvers. The following are PROHIBITED MANEUVERS and will be treated as an overspeed or over G if inadvertently performed: Tail Slide, Outside Loop, Snap Roll, and any other maneuver not contained in this manual.

2. Unusual Attitude Recoveries.

2.1. Nose-Low Recoveries. Many of the maneuvers demonstrated and practiced in flying training will result in intentional or unintentional nose-low attitudes. The following information will provide you with a sound basis for a recovery technique.

2.1.1. The recovery from any nose-low attitude should be made with smooth back pressure as you roll to a wings-level attitude. Start before the airspeed has increased to such an extent that aircraft limitations may be exceeded. Any time you are in a nose-low recovery situation with airspeed rapidly increasing, extend the spoilers and return the sailplane to level flight. Other situations may occur at lower airspeeds and shallower pitch attitudes. In these instances, recovery procedures may be modified to return to level flight with flying airspeed. Recovery should not involve the use of maximum allowable G unless the altitude available for recovery is critical. Should an over G occur, notify the SOF and perform a controllability check. Make an entry in the aircraft forms and ground the aircraft. (NOTE: Severe damage to the aircraft may result if G limits are exceeded.)

2.1.2. Recover from all nose-low attitudes smoothly, without excessive airspeed or loss of altitude. For most nose-low recoveries, it should not be necessary to approach maximum airspeed. Remember, the airspeed does not stop increasing as you begin raising the nose. It may increase until just before level flight is attained. Should maximum allowable airspeed be exceeded, notify the SOF, make an entry in the aircraft forms, and ground the aircraft. This write-up will result in an overall inspection of the aircraft structure. (NOTE: Severe damage to the aircraft may result if airspeed limits are exceeded.)

2.1.3. You must be aware of the potential for excessive altitude loss in any high-speed dive recovery. If the sailplane has progressed to a very high-speed dive, it is imperative that the spoilers be used for recovery.

2.2. Nose-High Recoveries. You will intentionally fly through nose-high flight attitudes many times during aerobatic practice. Occasionally, because of improper control procedures, you may find yourself in nose-high attitudes with less than optimum airspeed to continue the maneuver. Unless immediate and proper recovery procedures are initiated, the sailplane may be forced into an aggravated stall or a tail slide.

2.2.1. The objective of the nose-high recovery is to fly the sailplane to level flight as soon as possible without stalling. To accomplish this, initiate a coordinated roll toward 90° of bank to bring the nose of the sailplane down to the nearest horizon. The amount of bank angle depends on the nose-high condition and the rate the nose falls back to the horizon. If the nose is falling through the horizon before 90° of bank is reached, begin a coordinated roll-out to level flight. Ninety degrees of bank should not normally be exceeded during this type of recovery. As the sailplane approaches the horizon, roll to an upright attitude. In the event of a tail slide situation, freeze the controls in a neutral position until the nose starts to fall, then proceed as above.

2.2.2. An alternate means of recovery is to unload or neutralize the flight controls. This method of recovery should be used only during disorienting situations or if a stall indication is reached during the attempted nose-high recovery. Due to the sailplane's stability characteristics, it will eventually stabilize in a nose low attitude. Upon regaining flying airspeed, execute a nose low recovery and return the sailplane to level flight. CAUTION: Never release the stick and/or rudder pedals while flying aerobatics.

2.2.3. Your instructor will have you practice all techniques for recovery. As you gain proficiency, your instructor will allow you to decide on the technique best-suited for a given situation. There may be times when you attempt a nose-high recovery and have to transition to the unloaded technique due to insufficient airspeed or an approach to stall indication. However, you should learn to evaluate the existing situation and decide on the appropriate recovery technique.

2.3. Recovery From Inverted Flight. The correct procedure to recover from inverted flight is to execute a roll to the level flight attitude. The technique employed is the same as in executing any roll maneuver. Roll in the shortest direction to an upright attitude, using coordinated aileron and rudder inputs.

2.3.1. In a low airspeed situation, you may be required to lower the nose of the sailplane while performing the roll back to the level flight attitude. However, in a nose-high, no airspeed situation, a Split-S may be the most expeditious recovery. NOTE: Do not Split-S when the airspeed is greater than 70 kts. This may cause an overspeed and/or an over G.

2.3.2. Your instructor will give you the opportunity to practice this recovery technique. The instructor will fly the sailplane into an inverted attitude, then let you make the recovery. This will be practiced at various airspeeds. The correct recovery technique is a coordinated roll back to level flight.

CAUTION: Inverted flight can be very disorienting and improper recovery procedures can lead to unsafe situations.

3. Aerobatic Procedures.

3.1. General Procedures. Complete the following before performing any aerobatic maneuvers

3.1.1. Coordinate the appropriate aerobatic area with the SOF/Controller.

3.1.2. A clearing maneuver must be accomplished. (One 180°turn or two 90° turns)

3.1.3. Aerobatics should always be performed with the pitot tube extension.

3.1.4. The *Before Aerobatics Check* must be accomplished:

- **VENTS** - Close the side air vents to avoid stress and possible canopy damage while maneuvering.
- **STRAPS** - Both crewmembers ensure they are strapped in tightly.
- **LOOSE ITEMS** - Secure all loose items and microphones.
- **AIRBRAKES** - Close, lock, and guard airbrakes.
- **TRIM** - set. (near center) Do not change the trim while flying aerobatics.

3.1.5. Any time an overspeed or over G occurs, notify the SOF, perform a structural damage/controllability check, return to land. Ground the aircraft and document in the maintenance forms.

3.1.6. All maneuvers must be completed above 9000’ MSL within the western aerobatic area or by 1500’ AGL when performed elsewhere.

4. Basic Aerobatic Program.

4.1. General. The Basic Aerobatic Program is designed to introduce a small number of easily performed maneuvers. These techniques are used in order to set up a foundation for advanced aerobatic maneuvers.

4.2. Chandelle. During this maneuver the sailplane will constantly be increasing altitude, decreasing airspeed, and the nosetrack should describe a straight line through 180° of turn. Fly a constant bank angle of 60° until the roll-out is initiated. (see figure 1) Note: There is no Federation Aeornautique Internationale (FAI) figure for this maneuver.

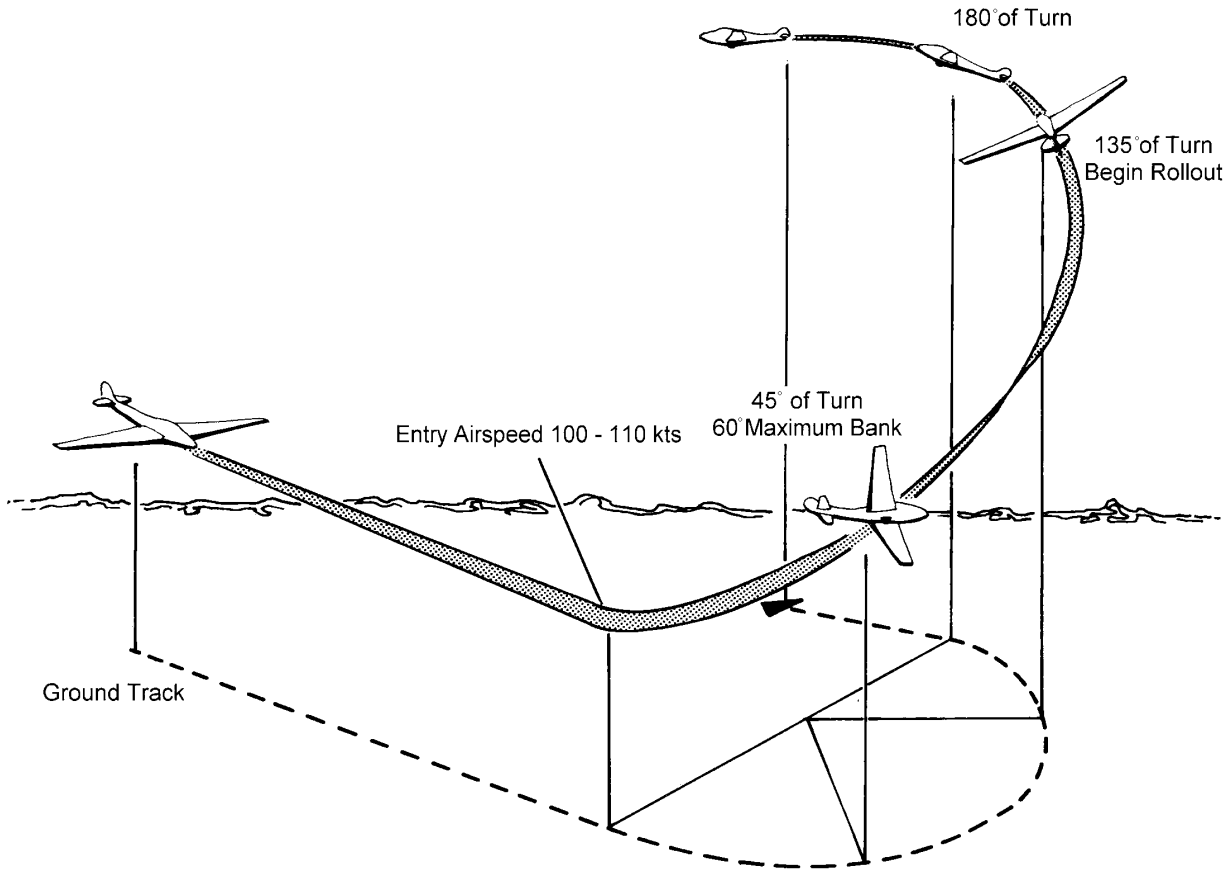


Figure 1, Chandelle (diagram)

4.2.1. Techniques.

4.2.1.1. Lower the nose 30-45° and accelerate to 100-110 kts.

4.2.1.2. Set up on a road, parallel the mountains, or pick a 180° point to finish on.

4.2.1.3. Basic Entry. While the nose is still below the horizon, start a roll in the desired direction at 100 kts to approximately 60° bank. Smoothly begin adding back pressure to approximately 3 Gs (reference G meter). An approximate checkpoint is to arrive at 45° of turn at 60° bank with the nose on the horizon.

4.2.1.4. Advanced Entry. Coordinate the roll and back pressure together to arrive at the horizon after 45° of turn at 60° of bank.

4.2.1.5. During the maneuver top aileron is required to maintain the constant bank angle and constant nose track.

4.2.1.6. At the 135° point, begin the roll-out using opposite rudder and aileron, maintaining a constant nose track.

4.2.1.7. The maneuver should end at the 180° point, wings level in a nose high attitude and close to slow flight airspeed (approximately 40-50 kts).

4.2.1.8. Recover by "pushing over" with zero or ½ positive G.

4.2.1.9. Remember that the Chandelle will end up approximately 500' higher than it started, the sailplane will be facing the opposite direction and be at a very low energy state.

4.2.2. Common Errors.

4.2.2.1. Beginning the maneuver with less than 100 kts.

4.2.2.2. Using too much/too little bank in the turn.

4.2.2.3. Not maintaining top aileron.

4.2.2.4. Not maintaining a constant nosetrack for the entire maneuver.

4.2.2.5. Rolling out too early/too late with regards to the reference point.

4.2.2.6. Not maintaining back pressure during the roll-out, resulting in a dropped nose track and fast airspeed.

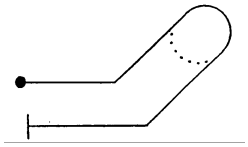


Figure 2, Lazy Eight (FAI Figure)

4.3. Lazy Eight. This is a slow, lazy maneuver with constantly changing pitch and roll. The sailplane will be describing a Figure 8 by making two 180° turns in the opposite direction. Throughout the maneuver the yaw string should be centered. (see figures 2 and 3)

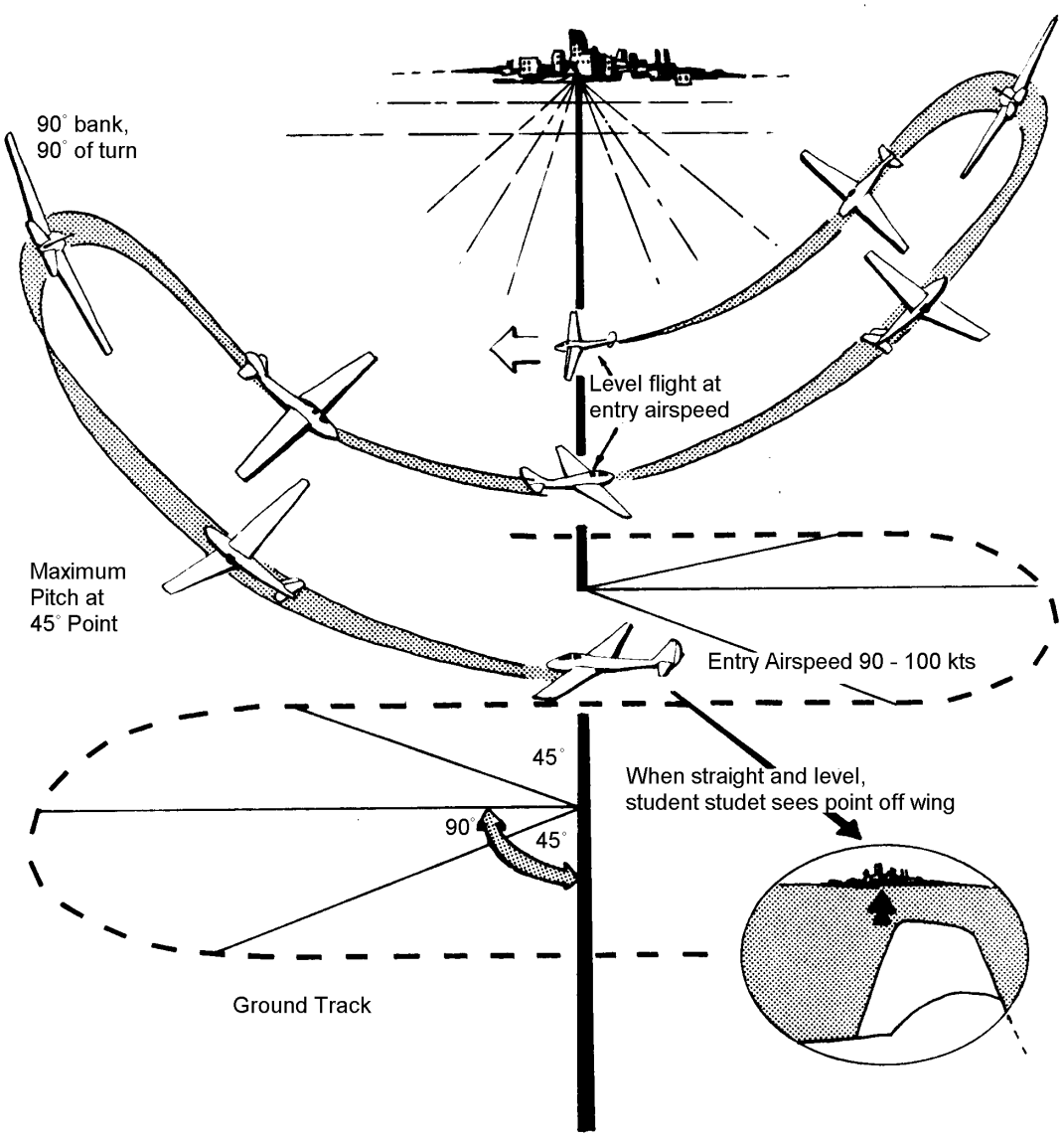


Figure 3, Lazy Eight (diagram)

4.3.1. Techniques.

4.3.1.1. Lower the nose 30-45° and accelerate to 90-100 kts wings level.

4.3.1.2. Choose a good 90° reference point in the desired direction of turn. Use a cloud or prominent landmark, close to the horizon.

4.3.1.3. Smoothly raise the nose, and as it passes through the horizon, begin banking slowly so that the highest pitch attitude will be reached at 45° of turn. The nose should be approximately 30-45° high (feet on the horizon).

4.3.1.4. Bank should continue to increase to be 90° at the 90° point of turn. Airspeed at this point should be 40-60 kts. Pitch should also be decreased so the nose passes through the horizon at 90° of bank.

4.3.1.5. At the 90° point, continue to allow the nose to fall through the horizon. Gradually reduce the bank so you have the lowest pitch and about 45° bank at the 135° point.

4.3.1.6. Continue reducing bank angle and pitch to roll out 180° opposite your entry point, wings level, and at entry airspeed of 90-100 kts.

4.3.1.7. Reverse the turn for the second half of the lazy eight and use the same above procedures.

4.3.1.8. Remember the maneuver should be symmetrical and lazy. Roll rate should be the same throughout, airspeed at each 90° point should be the same ($\pm$ 5 kts), and the nose should fly as far below the entry attitude as it went above (NOTE: The entry flight attitude for sailplanes is not the horizon--it is below.)

4.3.1.9. Open the spoilers immediately if acceleration through 120 kts is likely and perform an unusual attitude recovery.

4.3.1.10. The maneuver will carry you in the direction of your reference point and will lose approximately 300'.

4.3.2. Common Errors.

4.3.2.1. Beginning the maneuver at less than 90 kts.

4.3.2.2. Not hitting the 90° point at 90° of bank.

4.3.2.3. Hitting the 90° point but well before the nose passes through the horizon.

4.3.2.4. Having different airspeeds at each 90° point.

4.3.2.5. Not making the second turn with the same pitch and roll as the first.

4.3.2.6. Not hitting the 180° point.

4.3.2.7. Not finishing the maneuver at entry airspeed.

4.3.2.8. Beginning the roll too soon, preventing sufficient pitch.

4.3.2.9. Pulling too many Gs, too aggressive a maneuver.

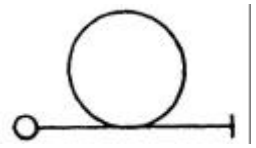


Figure 4, Loop (FAI Figure)

4.4. Loop. This maneuver uses a constant heading and variable pull through (Gs) describing a circle in the vertical plane. (see figures 4 and 5)

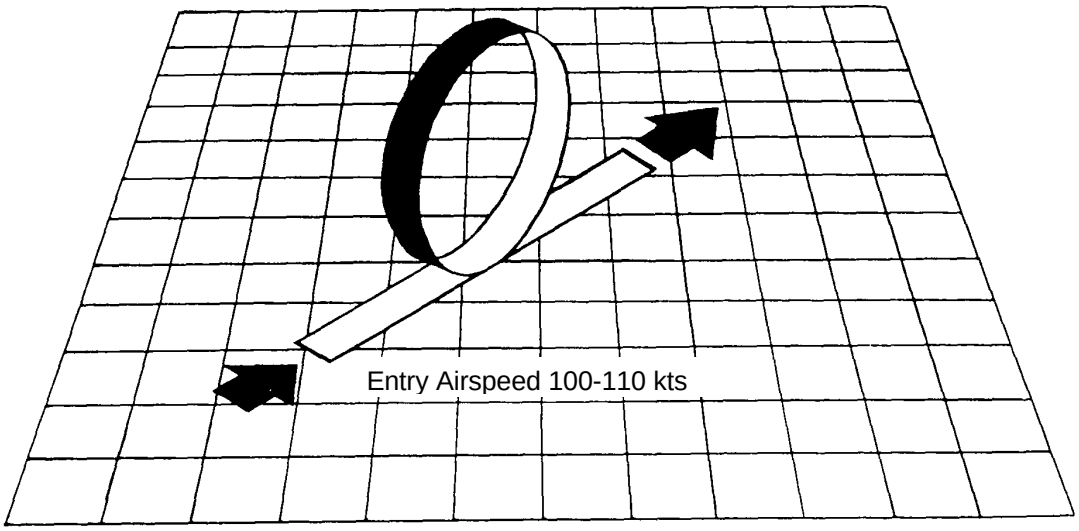


Figure 5, Loop (Diagram)

4.4.1. Techniques.

4.4.1.1. Lower the nose 30-45° and accelerate to 100-110 kts wings level. Use a section line or prominent landmark as an aimpoint.

4.4.1.2. Smoothly apply back pressure: 3½ - 4 Gs (reference G meter). Maintain a constant nose track as the airspeed bleeds off.

4.4.1.3. Look out each side to ensure a straight pull-up. The horizon should disappear evenly on both sides and be equidistant from each wingtip.

4.4.1.4. Be prepared to abort the maneuver if a tail slide appears likely.

4.4.1.5. At approximately the straight-up, vertical position, lay your head back and look for the opposite horizon. This will ensure your wings are still level. Correct any bank deviations.

4.4.1.6. Reduce back pressure as you pull the sailplane down to the horizon. Inverted airspeed should be 40-50 kts. If airspeed is higher than 70 kts when inverted, abort the maneuver and perform an unusual attitude recovery as an overspeed may occur on the pull through.

4.4.1.7. Once over the top, airspeed will increase rapidly. Steadily increase back pressure to pull the sailplane down to a nose low position.

4.4.1.8. Continue to look back to find your aimpoint (same section line, road, landmark), correcting any heading deviations that may have occurred in the pull-up.

4.4.1.9. Adjust back pressure through the pull through to arrive at entry airspeed at the completion of the maneuver.

4.4.1.10. Open the airbrakes immediately if acceleration through 120 kts is likely.

4.4.1.11. The maneuver should end where it started and will use/lose approximately 300'.

4.4.2. Common Errors.

4.4.2.1. Beginning the maneuver at less than 100 kts.

4.4.2.2. Using insufficient G on the pull up.

4.4.2.3. Rolling during the pull up.

4.4.2.4. Maintaining the same back stick pressure as airspeed decreases, causing approach to stall buffeting.

4.4.2.5. Using insufficient G on the pull through.

4.4.2.6. Ending the maneuver at other than entry airspeed.

4.5. Cloverleaf. This maneuver is a modification of a loop. When the nose reaches approximately 45° high, a quarter roll is executed in the desired direction of turn, followed by a Split-S type maneuver once the wings are level inverted. This is done four times, rolling in the same direction each time. (see figure 6) Note: There is no FAI figure for this maneuver.

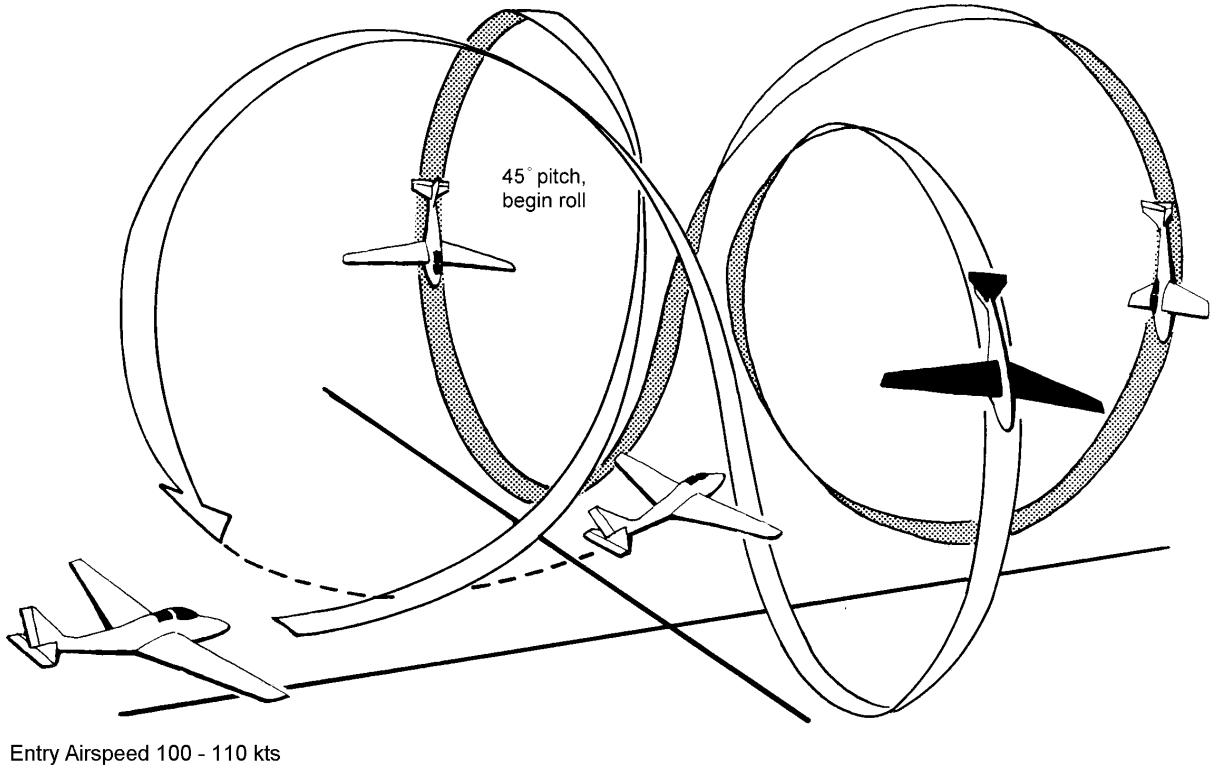


Figure 6, Cloverleaf (Diagram)

4.5.1. Techniques**.**

4.5.1.1. Lower the nose 30-45° and accelerate to 100-110 kts wings level. Pick a reference point off the wingtip in the direction of turn.

4.5.1.2. Smoothly apply back pressure - 3 ½ - 4 Gs (reference G meter). This should be a straight pull-up.

4.5.1.3. When the nose is approximately 45° high (feet on the horizon) begin a coordinated roll and pull toward your reference point. Use approximately ½ aileron and ¼ rudder inputs initially. Keeping your eyes on the reference point will allow you to fly directly towards it.

4.5.1.4. Neutralize rudder and ailerons as you approach the 90° point, to arrive at your reference point wings level inverted. At the 90° point, the sailplane should be wings level inverted. Airspeed should be 40-50 kts. If airspeed is higher than 70 kts when inverted, abort the maneuver as an overspeed/over G may occur on the pull through.

4.5.1.5. From the inverted position, increase back pressure and recover as in the pull through of a loop adjusting back pressure so that 100-110 kts is reached at approximately the 45° nose low position to begin the next leaf.

4.5.1.6. Continue as before until four consecutive leafs have been completed.

4.5.1.7. If properly flown, the maneuver will end up where it started approximately 1000-1200' lower. NOTE: To conserve altitude, all four leafs need not be accomplished.

4.5.2. Common Errors.

4.5.2.1. Beginning the maneuver at less than 100 kts.

4.5.2.2. Using insufficient G on the pull up.

4.5.2.3. Rolling too soon during the initial pull up.

4.5.2.4. Rolling too fast and undershooting the point.

4.5.2.5. Not using enough rudder/roll and overshooting the point.

4.5.2.6. Not pulling straight through the back side.

4.5.2.7. Arriving at the start of the next leaf with too much or too little airspeed.

4.5.2.8. Not flying four symmetric leafs.

4.6. High Speed Pass. This maneuver follows most aerobatic demonstrations and will not go below 500' AGL.

4.6.1. Techniques.

4.6.1.1. Start the maneuver at 1500' AGL, wings level. Lower the nose 30-45° and accelerate to 120 kts. (130 kts is the maximum allowable.)

4.6.1.2. Proceed along the show line to arrive at center no lower than 500'AGL. No wing rocking or wing flashing is allowed.

4.6.1.3. Perform a smooth pull up to conserve energy and maneuver for landing. (3 - 3½ Gs) Maneuver as required for landing. A 360° or teardrop pattern to landing is most common if the maneuver show line is parallel to the runway.

4.6.2. Common Errors.

4.6.2.1. Too aggressive a push over to accelerate.

4.6.2.2. Too aggressive a pull up.

4.6.2.3. Going below 500' AGL.

4.6.2.4. Not completing a "Before Landing Check" before landing.

5. Advanced Aerobatic Program.

5.1. General. The advanced aerobatic program consists of the following maneuvers: Slow Roll, Split-S, Immelmann, Cuban Eight (Forward and Reverse), Hammerhead (Stall Turn), Barrel Roll, and Inverted Flight Although these maneuvers are performed in UPT, the techniques used in the advanced aerobatic program are not, and are very difficult to perform correctly. DO NOT DEVIATE FROM THESE TECHNIQUES OR SAFETY OF FLIGHT MAY BE VIOLATED.

Figure 7, Slow Roll (FAI Figure)

5.2. Slow Roll. The Slow Roll is a very demanding maneuver in the TG-9A. It encompasses all aspects of aerobatic flight. The following techniques are not used in UPT and will be performed only when flying high performance sailplanes. (see figures 7 and 8)

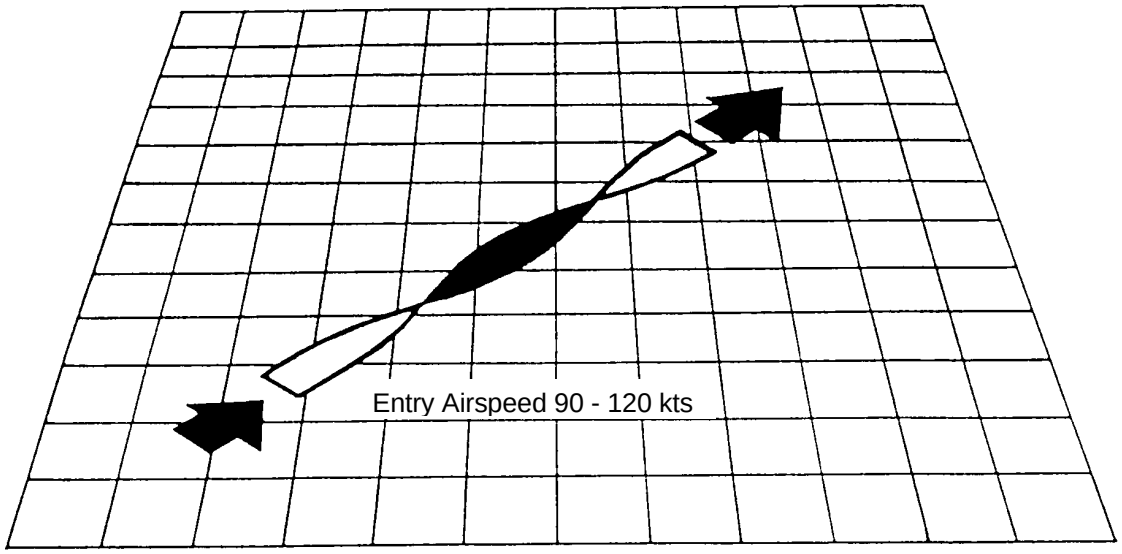


Figure 8, Slow Roll (diagram)

5.2.1. Techniques.

5.2.1.1. Lower the nose and accelerate to 90-120 kts.

5.2.1.2. Apply back pressure to reach 10-20° nose high.

5.2.1.3. Relax back pressure and unload to approximately 0 G.

5.2.1.4. Smoothly apply aileron and rudder in the desired direction of roll.

5.2.1.5. As you approach 90° of bank, start reversing rudder inputs. Continue to maximize aileron deflection and increase opposite rudder as the bank angle increases. After passing 90° of bank, forward stick pressure must be applied to prevent an inverted high speed situation.

5.2.1.6. After reaching the wings level inverted attitude, you must smoothly start taking out the opposite rudder and forward stick pressure - keep the ailerons deflected.

5.2.1.7. After 270° of roll, you must use pro rudder (top rudder) to keep the nose from dropping. As the sailplane approaches upright start blending in back pressure.

5.2.1.8. Continue aileron deflection to maintain a constant roll rate. Rudder inputs will be constantly changing throughout the maneuver from moderate pro rudder to slight opposite rudder back to moderate pro rudder

5.2.2. Common Errors.

5.2.2.1. Starting the maneuver with less than 90 kts.

5.2.2.2. Not raising the nose before starting the roll.

5.2.2.3. Not relaxing back pressure before starting the roll.

5.2.2.4. Improper/wrong rudder inputs during the roll.

5.2.2.5. Improper/wrong elevator inputs during the roll.

5.2.2.6. Not keeping a constant roll rate.

5.2.2.7. Not rolling on a point.

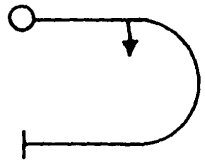


Figure 9, Split-S (FAI Figure)

5.3. Split-S. The Split-S is a maneuver that combines a half roll to wings level inverted followed by the second half of a loop. It will demonstrate how much altitude can be lost when an improper nose low recovery procedure is used. NOTE: For sailplanes the difference in altitude lost between a Split-S and an inverted nose low recovery is minimal. For high performance jet aircraft this is crucial, and a Split-S can lose more than 10,000' in a T-38. (see figures 9 and 10)

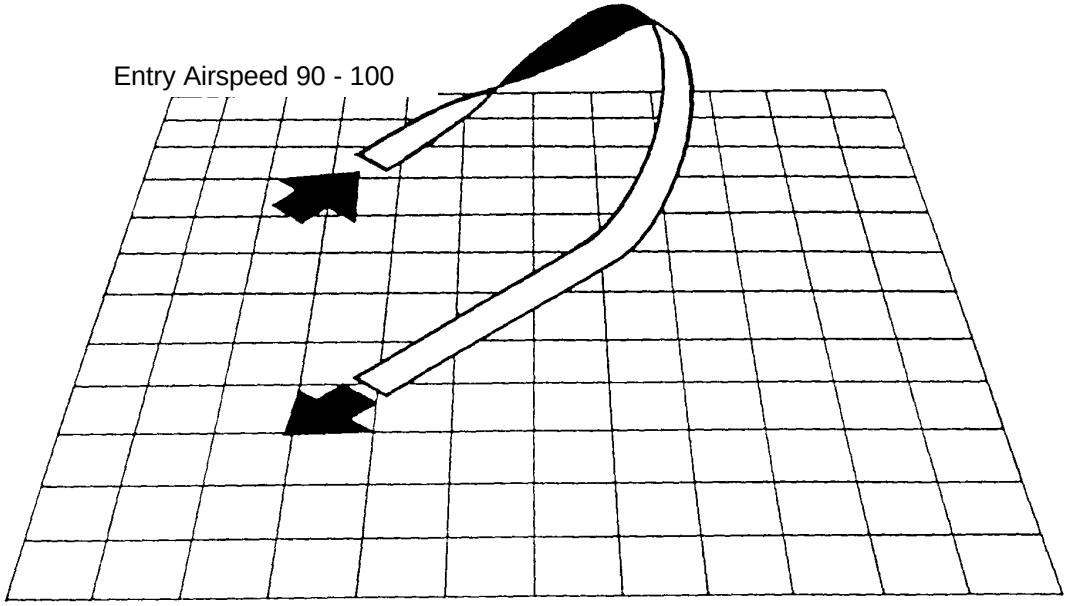


Figure 10, Split-S (diagram)

5.3.1. Techniques.

5.3.1.1. Lower the nose 30-45° and accelerate to 90-100 kts wings level.

5.3.1.2. Apply back pressure to reach approximately 10° nose high. Neutralize back pressure and smoothly apply full aileron deflection and coordinated rudder in the desired direction of roll. Passing 90°, reverse rudder input and apply forward stick as required to keep the nose above the horizon.

5.3.1.3. As the sailplane reaches an inverted slightly nose high attitude, neutralize ailerons and rudder.

5.3.1.4. Execute the last half of a loop to arrive wings level at 100-120 kts. NOTE: Do not pull through if airspeed is greater than 70 kts, instead perform an unusual attitude recovery.

NOTE: The roll to inverted flight need not be on a point due to the characteristics of the TG-9A; however, once inverted wings level the pull through should be straight.

5.3.2. Common Errors.

5.3.2.1. Starting the maneuver with less than 90 kts.

5.3.2.2. Rolling too slow - not reaching wings level inverted.

5.3.2.3. Not rolling coordinated - improper rudder inputs.

5.3.2.4. Allowing the nose to fall below the horizon before wings level inverted flight is attained.

5.3.2.5. Not neutralizing rudder or aileron before pull through.

5.3.2.6. Insufficient back pressure on the pull through.

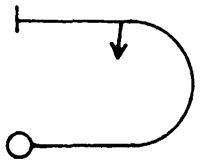


Figure 11, Immelmann (FAI Figure)

5.4. Immelmann. The Immelmann is a maneuver that combines several aspects of other basic maneuvers. It consists of the first half of a Loop followed by a half roll to level flight. The maneuver will turn you 180° and leave you at slow flight airspeed. It is difficult to perform because you are much slower when you attempt to roll. NOTE: These techniques will not result in a perfect Immelmann, but will give you the foundation required for performing Immelmanns at UPT. (see figures 11 and 12)

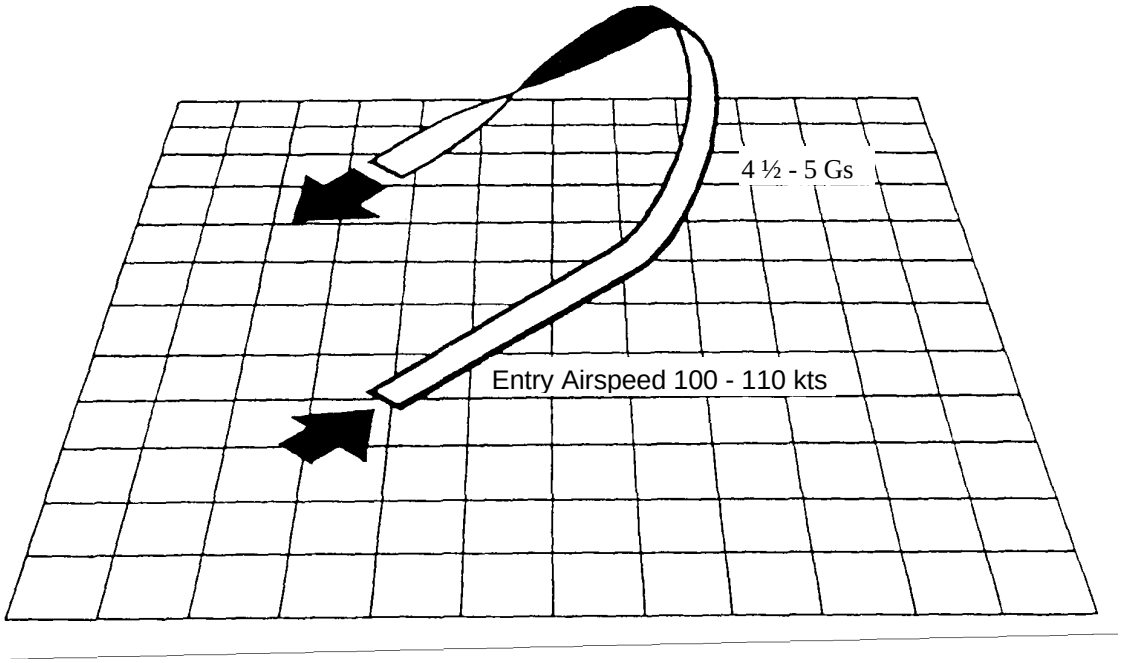


Figure 12, Immelmann (diagram)

5.4.1. Techniques.

5.4.1.1. Lower the nose 30-45° and accelerate to 110 kts wings level.

5.4.1.2. Apply back pressure to reach 4½ to 5 Gs. A higher G loading will give you more airspeed over the top for the half roll. CAUTION: You are very close to the G limits on this pull - DO NOT BE OVER AGGRESSIVE, (especially in light to moderate turbulence.)

5.4.1.3. Continue as in a loop until you approach the wings level inverted attitude. (Canopy bow on the horizon for the back seat reference.)

5.4.1.4. Push forward stick pressure (0 to ½ negative G) to stop the nose slightly above the horizon and begin a coordinated roll in the desired direction. Use full aileron deflection and approximately ½ opposite rudder deflection. You must use opposite rudder to stay coordinated

5.4.1.5. As you reach 90° of roll you must start blending in pro rudder (top rudder). As you complete the roll blend in back pressure to maintain level flight.

5.4.1.6. Remaining unloaded during the last half of the roll will minimize "washout." As long as you finish within 30° of heading it is an acceptable Immelmann. NOTE: The design and length of the wings causes this "washout" effect.

5.4.2. Common Errors.

5.4.2.1. Starting the maneuver with less than 100 kts.

5.4.2.2. Rolling during the pull-up.

5.4.2.3. Insufficient G on the pull-up.

5.4.2.4. Not pushing forward stick pressure before executing the roll.

5.4.2.5. Improper/wrong rudder inputs during the roll.

5.4.2.6. Not blending in back pressure during the last part of the roll - finishing the maneuver below the horizon.

5.4.2.7. Not finishing within 30° of heading after the half roll.

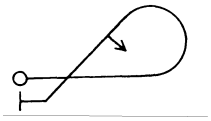


Figure 13, ½ Cuban Eight *Forward* (FAI Figure)

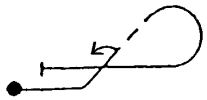


Figure 14, ½ Cuban Eight *Reverse* (FAI Figure)

5.5. Cuban Eight. *Forward*: The Cuban Eight is a showmanship maneuver consisting of a 5/8 Loop followed by a half roll performed twice. From a profile view it describes a Figure 8 in the horizontal position. The two half rolls are performed in opposite directions. NOTE: To be flown correctly, the Cuban Eight requires large stick inputs with negative G flight, and can be very disorienting. *Reverse:* Performing the Cuban Eight in reverse is very similar to a Split-S. NOTE: If the diagonal up line is held too long, the sailplane will stall inverted. This will make a straight line ground track impossible, due to the sailplanes natural tendency to upright itself when stalled inverted. (see figures 13, 14, 15, and 16)

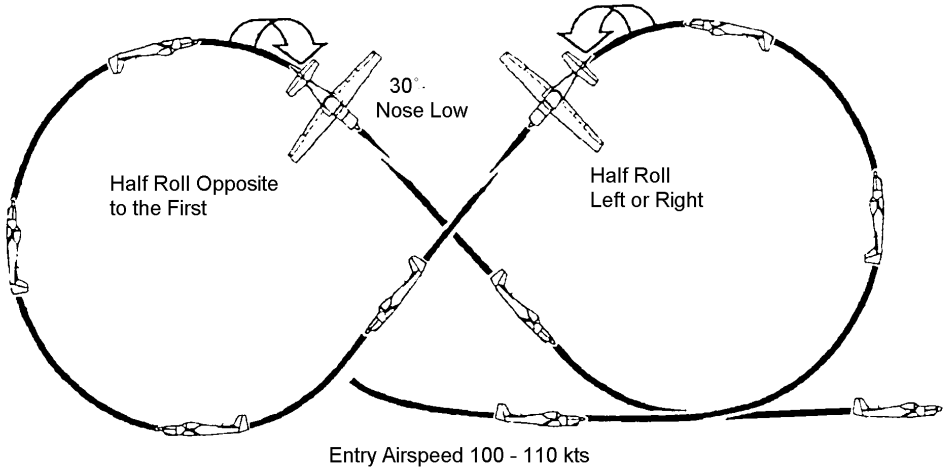
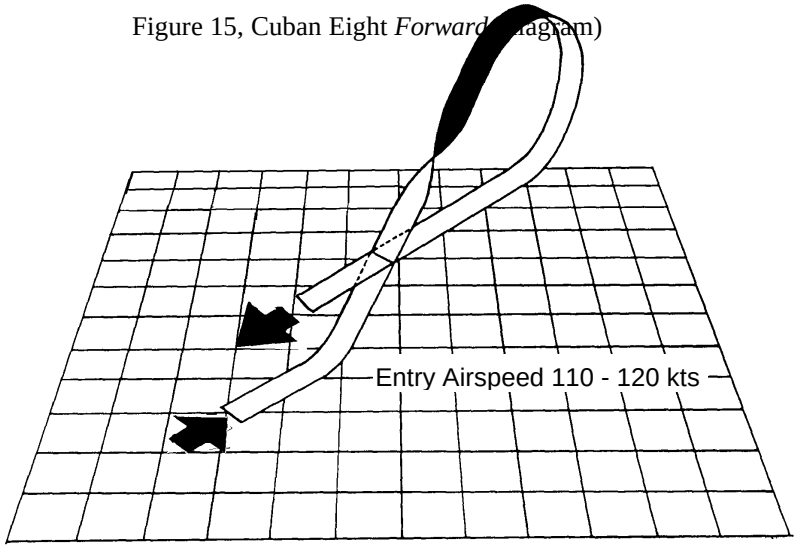


Figure 15, Cuban Eight *Forward* (diagram)



5.5.1. Techniques. *Forward:*

Figure 16, ½ Cuban Eight *Reverse* (diagram)

5.5.1.1. Lower the nose 30-45° and accelerate to 100-110 kts wings level.

5.5.1.2. Apply 3½ to 4 Gs as in a Loop. DO NOT BE OVERAGGRESSIVE ON THE PULL-UP - TOO MUCH AIRSPEED OVER THE TOP WILL RESULT IN AN OVERSPEED DURING THE ROLL.

5.5.1.3. Continue the back pressure until you are 30° nose low inverted. Push forward stick pressure to stop the nose from tracking. (approximately -1 G)

5.5.1.4. Begin a coordinated half roll in the desired direction. Remember opposite rudder must be used, initially. Start with ¾ to full aileron deflection and ½ to ¾ rudder deflection.

5.5.1.5. Smoothly blend rudder and stick pressure together to execute the roll around a point. After reaching wings level, hold the nose down to accelerate for the second half of the maneuver.

5.5.1.6. Execute the second half exactly the same as the first, except roll in the opposite direction.

5.5.2. Common Errors. *Forward:*

5.5.2.1. Starting the maneuver with less than 100 kts.

5.5.2.2. Insufficient G during the pull-up.

5.5.2.3. Excessive G during the pull-up - too much airspeed to safely execute the roll.

5.5.2.4. Rolling during the pull-up.

5.5.2.5. Not applying forward stick pressure before executing the roll.

5.5.2.6. Improper/wrong rudder inputs during the half roll.

5.5.2.7. Improper elevator inputs during the half roll.

5.5.2.8. Not rolling around a point

5.5.2.9. Not holding the nose down after the half roll.

5.5.2.10. Not rolling in the opposite direction on the second half of the maneuver.

5.5.3. Techniques. *Reverse:*

5.5.3.1. Lower the nose 30-45° and accelerate to 110-120 kts wings level.

5.5.3.2. Apply back pressure until you are 30° nose high.

5.5.3.3. Push forward stick pressure to approximately ½ G.

5.5.3.4. Begin a coordinated half roll in the desired direction

5.5.3.5. Smoothly blend rudder and stick pressure together to execute the roll around a point. After reaching wings level, hold the nose up to draw the inverted portion of the line.

5.5.3.6. As the sailplane approaches a stall, blend in back stick and pull straight through to level flight.

5.5.4. Common Errors. *Reverse:*

5.5.4.1. Starting the maneuver with less than 110 kts.

5.5.4.2. Insufficient G during the pull-up.

5.5.4.3. Rolling during the pull-up.

5.5.4.4. Not applying forward stick pressure before executing the roll.

5.5.4.5. Improper/wrong rudder inputs during the half roll.

5.5.4.6. Improper elevator inputs during the half roll.

5.5.4.7. Not rolling around a point

5.5.4.8. Allowing the sailplane to stall inverted.

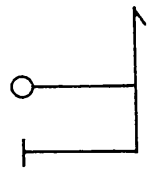


Figure 17, Hammerhead (Stall Turn) (FAI Figure)

5.6. Hammerhead (Stall Turn). This maneuver is an exaggerated ½ lazy eight. The sailplane is initially set in a vertical flight path. A turn or pivot is accomplished while the sailplane is still tracking in the forward direction. Ideally the radius of turn will be one wingspan. Upon turn completion, the sailplane will fly straight down. The maneuver is concluded by returning to level flight. DO NOT DELAY RUDDER INPUT BELOW 70 KTS OR A TAIL SLIDE MAY OCCUR. (see figures 17 and 18)

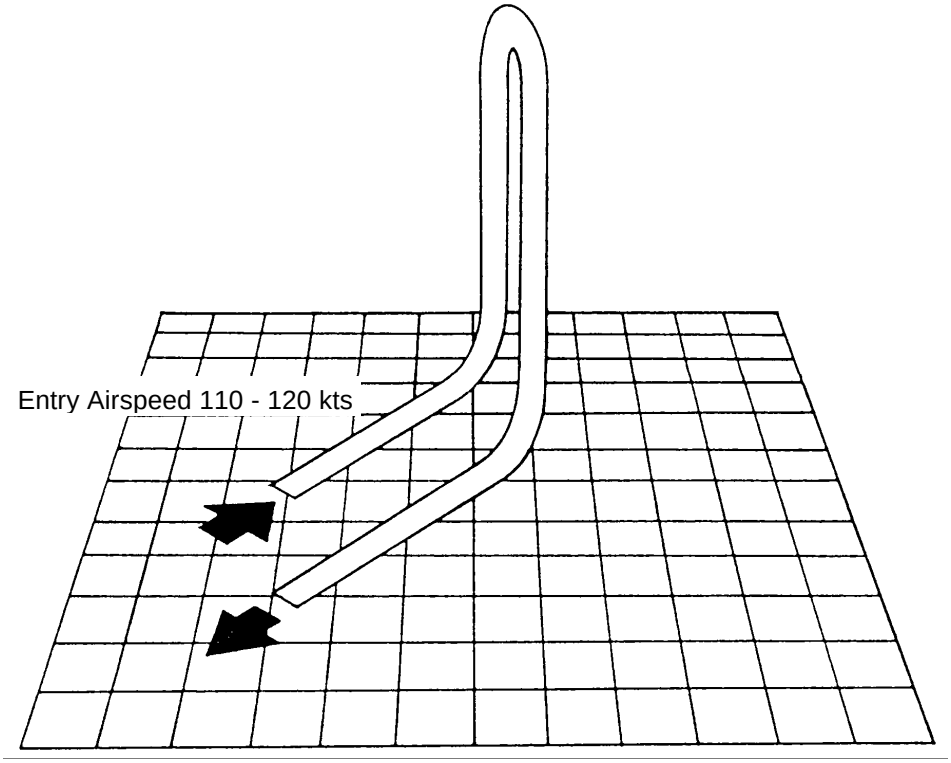


Figure 18, Hammerhead (Stall Turn) (diagram)

5.6.1. Techniques.

5.6.1.1. Lower the nose 30-45° and accelerate to 110-120 kts wings level.

5.6.1.2. Apply back pressure to reach 4½ to 5 Gs. The highest G loading will give more airspeed and a longer vertical portion. CAUTION: You are very close to the G limits on this pull - DO NOT BE OVER AGGRESSIVE, (especially in light to moderate turbulence.)

5.6.1.3. Hold the vertical flight path constant, (reference the wingtip and the horizon) until the airspeed slows to 75 kts.

5.6.1.4. Abruptly add full rudder in the desired turn direction. Half a second later, add full OPPOSITE aileron. Maintain full rudder until the sailplane approaches the vertical straight down. Take out the aileron input as the aircraft pitches down, maintaining the reverse entry heading.

5.6.1.5. Use forward stick pressure to fly the sailplane on the vertical down line. As the airspeed builds, recover to a normal flight attitude.

5.6.2. Common Errors.

5.6.2.1. Not reaching 4½ Gs minimum.

5.6.2.2. Not flying the sailplane in the vertical line.

5.6.2.3. Not using opposite aileron during the turn.

5.6.2.4. Allowing the nose to fall backwards during the pivot.

5.6.2.5. Slowing too much before initiating the turn.

5.7. Barrel Roll. This maneuver is a coordinated roll in which the nose of the sailplane describes a circle around a point on the horizon. (see figure 19) Note: There is no FAI figure for this maneuver.

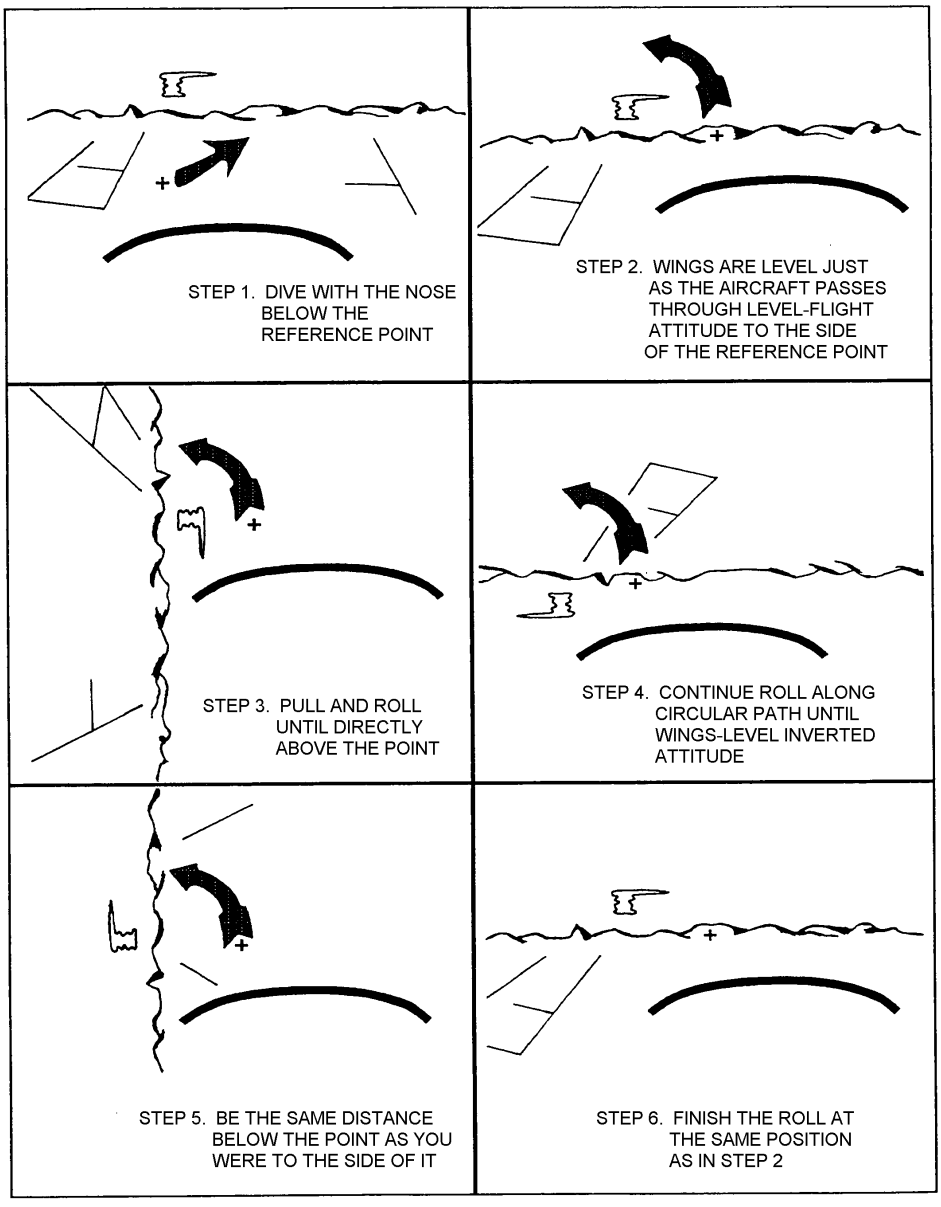


Figure 18, Barrel Roll (diagram)

5.7.1. Techniques.

5.7.1.1. Lower the nose 30-45° and accelerate to 90-100 kts wings level.

5.7.1.2. Select a reference point - cloud or prominent landmark - on or near the horizon approximately 20-30° off the nose in the desired direction of roll.

5.7.1.3. With the nose below the point, begin a 2½ to 3 G pull up. Wings are level just as the sailplane passes through level flight attitude to the side of the reference point.

5.7.1.4. Continue the back pressure until you are approximately 20-30° nose high. Begin a coordinated roll toward the point using approximately ¾ aileron and ½ rudder inputs. Arrive at 90° bank with the nose of the sailplane at its highest point above the reference point.

5.7.1.5. Continue to roll (ailerons will be full displaced with approximately ½ rudder input), but relax some of the back pressure so that you reach wings level inverted above the horizon the same distance to the opposite side of the reference point. As you approach the inverted attitude start taking out some of the rudder because the ailerons are becoming less effective at the slow airspeed. Airspeed should be approximately 40-50 kts. NOTE: Wings level inverted is approximately 20° nose high. Be prepared to abort the maneuver. If you reach wings level at or below the horizon a "Barrel Dive" will occur and possible overspeed/over G.

5.7.1.6. Continue the roll and blend in slight back pressure to bring the nose of the sailplane below the reference point as you did on top. Rudder in the direction of turn (top rudder) must now be increased. Plan to be at 90° bank at the lowest point below the reference point.

5.7.1.7. Continue roll and back pressure to arrive at the same distance (approximately 20-30°) from the reference point. Airspeed will accelerate to about 90 kts throughout the nose low portion. Airspeed must remain below 97 kts to prevent an asymmetric over G. Rudder must again be decreased as bank angle decreases and airspeed increases.

5.7.1.8. Open airbrakes immediately if acceleration through 97 kts is likely.

5.7.1.9. If you are not wings level by the time you pass the horizon inverted, a "Barrel Dive" is usually imminent. Abort the maneuver, perform an unusual attitude recovery.

5.7.1.10. This maneuver usually requires one statute mile and approximately 300-400' of altitude.

5.7.2. Common Errors.

5.7.2.1. Beginning the maneuver at less than 90 kts.

5.7.2.2. Trying to do the maneuver without enough forward area remaining to complete it.

5.7.2.3. Picking a reference point too close to the nose.

5.7.2.4. Rolling during the initial pull up.

5.7.2.5. Not maintaining a constant distance from the reference point throughout the maneuver.

5.7.2.6. Not using enough rudder and aileron to continue the roll at a constant rate.

5.7.2.7. Not playing the roll and back pressure across the bottom to end up where you started.

5.8. Inverted Flight. Inverted flight in the TG-9A is extremely difficult, and very disorienting to most pilots. Most of us have little, if any, instruction on the fundamentals of flying upside down. The following techniques are not used in UPT and will be strictly adhered to.

5.8.1. Techniques.

5.8.1.1. Enter Inverted Flight from either of the following:

- Half Loop to inverted.
- Half roll to inverted.

5.8.1.2. Half Loop Entry: Execute a normal half loop to the wings level inverted attitude. Allow the airspeed to build to 60-70 kts. Push forward stick pressure to the wings level inverted attitude.

5.8.1.3. Half Roll Entry: Execute a half slow roll to the inverted wings level attitude. Check airspeed between 60-70 kts. Push or relax stick pressure to maintain this airspeed.

5.8.1.4. After reaching the wings level inverted attitude with 60-70 kts, accomplish a coordination exercise inverted. Remember opposite aileron must be applied in relation to the desired direction of turn. Rudder inputs will be in the direction of turn. Practice 15-20° bank turns from this attitude. These maneuvers are disorienting and caution must be used at all times. When in doubt, execute an unusual attitude recovery.

5.8.1.5. Negative G loading requires a relaxing body position - the exact opposite from positive G loading. DO NOT EXERT PRESSURE AGAINST NEGATIVE Gs. INSTEAD, RELAX AND ENJOY THE RIDE.

5.8.1.6. Recover from inverted flight by executing a Split-S, or half roll to normal flight. The half roll technique is sometimes made easier by allowing the sailplane to stall inverted. Push the nose up 5-10° above the 60-70 kts picture. Allow the airspeed to decrease. As the sailplane approaches the stall, one wing will drop. Complete the roll to upright in that direction.

5.8.2. Common Errors.

5.8.2.1. Improper entry procedures.

5.8.2.2. Not applying enough forward stick pressure when inverted - resulting in a fast airspeed inverted.

5.8.2.3. Applying too much forward stick pressure and stalling inverted.

5.8.2.4. Improper control inputs when inverted.

5.8.2.5. Improper recovery procedures from an inverted unusual attitude.

5.8.2.6. Improper recovery procedure from inverted flight.

6. Aerobatic Instruction.

6.1. General. If you have never taught or instructed aerobatics, there are several lessons to be learned before you jump in. Sailplane aerobatic sorties compact a lot of maneuvering in a very, very short time. Take time on the ground to discuss what maneuvers are going to be flown, in what order, common mistakes, recovery procedures, etc. A few minutes before strapping in can save hours of heartburn later.

6.2. First Sortie Techniques.

6.2.1. Make sure the student is ready for the sortie.

6.2.2. Prebrief aerobatic area boundaries, straining maneuvers, transfer of aircraft control, Before Aerobatics Checklist, recovery procedures, and G to stick forces relationships.

6.2.3. The first sortie should emphasize unusual attitudes, G tolerances, stick inputs as related to G forces, and very basic aerobatic techniques.

6.2.4. In the area give the student each type of unusual attitude and emphasize the proper recovery procedures. Work on confidence building and don't worry about doing very many maneuvers.

6.2.5. After the student is familiar and proficient in these areas and altitude permits, try a Loop or Lazy Eight. Demonstrate all maneuvers first to pilots who have never performed aerobatics.

6.3. Basic Aerobatic Program Techniques.

6.3.1. After the first sortie objectives have been met, begin building a foundation by working on the basic aerobatic maneuvers first. Get the student to at least a Fair level on Chandelle, Loop, Lazy Eight, and Cloverleaf before progressing to the advanced, rolling maneuvers.

6.3.2. Don't try to do every maneuver on every sortie. Work on problem areas, one or two maneuvers, or area orientation.

6.3.3. Build the student's proficiency and confidence in all maneuvers.

6.3.4. Watch the student's head to ensure he/she is watching the proper points for the various maneuvers. If he/she isn't watching the reference point on a Cloverleaf or Lazy Eight, he/she probably won't roll out on it.

6.3.5. After the student has achieved a characteristic performance of Good or better in all Basic maneuvers, they may be recommended for the basic check. Keep in mind area orientation, safety of flight, G awareness, minimum number of sorties, and situational awareness before recommending them for a check ride.

6.4. Advanced Aerobatic Program Techniques.

6.4.1. Don't attempt to perform the advanced aerobatics until all objectives of the Basic Program are met.

6.4.2. Start out slowly and work on new techniques.

6.4.3. Get the basics of inverted flight early - they are used in all other areas of the Advanced Program.

6.4.4. Work on situational awareness and recovery procedures at all times.

6.4.5. Begin sequencing 2 or 3 maneuvers together. Explain how to finesse the airspeed coming out of one maneuver to attain entry airspeed for the next.

6.4.6. Once the student becomes more proficient, have him/her string the maneuvers together in a complete demo profile making sure he/she stays in the area. Explain which maneuvers compliment each other, i.e., Slow Roll followed by a Split-S or ½ Lazy Eight to keep from going out of the area. Most maneuvers will keep you in the same general area with only small movement relative to the ground except three: the Slow Roll and Barrel Roll which move you forward, and the Lazy Eight which moves you sideways.

7. Precision Flying Training. The following exercises are used to increase maneuver proficiency. They will lead to mastery of the basic aircraft control required for competition aerobatics. These practice exercises are not limited to precision aerobatics practice. They are also valuable for anyone who desires to become a more precise pilot. These maneuvers are designed to help the developing pilot make the sailplane do what he/she wants it to do. The ultimate goal is to teach the pilot to use both hands and both feet, to place the aircraft precisely in any and all attitudes—without consciously moving the controls. To practice these maneuvers, a TG-9A, or other aerobatic aircraft, is certainly not required. Any pilot, with just a little practice, should be able to do all of these maneuvers well.

7.1. Horizontal Axis Dot. The foundation of all precision flying is basic aircraft control. The pilot who cannot hold his attitude and point himself exactly where he wants will never truly progress to the professional level. One of the greatest aids to teaching this principle is the use of the longitudinal axis as a reference for aircraft control. This is done by imagining a dot on the canopy which becomes a constant and easy reference for heading and pitch.

7.1.1. To locate your dot, take a few extra seconds before takeoff to get seated properly and to note the actual horizon and where it passes through the windscreen. Next, imagine a line running straight forward from the center of your body and then vertically up the canopy. In the TG-9A and other tandem aircraft, this line will run up the center of the windscreen. Imagine a dot at the intersection of this vertical line and the horizon. You will use this same procedure in the air, after you have established a stable glide.

7.2. Glider Horizon. Since a glider's longitudinal axis dot will be below the horizon in a steady glide, a glider pilot's sight picture is not easy to define. When you get off tow, place your windscreen dot a certain distance below the horizon, the position of which corresponds to your glide angle. Your first few tries will be "best guesses," but, as you work with your dot, you will be able to refine its location and use it to quickly and accurately establish your proper gliding attitude. Airspeed is determined by the position of the dot relative to the horizon. Any change we make in pitch, and therefore airspeed, must be made relative to the position the dot will be, once the sailplane has stabilized at the desired airspeed. The location of the dot (below the horizon) is the glider horizon.

7.3. Turns and Glides. Once you have noted your longitudinal axis dot, aim it at a landmark on the glider horizon. As long as your dot remains on the landmark, in stable air, you will have a constant glide angle, airspeed and heading. If your dot moves to the side of the landmark, you will be off heading. If you raise the dot, your rate of descent and your airspeed will decrease; the opposite is true when the dot is lowered. Returning the dot to the landmark will provide a steady glide angle, airspeed and heading as soon as all aerodynamic forces come into balance.

7.3.1. To do normal turns, establish a shallow bank angle and observe how the dot tracks along the glider horizon. Holding the dot on the glider horizon will hold your airspeed. By using the dot in relation to the horizon as your attitude reference, you will find that all aircraft can be flown with the same visual reference. You will never again have to worry about knowing all the sight pictures for each angle of bank for each aircraft you will ever fly, whether single place or two place, front seat or back seat, sitting erect or reclining, with or without parachute. The dot is especially helpful in making level turns in a side-by-side aircraft. By tracking the dot along the horizon you will avoid climbing or descending when your sight picture is altered by the apparent cowl position due to the direction of turn

7.3.2. One problem in teaching turns is getting the student to hold the correct back pressure to maintain altitude/airspeed during a turn, including roll-in and roll-out. This is solved by having the student simply fly the dot along the horizon.

7.4. Slips. Practice precision slips. Maintain heading exactly. This is most easily done by using the longitudinal axis dot to aim at a landmark on the horizon. Enter the slip normally, apply opposite rudder to

prevent any heading change. Now for the tough part: reverse the bank. For example, during an established right slip the left rudder is used to hold heading. When left aileron is applied to reverse the bank, more left rudder is needed to hold the heading to compensate for the increased lift and drag of the downward-deflected right aileron. As the rate of roll is established and the wing rolls through level, left rudder is relaxed and right rudder is smoothly applied to keep the dot on the reference landmark.

7.4.1. Each reversal of bank requires an additional push on the rudder already being held. Not applying the extra rudder will cause the dot to move in the direction of the slip when the ailerons are reversed. The slip can be practiced to stop briskly at exactly the same angle of bank to both left and right and also to stairstep the bank changes at, say, 10, 20, 30, 40 degrees, etc., back and forth from one side to the other. All bank changes should be made smoothly and at a constant roll rate.

7.4.2. Practicing slips in this manner, leads directly into flying point rolls. Practicing slips as a ground reference maneuver will make crosswind take-offs and landings second nature. Use the pitot tube extension when practicing this maneuver in the TG-9A. You can expect to see large variations in indicated airspeed while you practice slips. This is because the pitot-static system is not compensated for uncoordinated flight. If you hold your attitude by keeping your dot on a landmark your actual airspeed will change very little.

7.5. Dutch Rolls. The logical extension of slips is the Dutch Roll. During the Dutch Roll the dot should not move from its reference landmark on the horizon. The dot should remain stationary while the entire windshield will appear to rotate around it. When the dot is fixed in its correct location, slips, turns and all other maneuvers can be flown properly.

7.5.1. The Dutch Roll maneuver is a continuous series of rolls (wing waves) in both directions, reversing at various symmetrical bank angles while holding various but steady roll rates, and can be reversed at any angle of bank from very shallow to very steep. Using a smooth roll rate is the key to making rudder coordination easier, and aiming your longitudinal axis dot at a landmark will help you hold heading and pitch. Anticipate the need to lead with rudder as you reverse the roll just as you did for each bank reversal during slips.

7.5.2. Since competition aerobatic sequences begin with and end with a wing wave, which is nothing more than three Dutch Rolls, it makes sense to do them vigorously and precisely. Show some confidence. After all, the judges' first impression of your flying ability will not be very good if you timidly flail all over the sky before you even start your sequence.

7.6. Combination Maneuvers. Now that you are becoming familiar with some of the quirks of flying and are gaining some proficiency in using the controls in unconventional ways, it is time to try combination maneuvers. The purpose of all these precision exercises is to put the aircraft exactly where you want by using the most advantageous control combination available without being conscious of making each movement. The combination maneuvers can be more fun than work, but they require a lot of skill to do well.

7.6.1. In these maneuvers, you will draw imaginary figures with the longitudinal axis dot. The easiest drawing to make is a square. To begin, raise the dot a comfortable distance straight up above the horizon and pause briefly to establish the first corner. Now, keep the wings level and skid the dot to one side and pause again, for the same amount of time, to make the second corner. The horizontal line should be twice as long as the vertical line. Next, lower the nose exactly vertically the same amount below the horizon as it was above the horizon and pause to hold the third corner. Skid the nose the other way to form the fourth corner, pause, and return to straight and level coordinated flight. You should have made a perfect square, half above and half below the horizon. Work at making sharp corners with equal pauses and square angles.

7.6.2. Make small squares and big squares, clockwise and counterclockwise. As proficiency increases, work on triangles and diamonds (perfectly straight diagonals are tough). Remember to keep the wings absolutely level all the time. When you are really good, try circles and figure eights.