*BY ORDER OF THE SECRETARY OF THE AIR FORCE*

*AIR FORCE MANUAL 11-249*

*11 AUGUST 2004*

*Flying Operations*

# *T-37B PRIMARY FLYING*

**COMPLIANCE WITH THIS PUBLICATION IS MANDATORY**


**NOTICE:** This publication is available digitally on the AFDPO WWW site at: **http://www.e-publishing.af.mil.**

OPR: HQ AETC/DOFV (Mr. Donald B. Graham)
Supersedes AETCMAN 3-3, Volume 2, 1 July 1993

Certified by: HQ USAF/XOO (Brig Gen Teresa M. Peterson)
Pages: 179
Distribution: F


This manual implements AFPD 11-2, *Aircraft Rules and Procedures.* It contains the basic principles, procedures, and techniques that apply to all personnel operating T-37B aircraft under operational control of Air Education and Training Command (AETC). This publication also applies to the Air National Guard (ANG). While this manual primarily addresses the student pilot, all aircrews must understand it provides the general guidelines for all T-37B pilots. This publication is designed to be used with technical order (TO) 1T-37B-1, *Flight Manual, USAF Series, T-37B Aircraft;* AFI 11-202, Volume 3, *General Flight Rules,* AFMAN 11-217, Volume 1, *Instrument Flight Procedures;* AFI 11-2T-37, Volume 1, *T-37B Aircrew Training;* AFI 11-2T-37, Volume 2, T-37B *Aircrew Evaluation Criteria;* and AFI 11-2T-37, Volume 3, *T-37B Operations Procedures.* It addresses basic flying tasks and planning considerations and presents a solid foundation on which student training missions can be accomplished and instructor continuation training maintained. It is not designed to be used as a step-by-step checklist of how to employ the T-37B. Use safety considerations as a guide in determining the best course of action for any situations encountered that are not specifically covered by this publication.

The 12 FTW and 80 FTW will supplement this manual with procedures for their unique mission requirements. The 19 AF/CC and HQ AETC/DO must approve all supplements to this manual. Refer recommended changes and conflicts between this and other publications to HQ AETC/DOFV, 1 F Street, Suite 2, Randolph AFB TX 78150-4325, on AF IMT 847, **Recommendation for Change of Publication.** Ensure all records created as a result of processes prescribed in this publication are maintained in accordance with AFMAN 37-123, *Management of Records,* and disposed of in accordance with the Air Force Records Disposition Schedule (RDS). See **Attachment 1** for a glossary of references and supporting information.

***SUMMARY OF REVISIONS***

**This document is substantially revised and must be completely reviewed.**

This publication replaces AETC Manual 3-3, Volume 2, *Mission Employment Primary Flying, T-37,* and incorporates all changes. Information has been substantially updated and reorganized.

# Chapter 1

# GENERAL INFORMATION

## 1.1. Introduction:

1.1.1. The objective of this manual is to provide techniques and procedures to aid you in becoming a professional military pilot. To accomplish this goal, you must attain the highest degree of proficiency possible. This requires initiative, good judgment, trained reflexes, and skillful flying, which come only as a result of study, practice, and determination. The information you learn here will form the foundation for your military aviation career. Good study habits are essential. Every detail is important if you expect to be a safe, professional pilot. Some important information from other directives is included in this manual, but in no way is this information to be considered all-inclusive.

1.1.2. The majority of the skills and techniques you develop in pilot training will come from your assigned instructor, from other instructors you fly with, and through your experiences. As you gain experience and confidence as a pilot, you will also be developing your ability to use sound judgment. This manual and other directives are vital to flying operations. However, because of the many different situations you will encounter as a pilot, these directives can only provide a basis for good judgment; they cannot replace it.

1.1.3. TO 1T-37B-1 (flight manual) contains detailed instructions for inspections, checks, and procedures. Additionally, it provides valuable background information necessary to understand the aircraft systems and why procedures and checks have been established. The flight manual and this publication complement each other.

## 1.2. Student Responsibilities:

1.2.1. Undergraduate pilot training is designed to graduate professional military pilots. Organizing and planning are major keys to fulfilling this objective. Your part of this process is to ensure you are properly prepared for the flight line, are well nourished, and have received adequate rest.

1.2.2. Each day when you report to the flight line, be prepared for any type of mission. This means more than simply reading about the maneuvers in this manual. You should know all the procedures for a given maneuver and be able to state the sequence of actions. Many students find that chair-flying is a helpful technique in preparing for a mission. This means you organize a mission profile and then simulate the flight mentally, reviewing each item you must accomplish. Your time in the aircraft is limited. If you prepare properly on the ground, your airborne time will be more profitable.

**1.3. Flying Safety.** Flying safety is more than merely a set of practices or a particular safety record; it is an attitude. You should continuously evaluate your performance by asking, "Did I perform that activity in a professional, disciplined, safe manner?" Do this from the time you start planning a flight until you finish debriefing. One of the greatest hazards in today's flying is the potential for a midair collision. Your best defense is to see the other aircraft first. Aggressively clear the airspace around you, using the techniques your instructor will show you.

**1.4. Ground Safety.** The flight line is a hub of activity. Consequently, this calls for extra attention on the part of everyone required to be there. When you are on the flight line, you must wear approved devices to protect your hearing against the harmful noise of T-37 engines. Because this protection will block out some of the other sounds that might warn you of danger, you must constantly be alert for hazardous situations. Stay clear of the aircraft danger areas as depicted in section two of the flight manual.

**1.5. Clearing:**

1.5.1. All aircrews operating in visual meteorological conditions (VMC) must maintain a constant vigilance for other aircraft. The use of radar monitoring or assigned areas does not relieve you of the responsibility to clear. An instrument flight rules (IFR) clearance only separates you from other known IFR traffic and participating visual flight rules (VFR) traffic.

1.5.2. When clearing, ensure your intended flight path is well clear of other aircraft. Some maneuvers in the area are good clearing maneuvers; others may require a clearing turn. The type of clearing will depend upon the maneuver, the configuration of the aircraft, and other flight planning factors. Be aware of the restrictions to visibility created by the canopy bows. Focus your eyes on a distant point, and use various search patterns (vertical, horizontal, etc.). Visual search must become a definite pattern instead of random looking. Constantly practice your search technique.

1.5.3. You can help yourself remain clear of local traffic by knowing areas of possible conflict. Know your local area course rules. Be aware of the location of the departure and recovery routes, flying areas, and traffic patterns. Emphasize clearing in these directions. Listen for radio transmissions to help you track traffic in your vicinity. This is commonly referred to as "clearing on the radios." The more you know about your immediate flying environment, the better you will be able to detect and avoid other aircraft.

1.5.4. Area procedures and radio transmissions are only part of the overall effort to avoid other aircraft. The most important ingredient is your ability to visually detect each aircraft. Aircraft unfamiliar with the training areas and routing may fly through your airspace, so be alert.

**1.6. Transfer of Aircraft Control:**

1.6.1. Whether in flight or on the ground, it is paramount to know who has control of the aircraft. When you are flying, stay on the controls until told otherwise. During transfer of control, the pilot relinquishing control will say, "You have the aircraft." The pilot assuming control will say, "I have the aircraft," and will shake the stick noticeably. It is not important who speaks first, but both pilots must verbally acknowledge the transfer. During critical phases of flight, relinquish the controls (stick, rudder pedals, and throttles) immediately on your instructor's verbal command so you will not obstruct any flight control or throttle movement.

1.6.2. Without intercom, transfer of aircraft control can result in disastrous crew confusion if not done in a positive, previously briefed manner. Aircrew confusion can result in two extremely hazardous situations: one where neither crewmember is flying the aircraft and one where both crewmembers are fighting for the controls. If intercom failure occurs while the instructor pilot (IP) is not physically flying the aircraft, the other crewmember will continue to fly until the IP assumes control by noticeably shaking the stick. If you, as the other crewmember, feel unexpected pressure on the control stick at any time, momentarily relax your grip to determine if the IP is trying to take control.

1.6.3. When the IP assumes control, the other crewmember will immediately relinquish control and show both hands to the IP. Normally the IP will maintain control for the remainder of the flight. However, some circumstances may necessitate a subsequent transfer of control. In these situations, the IP will yaw the aircraft with the rudder pedals to signal the transfer of aircraft control back to the other crewmember. The other crewmember will acknowledge by shaking the control stick and looking for the IP to show his or her hands are clear of the controls. Remember, if you are flying, stay on the controls until you know your instructor has control of the aircraft.

1.6.4. At no time will two people both be in control of the aircraft. This also applies to the brakes during engine runup for takeoff. Only the person in control of the aircraft will apply pressure to the brake pedals; the other person will closely guard the brake pedals.

**1.7. Radio Procedures:**

1.7.1. Under normal operations, radio voice communications should be kept to a minimum. A call to ground control for taxi clearance serves as the radio check. Remember, when the microphone button is depressed, the entire channel is blocked for other aircraft. Do not depress the microphone button during another aircraft's transmission. If another aircraft is making a transmission, anticipate an answer to the radio call and do not break in. Make sure the radio is on and the proper channel is selected.

1.7.2. A general format for professional radio communications is to broadcast who you are talking to, who you are, where you are, and what you want to do. It is imperative that your message be both clear and concise. Organize your thoughts, depress the microphone button, say what you intend to say, and get off the air. Do not transmit when another aircraft is in a critical phase of flight (such as in the flare while you are waiting for takeoff).

**1.8. Wake Turbulence.** All aircraft generate wake turbulence, and the T-37 is very susceptible to it. A pair of counter-rotating vortices trailing from the wingtips causes this disturbance. The vortices generated by other aircraft (especially aircraft larger than your own) can create serious problems for you. In some cases, the wake of another aircraft can impose rolling moments exceeding the control authority of your aircraft. Additionally, the turbulence generated within the vortices, if encountered at close range, can damage your aircraft or cause personal injury. It is important for you to imagine the location of the wake turbulence generated by other aircraft and adjust your flightpath accordingly.

1.8.1. **Vortex Strength.** The strength of the wake turbulence created by an aircraft is governed by the weight, speed, and shape of the wing of that aircraft. The most significant factor, however, is weight. The vortex strength increases proportionately with increased aircraft operating weight. The greatest vortex strength occurs when the generating aircraft is *heavy, clean,* and *slow.*

1.8.2. **Vortex Characteristics.** Trailing vortices have certain behavioral characteristics that can help pilots visualize the wake location and thereby take avoidance precautions:

1.8.2.1. Vortices are generated from the moment an aircraft rotates for takeoff because they are a byproduct of lift. Prior to takeoff or landing, pilots should note the rotation or touchdown point of the preceding aircraft. Tests show that the vortices remain spaced a bit less than a wingspan apart and drift with the wind. If wake turbulence is encountered, a slight change of altitude and/or lateral position (preferably upwind) should provide a flightpath clear of the turbulence.

1.8.2.2. Because the vortices sink at a rate of several hundred feet per minute, pilots should fly at or above the preceding aircraft's flightpath.

1.8.2.3. Once the vortices hit the ground, they drift with the wind at a speed of 2 to 3 knots. Thus, a light crosswind of 1 to 5 knots could result in the vortex of an arriving aircraft remaining in the takeoff zone for a period of time.

1.8.3. **Vortex Avoidance:**

1.8.3.1. When wake turbulence is anticipated, proceed with extreme caution. Do not depend solely on a controller to advise you of the possibility of encountering wake turbulence. Remember, the controller may provide wake turbulence separation, which may not be adequate in all situations. It is your responsibility in each case to ensure proper separation on the approach. Be especially aware of the possibility of wake turbulence during takeoff, approach, and landing. Do not tell the controller you are ready for takeoff until adequate wake turbulence separation exists.

1.8.3.2. When landing behind a larger aircraft on the same runway, stay at or above the larger aircraft's final approach flightpath and land beyond its touchdown point.

1.8.3.3. When landing behind a departing larger aircraft on the same runway, land prior to its rotation point.

1.8.3.4. When departing behind a larger aircraft, rotate prior to its rotation point and climb above the larger aircraft's flightpath until turning clear of its wake.

1.8.3.5. Ensure that an interval of at least 2 minutes has elapsed before taking off or landing after a larger aircraft has executed a low approach, missed approach, or touch-and-go landing.

1.8.3.6. At altitude, avoid flying below and behind a larger aircraft's path. When you anticipate the possibility of wake turbulence, remain upwind of the preceding aircraft's flightpath to keep you clear of that aircraft's wake turbulence.

1.8.3.7. Flying a nonprecision approach will very likely place your aircraft in the area of wake turbulence generated by an aircraft on a precision glidepath. If you are unable to remain above the aircraft's flightpath, consider increasing your spacing or going around. Use caution when going around from below the preceding aircraft's flightpath because you may fly through that aircraft's wake turbulence.

**1.9. Takeoff and Landing Data (TOLD).** On every flying mission, you will be taking TOLD to the aircraft. Initially, you will find the information at the duty desk or in the flight room. However, before solo you will be required to compute this information and understand how to apply the numbers. This information becomes even more important when flying from unfamiliar airfields because temperatures, pressure altitudes, and runway conditions may be significantly different from your home field.

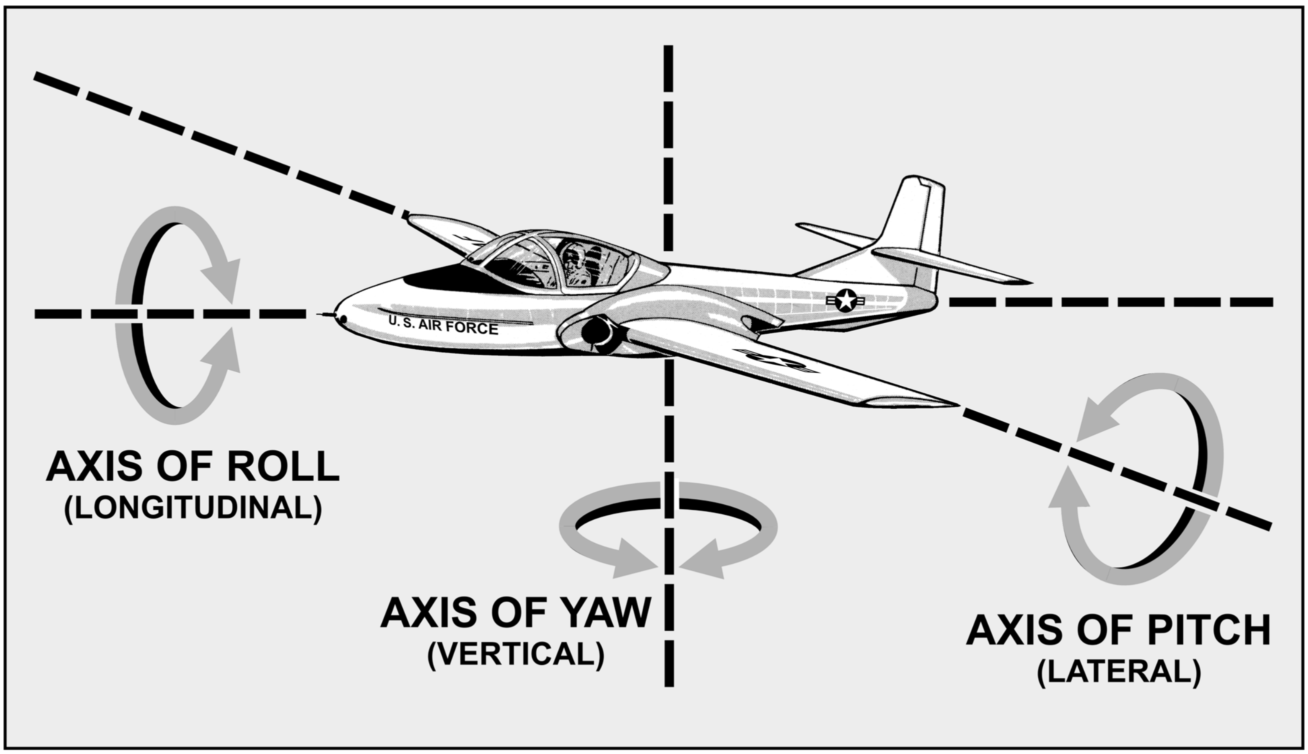
**1.10. Area Orientation.** You are required to carry a copy of your local in-flight guide and a map of the local flying area on all flights. Use your map and landmarks as primary references for departure, recovery, and area orientation. The aircraft's navigation equipment should be used as a backup in case of restricted visibility or unfamiliar area assignment.

## Chapter 2

## BASIC PRINCIPLES OF FLIGHT

**2.1. Effects of the Controls.** Each flight control has its effect on the attitude of the aircraft and controls the movement about one of its three axes (Figure 2.1.). You should learn these effects in order to control the aircraft and obtain the desired responses. Your instructor will demonstrate the use and effects of the controls, first in straight-and-level flight at cruising airspeed and then in other flight attitudes. The same predictable responses to control movements will result regardless of the attitude of the aircraft. Think of yourself as the pivot point about which all changes of attitude occur.

**Figure 2.1. Axes of the Aircraft.**




2.1.1. **Pitch.** Moving the stick forward and aft (fore/aft) controls the aircraft's pitch (movement about the lateral axis). To achieve level, climbing, or descending flight, hold the nose of the aircraft in a fixed position relative to the horizon. You can use many other outside references to determine pitch attitudes, such as the position of the wingtips or the glare shield in relation to the horizon. You can also check the desired pitch attitude by reference to the flight instruments. Your instructor will show you the outside and instrument references for climbing and descending flight. Continuous cross-check of all pitch references will result in better control of the pitch attitude of the aircraft.

2.1.2. **Yaw.** Yaw is movement about the vertical axis. When yaw exists, the ball in the turn-and-slip indicator is displaced from center. Also, yaw causes your body to lean toward one side of the cockpit (like when you round a corner in a car). Coordinated flight should be free of yaw even in a steep bank.

When the aircraft is coordinated, your body retains a comfortable, upright position. The proper use of rudder is essential for coordinated flight about the yaw axis.

2.1.3. **Roll.** Rotation about the longitudinal axis is caused by the lift differential created as aileron surfaces are moved out of the streamlined position of the wing. The wing with the raised aileron goes down because of decreased lift, and the wing with the lowered aileron goes up because of increased lift. The effect of either aileron is augmented by the simultaneous and opposite movement of the aileron on the other wing. In level flight, moving the control stick toward a wing raises that wing's aileron surface, causing the wing to go down and the aircraft to roll in that direction. Simultaneously, the other wing's aileron goes down, causing the wing to go up.

**2.2. Adverse Yaw:**

2.2.1. The movement of the aileron surfaces out of the streamlined position creates drag. This drag is not distributed equally on each aileron—the down aileron (on the up wing) produces the greater drag. When this condition exists, the aircraft does not turn immediately in the direction of aileron movement, but will yaw toward the top wing opposite to the direction of desired turn.

2.2.2. When you use ailerons to bank an aircraft, the aileron that goes down extends into the area of greater static pressure, increasing drag. Due to the shape of the wing, the aileron that goes down also increases the positive camber of that wing, increasing both lift and induced drag. At the same time, the aileron that goes up on the opposite wing decreases the positive camber of that wing, reducing lift and induced drag. This combination of factors causes the aircraft to tend to yaw in the opposite direction while the banking action is taking place. This adverse yaw tendency continues until the ailerons are neutralized.

2.2.3. Adverse yaw is most apparent at low airspeeds and extreme control-surface deflections. At low or near-stalling speeds, adverse yaw is very noticeable; at high speeds, it may not be noticeable at all. This is true because the movement required of the aileron surfaces is greater at lower speeds. The ailerons must be moved farther from the streamlined position to cause an appreciable alteration of lift in the slower slipstream. The higher the angle of attack (AOA), the greater the pressure on the bottom side of the wing (until the stalling speed is reached and the airflow disrupted). At high speeds, a small airstream alteration generates more lift than in a slower airstream; therefore, less aileron is needed to lift the wing.

2.2.4. Adverse yaw can be overcome by using the rudder. As you apply right or left aileron pressure, simultaneously apply rudder pressure on the same side. Use rudder pressure as long as the bank is changing. The correct amount of rudder pressure depends on the aircraft speed and the amount of aileron used. Keeping the ball centered in the turn-and-slip indicator is a guide to using the correct amount of rudder. Remember to use rudder and aileron pressure simultaneously, although the required amount of pressure will differ depending on the amount of aileron used, the airspeed, the effect of drag, and the design of the particular aircraft you are flying. Also remember that the aileron drag effect is present during recovery from a turn as well as during the entry. The rudder must again be used in the same direction as aileron stick pressure to counteract adverse yaw.

**2.3. Use of Controls.** When a control surface is moved out of its streamlined position, the air flowing past it will exert pressure against the control surface and try to return it to the streamlined position. It is this pressure you feel on the stick and rudders. The amount of pressure you feel is determined by the airspeed and the degree the control surface is deflected. The higher the airspeed, the greater the pressure.

2.3.1. **How To Use the Rudder.** Position your feet comfortably with all the weight on your heels. Let your heels rest on the cockpit floor with the balls of your feet on the rudder pedals. When you use the rudder, apply pressure smoothly and evenly by pressing with your foot just as if you were using the brakes of an automobile. Do not let your legs and feet become tense, but stay relaxed so you can feel rudder pressure.

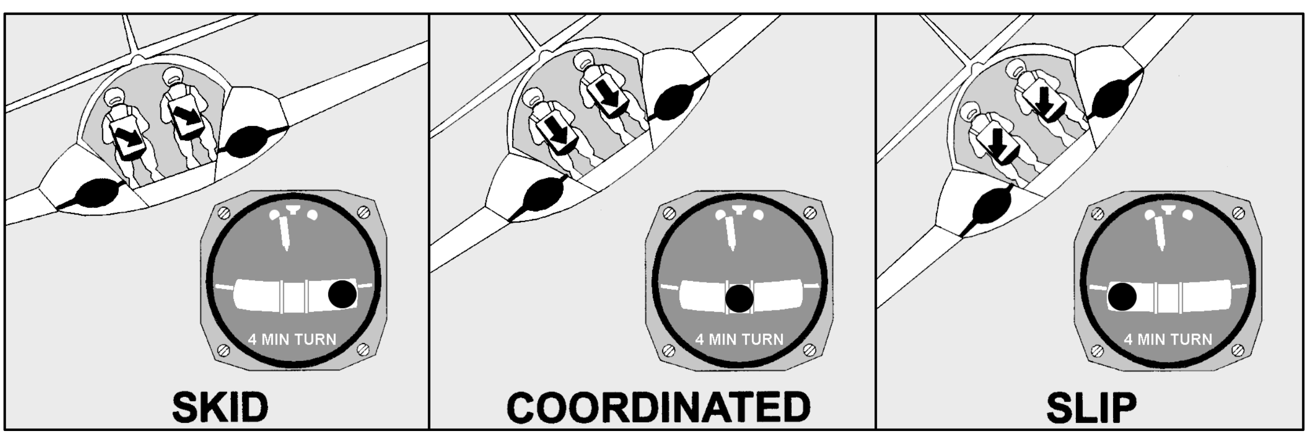
2.3.2. **How To Use the Stick.** Generally, you should hold the stick lightly, the same way you would hold the steering wheel of an automobile—relaxed and comfortable. Some maneuvers, such as aerobatics, require more positive pressures. Let your arms and hands relax so you can feel the counterpressure from the stick, but always control the aircraft. Never let it control you.

2.3.3. **How To Use the Throttles.** Normal throttle movement should be slow at low revolutions per minute (rpm) with the rate of movement increased as the engine rpm increases. You can advance the throttles more rapidly at higher rpm. As a guide, move the throttles at a rate slightly faster than engine acceleration. When time is critical (low altitude, thrust-deficient situations), rapid throttle movement is the most effective way to achieve maximum engine acceleration. Acceleration time is approximately 40 percent less when accelerating from 50 percent rpm to military power versus idle to military power.

2.3.4. **Coordination of Controls.** The effect of each control has been discussed individually, but you should realize that no single control movement provides all the control for a maneuver. To fly your aircraft efficiently, you must use the controls together. This is known as coordination of controls and is vital to smooth flying. After you know how the aircraft will react when the controls are used, you must learn how to use them properly. Rough, erratic use of any of the controls will cause the aircraft to react accordingly, so it is important to apply the pressures smoothly and evenly.

2.3.4.1. **Coordinated Flight.** In a coordinated level turn (Figure 2.2.) with constant bank and airspeed, the flightpath of the aircraft is a true circle if the wind is calm. Otherwise, the flightpath is not necessarily a true circle over the ground because of drift. Variation in the circular flightpath is also caused by uncoordinated control, erratic bank, or changes in airspeed.

**Figure 2.2. Direction of Force on a Body in Coordinated and Uncoordinated Turns.**




2.3.4.2. **Skid.** A skid is caused by insufficient bank angle in relation to the turn rate of the aircraft (Figure 2.2.). This will occur if you use too much bottom rudder pressure in relation to the aileron pressure or if any bottom rudder is held after a turn is established. A skid will also occur in level flight if the nose of the aircraft rotates sideways about the vertical axis when the wings are held level, resulting in a slow turn. This occurs when rudder pressure is inadvertently held or the aircraft is improperly trimmed.

2.3.4.3. **Slip.** A slip is caused by too much bank angle in relation to the turn rate of the aircraft (**Figure 2.2.**). When establishing a turn, if you use insufficient bottom rudder pressure in relation to the aileron pressure, a slip will result. You can also slip the aircraft by holding opposite rudder in a turn.

## 2.4. Composite Flight:

2.4.1. Composite flight requires the use of outside references supported by flight instruments to establish and maintain desired flight attitudes. You will use composite flight throughout your flight training.

2.4.2. All maneuvers are accomplished by establishing attitudes and progressively changing these attitudes throughout various stages of the maneuvers. Establish and maintain an attitude by positioning the nose and wings of the aircraft in relation to the horizon. Very small changes in attitude may not be readily noticed by outside reference to the Earth's horizon, but will be indicated by the flight instruments. Be careful. Depending solely on your instruments has several disadvantages. The most serious is the inability to adequately clear for aircraft and other hazards.

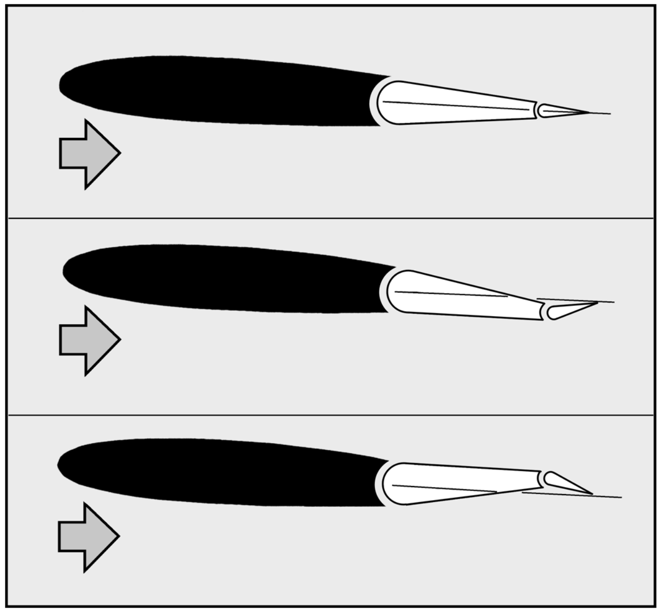
2.4.3. A good composite cross-check is necessary to ensure precise flying. Let the conditions dictate where you direct your attention. As visibility deteriorates, increase the use of flight instruments. Develop your cross-check so all necessary information is obtained at a glance. Always maintain vigilance to avoid a midair collision and remain oriented. Do not concentrate on any one reference. Maintain a constant vigilance for other aircraft. Check your reference, make a correction, look around, cross-check other references, and then return to the original reference, using all of the references to confirm the accuracy of your control pressures or the need for a further correction. Continually repeat this process in composite flying.

## 2.5. Trim:

2.5.1. When you consider all the factors affecting the aircraft in various conditions of flight, the need for trimming becomes apparent. Considerable force is required to hold the correct elevator control pressure for level flight with high airspeed. Flying would be very tiring if some means were not available to relieve these pressures.

2.5.2. Trim tabs act as levers and equalize the pressures exerted on either side of the parent control surface. To equalize pressures, the tabs are moved in an opposite direction from the parent control (**Figure 2.3.**). If the rudder is not trimmed properly, the aircraft will fly in a skid as indicated by the turn-and-slip indicator. The ball will be deflected while the needle is centered. To correct this condition, first apply rudder to center the ball (while holding the turn needle centered) and then relieve the pressure with rudder trim. To correct wing heaviness or rolling tendencies, adjust the aileron trim. When the pressures on the controls have been relieved, the aircraft is correctly trimmed.

**Figure 2.3. Trim Tabs—Aids to Smooth Flying.**



2.5.3. Because the trim tabs on the T-37 are all electrically operated, it is possible for any one of them to malfunction in flight because of inadvertent actuation, a stuck button, or a short in the system. Always trim in short clicks and avoid inadvertent trim actuation.

2.5.4. In the T-37, power changes normally do not require large, immediate changes in control pressures. The need for trim, therefore, is evident only gradually as the airspeed changes. Always think of trimming as a recurring process.

2.5.5. Other devices controlled by the pilot that also affect the aircraft attitude are the flaps, landing gear, speed brake, and thrust attenuators. However, these all have other primary purposes and their effect on aircraft control is incidental. Trim will compensate for these minor effects.

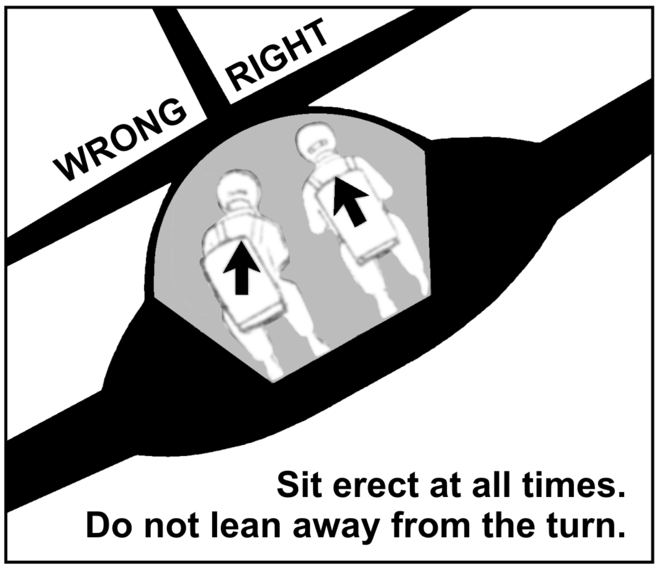
**2.6. Straight-and-Level Flight.** Simply practicing to fly straight and level will help you learn how to use the controls and combine the use of outside and instrument references for maintaining aircraft attitude. You will also learn to divide your attention by constantly checking all available references without concentrating on any one. Before practicing straight-and-level flight, however, you must be familiar with the flight instruments. You must understand the effect and use of the controls be relaxed and properly seated in the aircraft.

2.6.1. **Position in the Aircraft:**

2.6.1.1. Each time you fly, your seat position in the aircraft should be the same. This will ensure the references you see inside and outside the aircraft remain the same each time you fly. Ask your instructor to help you determine the correct position. If seat adjustment is necessary during ground operations, install the ejection seat safety pin before moving the seat adjustment lever. This will keep you from inadvertently raising the ejection seat handgrips. In flight, be sure your feet are clear of the ejection handgrips and the proper lever is moved. Do not install the ejection seat safety pins or attempt to hold the handgrips while adjusting the seat in flight.

2.6.1.2. Your posture in the aircraft is very important to all maneuvers. Do not lean forward, backward, or side to side. Instead, sit erect and move your head around freely. During turns, maintain this position. Do not lean away from the turn or attempt to keep your body vertical with the horizon (**Figure 2.4.**). Relax and ride with the turn. If you do not maintain a constant position in the cockpit, your outside references will continually change. Relaxed pilots are usually good pilots because they are free to think and can feel the pressures on the controls.

**Figure 2.4. Posture in a Turn.**




2.6.1.3. Adjust the rudder pedals fore and aft with the rudder adjustment handcrank provided for each set of pedals. Adjust the rudder pedals to a comfortable distance. With your feet on the pedals, you should have full travel of the rudder and brakes.

2.6.2. **Flight Instruments:**

2.6.2.1. The approximate power setting for normal straight-and-level cruise flight (200 knots indicated airspeed [KIAS]) is 82 percent rpm. Attaining level flight is a matter of consciously fixing reference points on the aircraft in relation to the Earth's horizon and comparing (cross-checking) this relationship with the flight instruments. The instruments you refer to for control of pitch attitude are the attitude indicator, altimeter, vertical velocity indicator (VVI), and airspeed indicator.

2.6.2.2. Your instructor will show you each instrument's indication in conjunction with outside references. Do not concentrate too much on one reference or stare at a particular reference. This will not only hinder your progress, but will create a dangerous situation because you will not be clearing for other aircraft. Check each outside and inside reference in turn and use each for minor control adjustments.

2.6.2.3. You must have a thorough knowledge of the design, location, and information presented by all instruments. Familiarity with these instruments and outside references enables you to determine the control pressures necessary to control the attitude and the direction of the aircraft. Control pressures should be smooth and applied with confidence. The beginning student often overcontrols from lack of experience, but this tendency can be minimized through practice of smooth application. Good control is a continuous succession of minor, almost imperceptible corrections to keep the aircraft in the desired flightpath.

2.6.3. **General:**

2.6.3.1. After you have had a little practice in straight-and-level flight and have learned to check all your references properly, you can establish the correct level flight attitude in a few seconds. You will learn to look around quickly and establish pitch, bank, and direction simultaneously. Power changes and trim technique will become second nature. A trim change is necessary when you find you must hold continuous stick or rudder pressure to maintain the desired flightpath.

2.6.3.2. The weight of your right arm on the stick may cause the ailerons to be slightly displaced, which will result in flying with the right wing low. In most cases, this will cause a very slight turn to the right. To keep the aircraft from turning, you would have to use a steady left-rudder pressure, but this would set up an undesirable cross-controlled condition. The solution is to place the weight of your right arm on your thigh and hold the control stick gently with your fingertips. This reduces any tendency to be heavy handed. Remember to check your references frequently to determine any tendency toward heavy handedness.

2.6.3.3. A common student error is the tendency to stare at the nose of the aircraft and attempt to hold the wings level just by observing the windscreen in relation to the horizon. This will not work—particularly in the T-37, which has a rounded glare shield—and usually results in flying with one wing low. This wing-low attitude requires the use of additional rudder to maintain straight flight and leads to a false conception of neutral control pressures as well as an uncomfortable seat position. You must let your eyes sweep along the horizon, picking up the wingtips, and make a mental note of required corrections. At the same time, look for other aircraft that might be flying in your area. Make your corrections and return to inside references to confirm them. Then look outside again in a continuous process. This will soon become second nature and effortless.

2.6.3.4. Straight-and-level flight requires almost no pressure on the controls if the aircraft is properly trimmed and the air is smooth. When you are flying through turbulence, the flight attitude may change abruptly. Do not fight the controls to stop these changes. Ride them out like a boat on a rough sea, making smooth, but firm, adjustments as needed.

**2.7. Turns:**

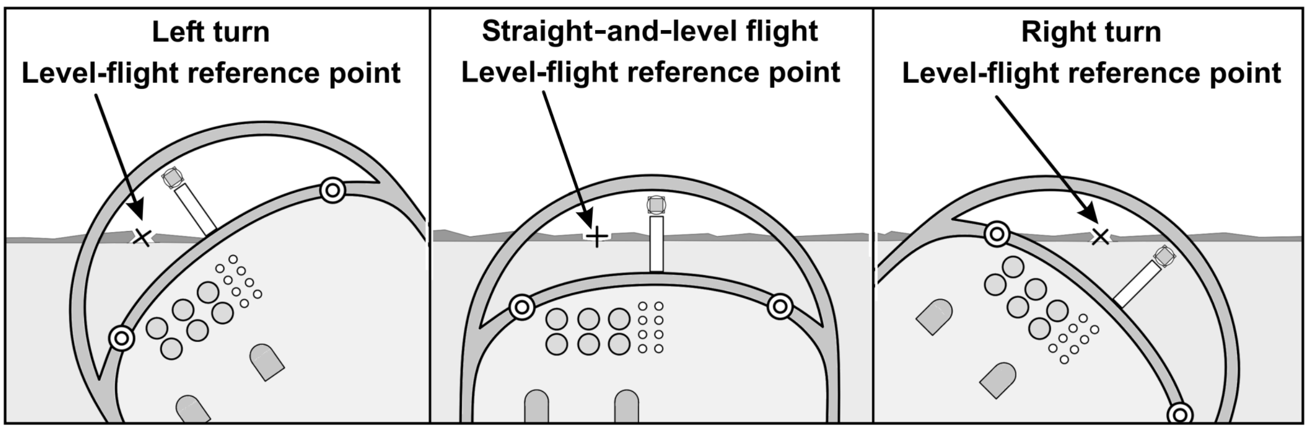
2.7.1. A turn involves the close coordination of all three controls: ailerons, rudder, and elevator. Because turns are incorporated into almost all aircraft maneuvers, you must learn to perform them well. A shallow turn is one with approximately 30 degrees of bank or less. A steep turn is a one with approximately 45 to 60 degrees of bank.

2.7.2. Before beginning any turn, look in the direction of the turn to clear above, below, and at your flight level. You do this to make sure the area is clear of other aircraft. Once you have cleared the area, simultaneously apply pressure to both ailerons and rudder in the direction of the turn. This pressure will move the control surfaces out of their streamlined position and cause the aircraft to bank and turn.

2.7.3. The rate at which the aircraft rolls is governed by the amount of pressure applied. Hold the pressures constant until you obtain the desired angle of bank. As you approach the desired angle of bank, return the ailerons and rudder to neutral. This stops the bank from increasing. The elevator pressure is not released, but is held constant to maintain a constant pitch attitude. Throughout the turn, the angle of bank should be held constant with adjustments of the ailerons, just as the wings are kept level in straight-and-level flight. In establishing this bank attitude, use both outside and instrument references.

2.7.4. As bank is introduced, a point on the windscreen directly in front of you will appear to pivot on the horizon. This imaginary level-flight reference point should remain on or near the horizon throughout the turn to maintain level flight (**Figure 2.5.**). As the bank increases, the pitch attitude will have to increase to compensate for the loss of vertical lift. In shallow turns, the increase in pitch attitude is relatively slight. As bank increases, the required increase in pitch attitude is more pronounced. Also, increased power is required in steep turns to compensate for the increased pitch and to maintain airspeed.

**Figure 2.5. Cockpit View of Level-Flight Reference Point.**




2.7.5. To correct a nose-low attitude in a steep turn, reduce the angle of bank with coordinated aileron and rudder pressure. Simultaneously use back stick pressure to raise the nose to the desired pitch attitude. After doing this, reestablish the desired angle of bank. Do not try to make corrections with any one of the three controls. Instead, use them together.

2.7.6. The rollout from a turn is much the same as the entry except control pressures are used in the opposite direction. Apply aileron and rudder pressure in the direction of the rollout (toward the high wing). As the angle of bank decreases, release the elevator pressure smoothly to maintain altitude. With decreasing angle of bank, the effects of centrifugal force and the loss of vertical lift are reduced.

2.7.7. Because the aircraft normally will turn as long as there is any bank, start the rollout before reaching your desired heading. The aircraft will turn some during the time it takes to level the wings. The steeper the bank, the more lead required to roll out on a desired heading. Release the pressures smoothly until the controls are neutralized as the wings become level.

2.7.8. Plan all of your turn exercises so you make precise turns; that is, with a constant angle of bank and a definite amount of turn. To make a precision 90-degree turn, align the aircraft with a road or section line on the ground and turn perpendicular to it. In the absence of any ground reference, pick a point on the horizon that is directly off a wingtip; then turn to that point. Clear the area as you do this.

2.7.9. A common misconception among students is that a steep turn is entirely different from a shallow turn. This mistaken idea probably comes from the fact that all of the aerodynamics of a turn are more prominent in a steep turn. The difference between steep turns and other turns is the amount of back stick pressure and power needed to maintain level flight.

2.7.10. A common error is the misuse of controls when entering a steep turn. Some students apply control pressures very rapidly and abruptly, using strong back stick pressure prematurely. This is sometimes caused by the natural tendency of the arm to move backwards as it moves to the side. Steep turns are easy to perform if you roll into them like you roll into shallow turns, but you should anticipate the need for additional back stick pressure and power as the angle of bank increases.

**2.8. Aircraft Instruments:**

2.8.1. Aircraft instruments should be used with outside references to ensure optimum aircraft performance. These instruments are divided into the following three categories:

2.8.1.1. Control instruments (attitude indicator and tachometer).

2.8.1.2. Performance instruments (altimeter, VVI, airspeed indicator, turn and slip indicator, and heading indicator).

2.8.1.3. Navigation instruments (very high frequency omnidirectional range [VOR], distance measuring equipment [DME], and instrument landing system [ILS] equipment).

2.8.2. The performance instruments indicate the need for a change in aircraft attitude. The change should be made by using the control instruments and cross-checking the performance instruments to ensure desired effect has taken place and then make adjustments as necessary.

**2.9. Pitch Control:**

2.9.1. **General.** The attitude indicator, altimeter, VVI, and airspeed indicator give indications of the pitch attitude of the aircraft and should be used with outside references. Small, timely pitch corrections on the attitude indicator and an accurate cross-check of the performance instruments are essential to developing good pitch control technique. Proper use of elevator trim is an integral part of pitch control; precise flying is very difficult without it.

2.9.2. **Attitude Indicator:**

2.9.2.1. To fly the aircraft straight and level, adjust the attitude indicator so the wings of the miniature aircraft (shown on the attitude indicator) are superimposed on the horizon bar. While changing pitch, note how the relationship on the instrument corresponds to the actual movement of the nose of the aircraft as it appears on the natural horizon. Cage the standby attitude indicator only when errors have been induced in the instrument and positive relation to level flight can be confirmed. TO 1T-37B-1 (flight manual) has information on the construction and limitations of the attitude indicators.

2.9.2.2. During in-flight practice, change the pitch attitude so the miniature aircraft indicates a climb of 2 degrees. Compare this movement to the movement of the nose of the aircraft as it appears on the natural horizon. Then reverse this maneuver to show a descent. You can maintain level flight by keeping the wings of the miniature aircraft centered exactly on the horizon bar. Changes in pitch attitude are normally very small, not more than 1 degree. Your instructor will occasionally place the aircraft in a steep climb or dive and have you return it to level flight so you can practice for special maneuvers that will come later.

2.9.3. **Altimeter:**

2.9.3.1. Fly the aircraft straight and level with a fixed power setting. To maintain a constant altitude and airspeed, the pitch attitude must remain constant. Raise the nose of the aircraft until the miniature aircraft is well above the horizon bar. Observe that the altimeter changes rapidly with any substantial change in pitch attitude on the attitude indicator. Make a small change in pitch attitude. Observe the correspondingly slow change in altitude indicated on the altimeter. Make an abrupt change in the pitch attitude. Observe the momentary lag in the altimeter. Note that a lag is not as apparent when a gradual change is made in the pitch attitude. Even though there is a momentary lag in the indication of the altimeter, if the pitch change is smooth and gradual, the altimeter gives an almost immediate indication of a change in pitch attitude.

2.9.3.2. To control the pitch attitude of the aircraft properly throughout a flight, you must use both the attitude indicator and the altimeter. Consequently, a system of cross-checking must be developed. Do not rely solely on the attitude indicator because a change in airspeed will require an attitude change to maintain level flight. With only two instruments at this stage of instruction, the cross-check consists of merely looking outside and then from one instrument to the other. During level flight, you should pay more attention to the attitude indicator than the altimeter, but cross-check the altimeter to make sure you are keeping the altitude constant.

2.9.3.3. Practice holding the altitude constant, using the attitude indicator and the altimeter. Correct for a deviation of 100 feet by changing the pitch attitude not more than 1 degree. Corrections in altitude are made by these small changes in pitch attitude.

2.9.4. **VVI.** Although the VVI gives an immediate indication of a change in pitch attitude, there is a short lag before it settles down and indicates the actual rate. This lag is directly proportional to the speed and magnitude of the pitch change. The VVI is a trend instrument; therefore, do not chase it. Make small corrections and then wait for the instrument to settle down. Use the VVI as a trend instrument to prevent overcontrolling. Practice maintaining level flight by cross-checking the attitude indicator, VVI, and altimeter. Place emphasis on precision. To learn the function of the VVI and its relationship to other pitch instruments, perform the following exercises:

2.9.4.1. From level flight, place the aircraft in a dive by making a large change in pitch attitude. While the vertical speed is rapidly decreasing in the descent, pull the aircraft up into a climb. Observe that after the lag, the vertical speed reverses its direction of movement and begins to move rapidly upwards, indicating a change in pitch attitude.

2.9.4.2. During practice, raise the nose of the aircraft so the attitude indicator indicates a climb of 1 degree. A change in pitch of this magnitude indicates a vertical speed of 300 to 400 feet per minute (fpm). This relationship between the attitude indicator and the VVI is for low-speed flight. In higher performance aircraft at higher speeds, a 1-degree pitch change might indicate a climb of as much as 1,000 fpm.

2.9.4.3. For altitude corrections, one technique is to change attitude to get a vertical speed in fpm that is about double the error in feet of altitude. For example, if you are 100 feet off your altitude, a 200 fpm correction is generally suitable.

2.9.4.4. In level flight, cross-check the three pitch instruments to detect a deviation in altitude. Add VVI to the sequence of the pitch-attitude cross-check previously described. Any deviation of the vertical speed needle from zero shows the need for a change in pitch attitude.

2.9.4.5. Next, establish a climb or descent of about 100 fpm. Note that the VVI shows the change in pitch attitude earlier than the altimeter and the VVI's movement is easier to detect than the attitude indicator.

2.9.4.6. Now descend to 100 feet below the desired altitude and establish a climb to return to the original altitude. To do this, change the pitch a small amount on the attitude indicator and cross-check the VVI to maintain a climb of approximately 200 fpm. Cross-check the altimeter to determine when to start the leveloff. (Normally 10 percent of VVI will be an adequate lead point.)

2.9.5. **Airspeed Indicator.** Airspeed remains constant when in straight-and-level flight with a constant power setting. Small changes in pitch attitude produce very slow changes in airspeed. Extreme changes in the pitch attitude produce faster changes in airspeed. From cruising airspeed in straight-and-level flight, climb or dive the aircraft. The apparent lag in the airspeed indication is caused by the time required for the aircraft to accelerate or decelerate after the pitch attitude changes. However, there is no appreciable lag in the correct indication of this instrument. Bring the airspeed indicator into the cross-check the same way as the attitude indicator, altimeter, and VVI. As more instruments are added, a quicker cross-check is needed.

2.9.6. **Elevator Trim.** Your instructor will have you fly the aircraft in level flight with the elevators out of trim. Note that back stick pressure is necessary to hold the desired pitch attitude. Adjust the elevator trim to relieve the pressure and note how the aircraft flies hands off. In straight-and-level flight, change the power setting to note how it becomes necessary to hold pressure on the stick to hold your altitude as airspeed changes. Relieve this pressure with elevator trim. <u>The importance of keeping the aircraft trimmed cannot be overemphasized.</u> From level flight, you will make various power changes and practice using elevator trim.

2.9.7. **Summary.** An efficient composite cross-check (inside and outside references) is essential for precise flying. The earlier a deviation is noted, the smaller the correction necessary to counteract the deviation. The attitude indicator is the most informative instrument for pitch attitude control in level flight, but you should cross-check the altimeter and VVI with the attitude indicator to ensure the altitude remains constant.

**2.10. Bank Control.** An accurate and timely cross-check between control and performance instruments is necessary to achieve good bank control. The attitude indicator gives direct information about the bank attitude of the aircraft. The heading indicator and turn indicator provide turning information. When you are in straight-and-level flight, maintain your attitude by using the horizon and the attitude indicator. Use the performance instruments to help maintain a constant heading and altitude. The cross-check should always be as rapid and accurate as possible, even in simple maneuvers. This allows more time to direct your attention to other matters in the advanced phases.

2.10.1. **Attitude Indicator:**

2.10.1.1. Through gyroscopic properties, the horizon bar stays parallel to the actual horizon. The aircraft's actual attitude is duplicated on the attitude indicator by the miniature aircraft. This is easier to visualize if you imagine yourself in the miniature aircraft. Proper control of the miniature aircraft translates to proper control of the actual aircraft. Two indications on the ARU-44A attitude indicator are used to determine if the aircraft is inverted. If the bank pointer is in the bottom half of the instrument case, the aircraft is inverted. If the words "climb" or "dive" or the numbers showing degrees of climb or dive (30 to 60 degrees) appear upside down, the aircraft is inverted.

2.10.1.2. Precession errors in the attitude indicators frequently occur when executing steep turns. The maximum precession error usually occurs after 180 degrees of turn. When the aircraft returns to straight-and-level flight, the miniature aircraft may still show a slight bank because of the precession of the attitude indicator in the turn. During a steep turn, the precession will be more apparent than in a normal turn.

2.10.2. **Heading Indicator.** The heading indicator gives an indirect indication of bank. As you roll the aircraft into a very shallow bank, the heading pointer moves slowly in the direction of bank. When you increase the bank, the corresponding increase in the rate of turn on the heading pointer. For turns of 30 degrees or less, the bank angle should approximate the number of degrees to be turned. For turns of more than 30 degrees, use a bank angle of 30 degrees. This is a good rule to prevent overcontrolling the aircraft. After becoming proficient, add the heading indicator to the cross-check with the other instruments used to maintain straight-and-level flight.

2.10.3. **Turn-and-Slip Indicator:**

2.10.3.1. This instrument is composed of two major elements—the turn needle and the ball. The importance of the turn-and-slip indicator has been de-emphasized in recent years because of improved reliability of attitude indicators and improved instrument flight procedures. However, it is still used when trimming the aircraft and for emergency bank indications if the attitude indicator fails. If such a failure occurs, the turn-and-slip indicator is the only instrument available to help keep the aircraft upright.

2.10.3.2. When the turn needle is exactly centered, the aircraft is in wings-level flight. When the aircraft is banked, the turn needle will deflect from center indicating the direction of turn. Your instructor will have you occasionally cross-check the turn needle to support the other instrument indications.

2.10.3.3. The ball is used to determine whether the aileron and rudder trim are set correctly. The aircraft is improperly trimmed when the wings are level, but the ball is not centered. Hold the wings level with the aileron pressure and center the ball with the rudder. Relieve all pressures by adjusting the appropriate trim. <u>It is very important to keep the aircraft trimmed properly at all times.</u>

2.10.3.4. Precise flying is not difficult if the aircraft is trimmed and the instruments are cross-checked properly. An accurate and timely cross-check between outside references, control, and performance instruments makes it a lot easier.

**2.11. Power Control.** Correct power settings and standard procedures for changing airspeeds are essential to proper power control. Your instructor will provide techniques that will enable you to quickly set the approximate power setting for the desired performance. The cross-check method used for control and performance is also applicable to power control. Increase the speed of your cross-check when power changes are made. Power changes that result in airspeed changes affect the attitude of the aircraft. These changes require elevator control pressure to prevent any undesired change in the pitch attitude and rudder control pressure to prevent any undesired yaw in the aircraft. Elevator and rudder trim relieve these pressures.

2.11.1. **Power Corrections:**

2.11.1.1. When you increase power, the aircraft has a tendency to climb as the airspeed increases. Forward pressure on the elevator control is necessary to maintain a constant altitude. Use elevator trim as necessary. With a decrease in power, the nose has a tendency to drop as the airspeed decreases. Use back stick pressure followed by elevator trim to maintain altitude.

2.11.1.2. There is a specific power setting that will hold airspeed at the altitude you choose. If you want 200 KIAS at 10,000 feet, level off at 10,000 feet, accelerate, and set the power on the tachometers to the rpm you think should hold 200 KIAS. Keep the aircraft at 10,000 feet with elevator control and cross-check the airspeed indicator. If the airspeed stabilizes at more than 200 KIAS, you must reduce rpm. If the airspeed stabilizes at less than 200 KIAS, you must increase rpm. Again allow the airspeed to stabilize to determine whether a further power correction is needed. Altitude is maintained with pitch control; airspeed is maintained with power control. A quick cross-check between the airspeed indicator and the altimeter will indicate the need for a power or pitch change.

2.11.2. **Combined Corrections:**

2.11.2.1. When the altitude is correct and the airspeed is not, a power change is needed to regain the desired airspeed. When both altitude and airspeed are incorrect, use the elevator control to correct the altitude and power to adjust the airspeed.

2.11.2.2. If you are below the desired altitude with a high airspeed, you may be able to deplete the excess airspeed with a pitch correction that will return you to the desired altitude. Similarly, if you are above the desired altitude with a low airspeed, you may be able to regain your desired airspeed with a pitch correction that will return you to the desired altitude. This is the reason you generally correct first for pitch and then for power, as required. Obviously, if you are high and fast or low and slow, you will need simultaneous corrections of both pitch and power. You will be required to combine the cross-check of the control and performance instruments with precise power control to maintain straight-and-level flight. During power corrections, the speed of the cross-check must be increased so control corrections can be timely and small.

# Chapter 3

# MISSION PREPARATION

**3.1. Mission Preparation.** Solid mission preparation requires more than just having book knowledge. Physical and mental preparation means going over all mission events to minimize surprises. Use the following procedures to enhance your mission preparation:

3.1.1. **The Day Prior to the Sortie.** Although mission preparation can begin earlier, it should start no later than the day prior to the scheduled sortie. The following list is a guide, but is not all-inclusive:

3.1.1.1. **Check the Schedule.** Know the basic mission type and prepare accordingly. If you are flying a formal sortie (for example, syllabus, upgrade, check ride), refer to the appropriate publications and syllabus. The brief is not the time to find out that you do not know the references for a formation takeoff.

3.1.1.2. **Contact the Instructor Pilot (IP).** Ask if you can help with anything for the brief. Make the IP aware (from the beginning) that you are motivated and ready to fly the sortie.

3.1.1.3. **Review Appropriate Publications.** After reviewing key publications like the syllabus, you will have a good idea of what to expect for the next day's sortie. As a minimum, read the parts applicable to your sortie. That way, when you are asked a question in the brief, you will know the answer.

3.1.1.4. **Maintain Daily Standards.** In accordance with unit standards, be prepared to brief any or all of the following: weather, notices to airmen (NOTAM), airfield status, TOLD, emergency procedure (EP) of the day, and threat or topic of the day.

3.1.1.5. **Chair-Fly the Sortie.** Whether you physically sit down and chair-fly or just go over the mission in your mind is unimportant. The important thing is to understand the potential flow of the mission and how to accomplish the required maneuvers.

3.1.1.6. **Get Rest.** If you stay up all night to study for the mission, it will be evident in the brief and during the sortie.

3.1.2. **The Day of the Sortie.** If you did not perform the procedures in paragraphs **3.1.1.** the day prior to the mission, accomplish them now. If you did perform the procedures, review them again. The following habit pattern has been time tested and will ensure you are well prepared:

3.1.2.1. **Show Up On Time.** Get to the squadron early without violating your crew rest. By being at the squadron early, you will be able to stay ahead of, and more easily adapt to, last minute changes. You never want to be "behind the power curve."

3.1.2.2. **Prepare for the Briefing.** Check the weather, NOTAMs, flying status, TOLD, etc. Be prepared to brief any and all applicable information.

3.1.2.3. **Brief On Time.** Be in the briefing room early. Copy appropriate items from the briefing boards. If you see something on the board you think you might need, put it on your mission card. (Most IPs write items important to the mission on the board.)

3.1.2.4. **Complete Fuel Planning.** Ensure you understand the fuel requirements for the mission and compute appropriate joker and bingo fuel. See AFI 11-2T-37, Volume 3, for guidance.

**3.2. Mission Briefing:**

3.2.1. **Briefing Procedures.** A preflight briefing precedes missions throughout the Air Force. The IP or flight lead is charged with briefing duties and responsibilities for each mission and ensuring objectives are met. A thorough briefing is absolutely essential to ensure safe and effective mission accomplishment. The IP or flight lead should start the briefing on time and emphasize overall mission objectives and individual flight member responsibilities. As a minimum, he or she will use the briefing guides in AFI 11-2T-37, Volume 3, and include discussions on special interest items (SII), special instructions (SPINS), and applicable training rules (TR). Each crewmember should be prepared for the briefing and be on time—no excuses.

3.2.2. **Standard Mission Elements.** Mission elements may be briefed as "standard" provided they are published and the proficiency level of all crewmembers allows them to be briefed as such. The majority of the brief should focus on "what" and "how to."

3.2.3. **Briefing Techniques.** The briefing sets the tone for the entire mission. Write the mission objectives on the board and outline the standards used to measure success. Be dynamic and enthusiastic, challenging the crewmembers to meet mission objectives. Involve everyone by asking questions to keep their attention and also to determine the briefing's effectiveness. Always provide an atmosphere and opportunity for questions. Asking yourself, "What's different about this mission?" can enhance your situational awareness, increase safety, and provide an excellent big-picture perspective.

3.2.4. **Briefing Attendees.** When the IP or flight lead is ready to start the brief, you should be, too. Consider the following:

3.2.4.1. Listen to every word briefed. Because you have memorized the standards and could recite them verbatim, many items may be briefed as "standard." Nevertheless, the IP or flight lead will brief other specifics pertinent to the mission that may not be standard. Consider writing nonstandard items (mission-conduct-specific items) on your briefing card and reviewing them before stepping to your aircraft.

3.2.4.2. Never leave with questions unanswered. Some briefers welcome interruptions for questions, but many prefer to hold questions until the end. If you have a question for later, write the topic on your lineup card and ask the question when prompted by the IP or flight lead. Adhere to the IP or flight lead's style with respect to questions.

**3.3. Mission Execution.** Mission execution becomes significantly easier when you are prepared. To transform preparation into a well executed mission, consider the following:

3.3.1. **Be Ready To Step on Time.** Check early for personal equipment that may have been sent out for inspections or maintenance, arrange for spare equipment if necessary, and have all your "logistical" needs in hand (maps, checklists, etc.).

3.3.2. **Prioritize Your Tasks.** Today's missions require you to efficiently accomplish many tasks in little time. At its most basic level, task management in the air "boils down" to three tasks—aviate, navigate, and communicate. It is obviously much more complex than that; but, in a crisis situation, setting and following those three basic priorities allows you to safely reach a condition where you can inventory all potential tasks and establish secondary priorities.

3.3.3. **Be in Position.** This requires a certain level of aggressiveness, which should not be confused with the rate of flight control movement. Aggressiveness is a persistent unwillingness to accept deviation, indecision, or the unnecessary waste of time, fuel, or opportunity. However, never make a correction of such magnitude or speed that it constitutes a hazard to the flight.

**3.4. Mission Reconstruction and Debriefing.** Even though the mission is over, learning is not. After each flight, your IP or flight lead will review the mission. This review should clear up any mistakes made, but you should ask questions if you did not grasp all of the steps in any of the maneuvers. Becoming a military pilot demands that you understand each lesson fully, including mistakes you made and how to correct them. The time to ask questions is immediately after the flight, when problems or concerns are still fresh in your mind. To maximize learning for everyone during the debrief, certain standards of conduct must be followed as shown below.

3.4.1. **Administrative Requirements.** Complete all required paperwork accurately and in a timely manner. The possibilities are numerous, to include AFTO Form 781, **ARMS Aircrew/Mission Flight Date Document;** training requirement logs; airspace usage logs; bird strike reports; maintenance deviation reports; safety reports; grade sheets, and grade book logs. You should build a good habit pattern for those items to be accomplished before the debrief and for those that can wait until afterward.

3.4.2. **Goal of the Debrief.** The main goal is to determine if the briefed mission objectives were achieved and to what level. Your IP will cover which training objectives were met and which were not. Listen attentively to the techniques and procedures covered in order to improve future performance. Do not hesitate to ask your IP questions if you do not fully understand any aspect of the mission debrief.

3.4.3. **Reconstruction of the Mission.** The more people involved in the mission, the more important it will be to begin the reconstruction at a specified time. The IP or flight lead will debrief by objective, examining how well each objective was achieved. At the end, he or she will summarize with emphasis on the basics, major learning points, and considerations for future missions. The student pilot should accomplish the following for the debrief:

3.4.3.1. Write the mission objectives on the board.

3.4.3.2. Review the mission. Make notes to jog his or her memory.

3.4.3.3. Be ready before the IP or flight lead.

3.4.3.4. Leave his or her ego outside the briefing room. When debriefing, remain objective to maximize learning. A critique of performance is not a personal attack.

# Chapter 4

## START, TAXI, TAKEOFF, CLIMB, AND LEVELOFF

**4.1. Checklist Discipline.** The flight crew checklist is an abbreviated version of the flight manual used by pilots to ensure procedures are followed. Good checklist discipline is an integral part of military flying. Except for critical phases of flight, refer directly to the flight crew checklist or equivalent to ensure completion of all items. However, you do not have to refer to the checklist to complete each individual item. You may accomplish a few items and then refer to the checklist to ensure all items are completed. The pilot at the controls should initiate all checks and ensure the asterisked items are accomplished. Challenge and response is used to accomplish all asterisked items.

**4.2. Preflight:**

4.2.1. The preflight check starts before you reach the aircraft. Survey the taxi routes for any obstructions; for example, repair work on or near the ramp, stray equipment, or personnel who might be harmed by the jet blast. A complete visual inspection of the aircraft is a very important part of each mission. Use particular care while checking the canopy jettison and ejection systems. Ensure all safety pins are well seated.

4.2.2. AFTO Forms 781 are the official logs of aircraft operation, servicing, and maintenance. The importance of checking these forms cannot be overemphasized. Report discrepancies, such as improper status or failure to sign off the preflight inspection, to your IP or a qualified maintenance representative. Do not accept the aircraft until you are satisfied it is flyable. Definitions of the status symbols are included in the individual jackets.

4.2.3. When checking the oxygen quantity, ensure you have enough to complete your mission (300 pounds per square inch [psi] minimum for local sorties). TO 1T-37B-1 (flight manual) and TO 1T-37B-CL-1, *T-37 Abbreviated Flight Crew Checklist,* contain an oxygen duration chart to aid your decision. If you have any doubt about your oxygen quantity, have the oxygen system refilled prior to flight. Also compare the actual oxygen quantity with the AFTO Form 781 entry in an effort to identify any leaks. If you suspect a leak, check with maintenance personnel prior to flight.

4.2.4. The items in your preflight checklist are listed in an order that begins from the left nose section and moves toward the front. This system makes it easy to learn and reduces the margin for error. As in the visual inspection, consider each item as important as the next. If you overlook an item, certain systems may become inoperative or damaged. Therefore, refer to the checklist to ensure all items are completed.

4.2.5. Carefully check for fluid leaks in the wheel well, speed brake, and engine bay areas. These leaks are usually apparent from the presence of fluid along the fairing doors, seams, and line couplings. Check the security of all airlock fasteners closely to prevent losing panels in flight. Ensure air lock fasteners are flush. Tap access panels with your hand to detect looseness. Check the general condition of trim tabs, hinges, and control surfaces. Binding of the controls and cracked hinges on control surfaces are reasons for rejecting the aircraft. If you are not sure about the condition, setting, or operation of any single item, check with your IP or maintenance personnel. The pilot in command has final authority to accept or reject an aircraft.

4.2.6. Following each sortie, accomplish a postflight inspection of the aircraft to examine its general condition. Look for any abnormalities requiring the attention of maintenance personnel, such as missing panels, damaged tires, leaking fluids, scrapes, dents, or evidence of bird strikes.

**4.3. Interior Check and Starting Procedures:**

4.3.1. Moving aircraft controls with personnel near the aircraft can be hazardous. Keep your hands clear of all controls any time someone is under or near your aircraft. The crew chief is your safety observer. Be sure to communicate your intentions through the use of ground visual signals before moving the controls and monitor the crew chief's visual signals closely for safety.

4.3.2. The items in your interior inspection checklist are listed in an order that begins from the left of the cockpit and moves to the right. This system makes it easy to learn and reduces the margin for error. As in the preflight inspection, consider each item as important as the next. If an item is overlooked, certain systems may become inoperative or damaged. Therefore, refer to the checklist to ensure all items are completed.

4.3.3. <u>The importance of a thorough and proper oxygen system check cannot be overemphasized.</u> A complete and unhurried check of this system is as important as any of your preparatory or in-flight procedures.

4.3.4. During engine start, while closely monitoring the engine's revolutions per minute (rpm) and exhaust gas temperature (EGT), occasionally glance at the crew chief. He or she may give the first indication of anything unusual in your start. The canopy is normally fully open during engine start. When conditions dictate that the canopy should be closed during engine start, ensure the canopy is fully closed and locked. Stow loose articles in the cockpit before starting an engine or opening the canopy with an engine running. Do not hand objects over the side of the cockpit unless the engine on that side is shut down and has stopped rotating. During aircraft operations, the canopy must be full up or down and locked. You may, however, raise or lower it while taxiing.

**4.4. Instrument Cockpit Check.** Before flying, make sure each flight instrument and navigational aid (NAVAID) is working properly because you will need them to safely fly the aircraft in instrument conditions. In addition, AFMAN 11-217, Volume 1, requires a check of the equipment before flight. Checking the following items in your checklist will satisfy all requirements:

4.4.1. **Navigation Publications.** Ensure all publications required for your departure to destination and alternate are current.

4.4.2. **Pitot Heat.** Check for proper operation, including the heating of the stall warning transducer vane.

4.4.3. **Clock.** The clock should be running and set at the correct time.

4.4.4. **VVI.** The pointer should be at zero.

4.4.5. **Attitude Indicators.** These should be erect with the bank pointer aligned with the zero bank index. No warning flags should be visible. Set the miniature aircraft on the horizon with the pitch trim knob.

4.4.6. **Magnetic Compass.** Check the accuracy of heading information.

4.4.7. **Heading Indicators.** Check the accuracy of heading information. Look for correct movement in turns.

4.4.8. **Airspeed Indicators.** Check the pointers and rotating airspeed scale for proper indications.

4.4.9. **Altimeters.** Set the current altimeter setting. The maximum error of each altimeter at a known elevation point is 75 feet. The 10,000-, 1,000-, and 100-foot counter-drum pointers should indicate the appropriate elevation.

4.4.10. **VOR Check.** Tune and identify the station (all off flags should be out of sight). If you have a reliable signal, perform the self-test or the ground check. (If either check is out of limits, consider the VOR unreliable.)

4.4.11. **VOR Self-Test.** Tune, identify, and monitor the station. Place 315 degrees in the CSW and press the VOR/ILS test button. The CDI will center within ± 2 degrees, the bearing pointer should indicate 315 degrees with a TO indication, and the marker beacon light will illuminate. If the VOR self-test functions properly, a check of the VOR at the designated ground checkpoint is optional. However, it is important to use all information when checking NAVAIDs, especially when weather conditions are marginal.

4.4.12. **VOR Ground Check.** Tune, identify, and monitor the station. Ensure the bearing pointer points to the station. The allowable error at the ground checkpoint is ± 4 degrees. Check that the CDI centers within ± 4 degrees of the designated course. Rotate the course set knob and check for proper CDI displacement. Continue rotating the course select knob and check that the TO/FROM indicator changes when the selected course is approximately 90 degrees to the bearing pointer.

4.4.13. **DME Check:**

4.4.13.1. **Self-Test.** Tune, identify, and monitor the station and perform the self-test. The DME will automatically self-test when power is applied or by momentarily holding the selector to test. The self-test will conclude with a display of either SELF TEST PASS or SELF TEST FAIL. The DME should return to the approximate distance from the station.

4.4.13.2. **Ground Check.** Check the DME at the ground checkpoint (if available). The distance indicator should be within 1/2 mile or 3 percent of the distance to the facility, whichever is greater.

4.4.14. **ILS.** If a valid ILS frequency is received, the ILS self-test may be used. With the localizer identified, check for no off flags, absence of TO/FROM indication, and proper needle deflection in relation to aircraft position. The radio magnetic indicator (RMI) bearing pointer should park at the 4 o'clock position. Pressing the VOR/ILS test button will illuminate the marker beacon light.

4.4.15. **Turn-and-Slip Indicator.** Check to ensure each needle indicates proper movement in a turn and each ball is free to move in its glass tube.

## 4.5. Taxiing:

4.5.1. The T-37 is equipped with nosewheel steering to turn the aircraft while taxiing.

4.5.2. After performing the before-taxi check, visually clear to the front and rear. Increase power as necessary, depress the nosewheel steering button, and release brakes. Pick up momentum straight ahead, simultaneously apply rudder in the desired direction of turn, and reduce power (normally to idle). Avoid the tendency to neutralize the rudder pedals just as the aircraft starts turning. This will merely straighten the nosewheel, necessitating the application of rudder to put the aircraft back in the turn.

4.5.3. If you need a sharper turn than can be made with the steering mechanism, release the nosewheel steering button and use the inside brake to establish the angle of turn desired. When you do this, keep the inside wheel rolling. Any attempt to pivot the aircraft on a locked inside wheel will damage the wheel, tire, and strut. This is particularly dangerous because the damage may not be apparent, but the gear may be damaged enough to collapse under the strain of landings. To make sure the inside wheel rolls, release the inside brake intermittently. Apply the brakes smoothly, evenly, and cautiously at all times.

4.5.4. When leaving a parking area, be especially alert for aircraft taxiing past your position. Also watch for personnel, ground equipment, etc.

4.5.5. When clear of the parking area, use power as needed to keep the aircraft rolling at a moderate speed. Nosewheel steering will be more sensitive as taxi speed is increased. Use the brakes as sparingly as possible to prevent excessive wear and overheating. Keep taxi time to a minimum because of the high rate of fuel consumption.

4.5.6. While taxiing, do not perform checks until the aircraft is in an unobstructed area. Do not concentrate all your attention inside the cockpit.

4.5.7. Spacing between taxiing aircraft must be a minimum of two ship lengths (75 feet) when staggered in trail. If you must taxi directly behind an aircraft, increase the spacing to a minimum of four ship lengths (150 feet) to avoid exhaust fumes and foreign object damage (FOD). In addition to this AETC-specific guidance, Air Force guidance on aircraft ground operations is published in AFI 11-218, *Aircraft Operations and Movement on the Ground.*

4.5.8. Exhaust gases contain harmful quantities of carbon monoxide—an odorless, but toxic gas. Use 100 percent oxygen to prevent breathing these gases. When the aircraft ahead of you has cleared, be sure to reset your oxygen to normal, because your oxygen supply will be depleted prematurely if the regulator is left on 100 percent for the entire flight.

**4.6. Taking the Active Runway.** Once cleared for takeoff, ensure the canopy is down and locked and confirm the approach and departure ends of the runway are clear of aircraft. Note the takeoff time. Attempt to taxi into a takeoff position that will allow the maximum use of runway. Remember, runway behind you is useless! Ensure your nosewheel is aligned straight down the runway and confirm your heading system is within tolerances. Make absolutely certain all applicable procedures and checklist items have been completed.

**4.7. Takeoff Options.** Initially, you will practice static takeoffs. Later, you and your IP will have the option of a rolling takeoff.

4.7.1. **Static Takeoff:**

4.7.1.1. One method of initiating the takeoff is a static engine runup. Pump up the brakes and exert as much pressure as necessary to prevent creeping during engine runup. Look down the runway and advance the throttles to military power, glancing into the cockpit only momentarily to ensure the engine instruments are within limitations. Your primary concern at this time is to ensure the aircraft is not creeping forward or pulling to one side. If the brakes will not hold satisfactorily at military power, reduce power and pump up the brakes again. (If the brakes do not hold on the second runup, abort the aircraft.)

4.7.1.2. When the engines have stabilized at military, complete the lineup checklist. Divide your attention between checking each item and holding the aircraft in position. When you are ready to begin the takeoff roll, engage the nosewheel steering and release the brakes.

4.7.2. **Rolling Takeoff.** A rolling takeoff is used primarily to aid traffic flow in a busy pattern. It is actually a smooth combination of taxi, application of power, and the takeoff roll. Rolling takeoffs have a negligible effect on TOLD; no recalculation is required.

**4.8. Takeoff Roll:**

4.8.1. As you taxi into takeoff position, check the windsock or other wind indicators or get wind data over the radio so you can anticipate any crosswind. With the aircraft lined up straight down the runway, maintain directional control with smooth rudder application and make sure the elevator is approximately neutral. You will feel the elevator gradually become effective as the airspeed builds. At this point in the taxi-flight transition, the aircraft is being flown more than taxied. As this occurs, you need to make progressively smaller rudder corrections.

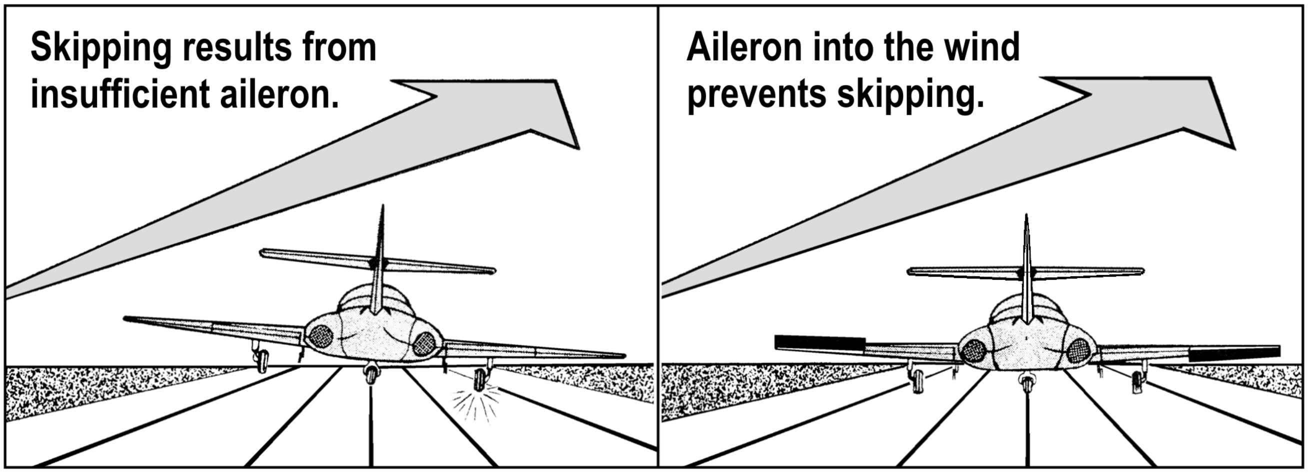
4.8.2. At approximately 65 KIAS (or computed nosewheel lift-off speed), smoothly apply back stick pressure to establish the takeoff attitude and release the nosewheel steering button. Because a good takeoff depends on takeoff attitude, it is important to know how this attitude is attained. The ideal takeoff requires minimum pitch adjustment after the aircraft becomes airborne. Your IP will demonstrate the takeoff attitude. Use whatever back stick pressure is necessary to hold this attitude. Keep the wings level by applying aileron pressure.

4.8.3. At the takeoff point, all flight controls are effective in maneuvering the aircraft. At any time during the takeoff, a situation may arise that requires an abort. The decision to abort depends on the nature of the problem, speed, and runway remaining. You must make decisions accurately and quickly. With certain types of malfunctions, you may find it advisable to continue the takeoff and then land as soon as practical. In any event, use TO 1T-37B-1 (flight manual) procedures and limitations to help you make your decision to abort or continue the takeoff. Your IP will help you develop the judgment to make accurate, timely decisions. There is *no* substitute for good judgment.

4.8.4. The initial takeoff roll technique for a crosswind is the same as for a normal takeoff except the aileron is held into the wind as the takeoff roll is started. You will also need to adjust rudder input (opposite the aileron) to keep the aircraft from weathervaning (that is, streamlining itself into the wind). As the aircraft approaches flying speed, the ailerons become more effective. You must reduce aileron deflection to keep the wings level, but you have to maintain some aileron deflection throughout the takeoff roll. This aileron deflection is necessary because the upwind wing develops more lift, causing it to fly (begin rising) before the downwind wing.

4.8.5. If the upwind wing rises and exposes more impact surface, a skipping action may result (**Figure 4.1.**). This is a series of very small bounces caused by the aircraft attempting to fly on one wing and then settling back onto the runway. During these bounces, the crosswind will move the aircraft sideways and the bounces will develop into side skipping. This skipping imposes stress on the landing gear that could result in materiel failure. In addition, the tendency of the aircraft to weathervane increases.

**Figure 4.1. Skipping on Takeoff.**



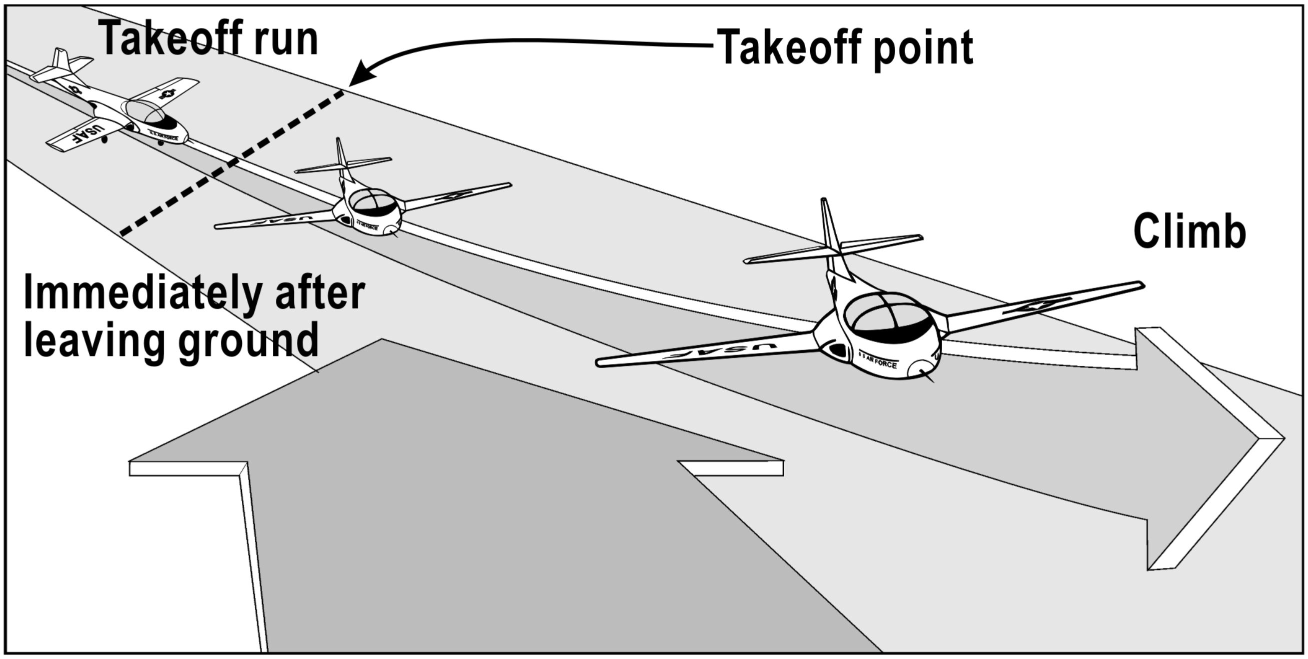

4.8.6. Use caution during takeoffs in gusty wind conditions or rapidly changing wind direction and velocity. Make timely corrections to maintain directional control.

## 4.9. Leaving The Ground:

4.9.1. Maintain the takeoff attitude picture set at rotation throughout lift-off. As the airspeed accelerates through approximately 90 KIAS, the aircraft will fly off the ground. Changes in fuel weights and flap settings will vary takeoff airspeeds. As the aircraft leaves the ground, maintain the correct flight attitude and direction. If insufficient back stick pressure is held, the aircraft may settle back to the runway after the initial lift-off. However, be careful not to force the aircraft into the air by applying too much back stick pressure before adequate flying speed is gained. If this happens, the nose may rise so high that a stall develops. Forcing the aircraft into the air prematurely is an unsafe practice and must be avoided.

4.9.2. As the wheels leave the runway with a crosswind present, the aircraft will start drifting with the wind. Relax the rudder pressure, allow the aircraft to turn into the wind until an adequate crab is established, and then neutralize the crosswind aileron. Continue to climb in the crab to maintain runway alignment on the takeoff leg (**Figure 4.2.**).

**Figure 4.2. Crabbing Into the Crosswind After Takeoff.**




**4.10. After Becoming Airborne:**

4.10.1. The aircraft will pick up speed rapidly after becoming airborne. When you are safely airborne and have attained a minimum of 100 KIAS with a positive climb rate, prepare to raise the landing gear. To prevent premature gear retraction, make this a conscious act, using the flight condition of the aircraft as the cue. Never allow gear retraction to become a habitual action or rely on a single cue, such as airspeed. Before raising the gear handle, the pilot flying the aircraft on all dual sorties will make a "gear clear" call. A verbal response is not required except for pre-solo sorties. On pre-solo sorties, the IP will clear the student to raise the gear. In cases other than pre-solo, the "gear clear" call is advisory only. It is intended to make the pilot consciously aware of the act of raising the gear and to emphasize that the other crewmember has a responsibility to ensure gear retraction is done properly.

4.10.2. When the gear handle is up and the airspeed is above 110 KIAS, retract the flaps and adjust the pitch attitude slightly to compensate for the loss of lift. After takeoff, confirm the gear handle is up, warning light in the gear handle is extinguished, flaps are up, and engine instruments are checked. Early recognition of power failure is critical. In this aircraft, loss of thrust is usually detected by referring to the engine instruments (tachometer and EGT), the engine sound, or a change in aircraft direction. Failure to attain or maintain airspeed may also be a clue. During operations such as takeoffs, where loss of thrust is critical, the need for monitoring engine instruments is even more important. Therefore, you should learn to cross-check engine performance instruments during takeoffs.

4.10.3. As airspeed increases, trim to relieve the pressure on the control stick. If no elevator or trim corrections are made during departure, the increased control effectiveness at higher airspeeds will cause a steeper-than-desired climbout. To counter this, continue to increase forward stick pressure on the elevator to maintain the desired climb angle. Concentrate on maintaining the desired pitch attitude after lift-off and trim to relieve control pressures.

4.10.4. When an aircraft has taken off immediately ahead of you, anticipate the possibility of wake turbulence, especially if the wind is calm or straight down the runway. Although sudden deviations in flight attitudes may occur, do not become alarmed. Use firm control pressures to make a very shallow turn in either direction to fly out of the wake turbulence. Then realign the aircraft with the original flightpath. If a crosswind is present, make the turn upwind because the wake turbulence will be blown away from your flightpath.

**4.11. Climb and Leveloff:**

4.11.1. **Turns After Takeoff.** There are several considerations you must keep in mind before initiating a turn after takeoff. Are you flying under VFR or IFR? Are you required to visually maintain a traffic pattern ground track or adhere to a published instrument departure procedure? Have you been cleared for a closed pattern or directed by tower controllers to turn so as to avoid converging with aircraft operating on an adjacent runway? In general, climb straight after takeoff until you are past the departure end of the runway, at a minimum of 150 KIAS, and at least 400 feet above the airfield before making any turns. Pilot judgment and specific instructions from the tower or runway supervisory unit (RSU) may result in modifications to this guidance.

4.11.2. **Climbs:**

4.11.2.1. A normal climb is made at an angle and airspeed that result in the optimum gain in altitude in relation to time (best rate of climb) with power set at military. Below 10,000 feet, climb at 180 KIAS; above 10,000 feet, maintain 160 KIAS. This is called a tech-order climb. You have the option to modify this climb schedule to suit specific mission requirements.

4.11.2.2. If the climb is started from cruising airspeed, increase the pitch to gradually decrease the indicated airspeed to obtain the tech-order climb airspeed for your altitude and advance power to military. This change in airspeed is gradual rather than immediate because of the momentum of the aircraft and added power for the climb.

4.11.2.3. Trim is an important consideration during a climb. When you have established the climbing attitude, trim the aircraft to relieve all pressures from the controls. Trim should be a continuous process throughout the climb and leveloff. When you adjust the flight attitude and/or airspeed, retrim the aircraft.

4.11.3. **Straight-Ahead Climbs:**

4.11.3.1. To establish a straight climb from level flight, advance the throttles to maximum and raise the nose to a climbing attitude. All pitch changes should be made using outside references when available. Straight flight can be maintained by using section lines or other outside references supported by the heading indicator. A wings-level attitude should be maintained by outside references, although an occasional glance at the attitude indicator will help.

4.11.3.2. Your IP will show you the climbing attitude at different altitudes and the outside references to maintain it. If the wingtips are equal distance from the horizon, a wings-level attitude should be indicated on the attitude indicator. As the climb is established, use back stick pressure to increase the pitch attitude. When the airspeed decreases to the desired reading, the amount of back stick pressure required to hold the airspeed will become constant. Use elevator trim to neutralize stick pressures. Once this is done, you will be able to maintain an attitude without holding pressure on the stick.

4.11.4. **Climbing Turns.** During turns, the loss of vertical lift becomes greater as the angle of bank increases, so shallow-banked turns should be used to maintain a good rate of climb. During the early part of your training, make each turn a separate maneuver, pausing momentarily before establishing another turn. This will give you practice in entering and recovering from climbing turns. If you trim in the turn, you will experience different pressures during the rollout and you must retrim when the wings become level. Clear the area continuously during climbing turns.

4.11.5. **Leveloff From Climbs.** Stop your climb at a selected altitude and establish level flight. Start the leveloff by using a lead point that will ensure a smooth transition to the desired leveloff altitude. One technique is to use a lead point that is approximately 10 percent of the VVI. For example, if you are climbing at a rate of 2,000 fpm, start the level off 200 feet below the desired altitude. At the lead point, smoothly lower the nose of the aircraft to level flight. Adjust the throttles as necessary to obtain the desired airspeed (200 KIAS cruise power is approximately 90 percent) and retrim the aircraft. Trimming is a continuous process from the time you lower the nose until the airspeed stabilizes.

4.11.6. **Climb and Leveloff Checks.** Aircrews must perform an operations check according to TO 1T-37B-1 (flight manual) when passing 10,000 feet mean sea level (MSL) and again at final cruise altitude. An operations check is not required for intermediate leveloffs, and aircrews may combine the 10,000-foot and leveloff checks when leveling at or below 14,000 feet MSL. Aircrews will perform additional operations checks every 15 minutes thereafter.

# Chapter 5

# CONTACT FLYING

## *Section 5A—Overview*

**5.1. Introduction.** Contact flying in the T-37 incorporates those areas of training in which pilots learn and practice the basics, to include takeoffs, landings, and a wide variety of area work. Contact training is flown with an emphasis on using primarily outside, visual references—the horizon, ground, runway, etc. The basic objective of contact flying is to build a solid feel for the aircraft's performance capabilities through a large portion of its flight envelope, to include stalls, aerobatics, and both normal and emergency traffic patterns.

**5.2. Area Orientation.** Maintaining constant area orientation is critical to contact flying in an assigned military operating area (MOA), and it will help ensure your safety and the safety of those flying under, over, or near your airspace. Effective area orientation will also improve your in-flight planning and profile execution.

5.2.1. **Primary Means.** Whenever they are available, use visual references as the primary means of lateral area orientation. Along with enhancing clearing, this will improve your use of ground references and maximize your awareness of nose position, track, and rate. You should study local area maps before flight, review visual references in your preflight briefings, and carry maps with you in flight for quick reference and review. Use the altimeter for vertical area orientation.

5.2.2. **Secondary or Backup Means.** When visual references are not available, use VOR radials and DME. When possible, set up the VOR for area orientation before entering the area. Your IP will show you different techniques for using the RMI, course indicator (CI), and magnetic bearing on the DME.

**5.3. In-Flight Planning.** Staying in the area is a safety-of-flight requirement, but accomplishing mission objectives requires planning skills. In-flight planning is a unique decision-making skill requiring you to manage (and usually modify, real time) your mission profile based on your assessments of area boundaries, aircraft energy, aircraft performance capabilities, maneuver parameters, and mission requirements.

**5.4. Energy Management.** Airspeed provides the kinetic energy required to maneuver the aircraft. Altitude provides potential energy that may be exchanged for airspeed. Power settings can be used to gain or lose energy. Energy management requires maintaining effective combinations of altitude and airspeed, power settings, and fuel awareness. The ideal energy level occurs near the middle of the altitude block at 150 to 200 KIAS. You can perform any aerobatic maneuver from this energy level.

5.4.1. **Exchange Rates.** Altitude and airspeed can be traded at a given rate. The most common rule of thumb is 1,000 feet of altitude is worth about 50 knots of airspeed. You can exchange altitude and airspeed in these proportions by using military power with the canopy bow on the horizon or 20 degrees nose-high.

5.4.2. **Maneuvers:**

5.4.2.1. Plan your maneuvers to flow from one to another. Spins, traffic pattern stalls, the cloverleaf, split-S, nose-low recoveries, excessive Gs, and steep-banked turns are energy-losing maneuvers. Energy-gaining maneuvers include power-on stalls, the nose-high recovery, stability demonstration, and chandelle. The loop, barrel roll, aileron roll, and lazy eight are all energy-neutral maneuvers. Over-the-top maneuvers require high airspeed, but they must start near the bottom of the altitude block to remain within the vertical area boundaries. The split-S requires slightly higher-than-average energy levels, but is basically a high-altitude, low-airspeed maneuver. The large range of airspeeds and altitudes in the middle accommodate lazy eights, barrel rolls, and chandelles.

5.4.2.2. Starting at your optimum energy level, you can make a quick exchange of airspeed and altitude in proper proportions and begin any aerobatic maneuver. However, any large deviations from optimum energy will make many maneuvers temporarily impossible. Clearly, no single energy level is appropriate for every profile or portion of one.

5.4.3. **Power Settings.** Effective energy management requires choosing appropriate power settings before beginning a maneuver. For example, approximately 90 percent rpm is a typical level-flight power setting, and any maneuver more demanding than cruise will lose energy if flown at 90 percent rpm. Maneuvers involving buffet or high G require high-power settings to preserve energy. If you intend to return to the pattern after your next maneuver, an energy preserving power setting might not necessarily be appropriate because you may have to descend to depart the area. Assess your profile and your return to base (RTB) altitude when ending your area profile.

5.4.4. **Fuel.** In addition to airspeed and altitude, fuel provides another energy source. While airspeed can be exchanged for altitude (and vice versa), fuel can only be depleted. Therefore, you cannot afford to waste it. If you unnecessarily bury yourself in the bottom of the area, you have to waste fuel to regain a useful energy level before you can resume maneuvering. Similarly, if you convert fuel into more airspeed and altitude than you need, the action is just as wasteful, because you will need to dissipate that energy before you can resume the profile.

5.4.5. **Energy Levels.** Effective energy management will minimize the necessity for corrections. When you create an ineffective energy level, however, you need to take appropriate corrective action. To change energy levels while maneuvering, choose power settings higher or lower than the energy-preserving values.

5.4.5.1. **Losing Energy.** Losing energy is easy through the use of low power settings, increased drag due to configuration or speed brake, and/or increased G-loading.

5.4.5.2. **Gaining Energy.** Gaining energy is enhanced with light G-loading (no buffet) and the maximization of excess thrust. Use military power for most energy-gaining maneuvers.

5.4.5.3. **Whifferdills.** A whifferdill is essentially a single leaf of a lazy eight. Avoid horizontal maneuvering (level turn) by using both climbing and descending whifferdills. Practice completing maneuvers and then getting the nose up instead of staying in level flight. This habit has many benefits. It allows time to think, plan, and regain orientation; it facilitates area management by requiring less horizontal area because you are maneuvering in the vertical and at lower airspeed; it enhances clearing; and it puts you more often at higher altitudes where fuel flow is lower. Climbing whifferdills to gain energy are best accomplished at military power.

5.4.5.4. **Conserving Energy.** The energy management goal is to stay close to the desired energy level. As mentioned in paragraph **5.4.2.**, certain contact maneuvers characteristically gain or lose energy so you must plan your profile accordingly. The optimum profile would string maneuvers in succession without a break. However, due to the different entry parameters, this is not always possible for an entire profile. The equalizer between maneuvers is the whifferdill.

**5.5. Fuel Management.** Effective fuel management begins during mission planning and continues throughout the mission until the final landing. Effective fuel management is not only critical for a safe RTB and landing, but it helps optimize training opportunities and achieve mission objectives. You must plan joker and bingo fuel according to area and pattern training requirements and recovery conditions (weather). Once in the area, it is important to complete your profile prior to joker or bingo fuel so the pattern work is not slighted. Effective fuel management involves more than leaving the area when you are finished with the profile.

**5.6. Increased G-Maneuvering.** During a typical mission you will perform maneuvers at different and ever-changing G levels. This is especially true of any maneuver that starts with extreme nose-down attitude at low airspeed and transitions to increasing airspeeds and higher G loads, such as nose-low recoveries, spin recoveries, and split-S maneuvers. To maintain maximum alertness and avoid grayout, blackout, or loss of consciousness during aerobatic flight, an effective anti-G strain is essential.

5.6.1. **Anti-G Straining Maneuver (AGSM):**

5.6.1.1. It is important to start the AGSM before the onset of the G forces and maintain the strain throughout the period of increased G-loading. The amount of strain required will vary with the amount of applied G force. When encountering high-G situations, all elements of the AGSM are required. During an AGSM, anticipation of the necessary strain, full muscle contraction, and constant breathing cycles become vital. Lower-G situations will still require all elements of a full AGSM, but at a lower level of strain intensity. Your IP will provide guidance on how to properly accomplish the AGSM, and he or she will ensure you can perform it properly.

5.6.1.2. Accomplish the AGSM by firmly contracting the muscles of the legs, abdomen, and chest; taking a deep breath; and trying to exhale against a closed airway. Ensure that you begin the AGSM just prior to G onset and strain at full intensity until reaching maximum planned G load.

5.6.1.3. Once "on top of the Gs," think about the AGSM as a continuous maneuver and vary the intensity of the strain as necessary based on your G-loading. Continue to strain and simultaneously breathe, approximately every 3 seconds. As you vary the strain, and especially when you increase intensity, pay careful attention to proper breathing techniques. It is important not to hold the strain too long without breathing because this will reduce G-tolerance.

5.6.1.4. If grayout occurs at the onset of G forces, application or intensification of the AGSM may not eliminate the grayout. If altitude and/or airspeed are not critical, return to one G flight, reapply the anti-G strain, and continue maneuvering. Be careful not to exceed aircraft limits or your personal G limit for the particular day. For a description and proper techniques on the AGSM, refer to AFPAM 11-419, *G-Awareness for Aircrew.*

5.6.1.5. Remember that while flying aerobatic maneuvers, you will be exposed to different G levels. By anticipating these Gs early and performing the AGSM properly, you may avoid grayout, blackout, and loss of consciousness.

5.6.2. **AGSM Demonstration:**

5.6.2.1. Your IP will perform an AGSM demonstration to allow you to practice your anti-G strain technique and familiarize you with increased G flight. The demonstration will consist of a series of turns, each at a constant G level, with a break between turns for critique and rest. The maneuver will be flown at gradually increasing G levels, starting at 2 Gs and increasing to 4 Gs, depending on your proficiency.

5.6.2.2. Your IP will advise you before maneuvering to ensure you are prepared. If at any time you approach your G tolerance, tell your IP. It is important that the demonstration be of sufficient duration to ensure you can perform the AGSM properly. The AGSM cycle should last a minimum of 10 seconds (about three breathing cycles).

5.6.3. **G-Awareness Exercise:**

5.6.3.1. If an AGSM demonstration is not done, perform a G-awareness exercise before flying any maneuver that may result in increased Gs. The G-awareness exercise should be a level turn, using military power. Begin the maneuver with sufficient airspeed (220 to 240 knots) to sustain 4 Gs. It is critical that G onset should be slow and smooth to allow sufficient time to evaluate the effectiveness of your AGSM and your G tolerance for this sortie.

5.6.3.2. Attempt to maintain 4 Gs for approximately three to four breathing cycles in order to allow full cardiovascular response. If you begin to grayout during the maneuver, immediately return to 1G flight, reevaluate your straining technique, and then attempt to reaccomplish the G-awareness exercise.

5.6.3.3. If you determine that your personal G-limit for this particular sortie is insufficient to complete planned maneuvers, modify your profile to avoid exceeding your personal limits.

**5.7. Flight Control Characteristics:**

5.7.1. **Rudder.** Effective use of the rudder is important throughout the flight regime of the T-37 and should not be ignored. Generally, the rudder is the most effective control surface at a high AOA.

5.7.2. **Ailerons.** Ailerons are most effective at a low AOA and become less effective as the AOA increases.

5.7.3. **Speed Brake.** Little or no pitch change occurs when activating the speed brake.

5.7.4. **Trim Techniques.** Proper trim technique is essential for smooth and precise aircraft control during all phases of flight. The basic rule for proper trim is simple—establish and hold a desired attitude by applying control stick pressure and then trim to relieve the pressure. Normally, large trim changes are not necessary. Use "clicks" of trim when retrimming the aircraft. When possible, fly the aircraft in a fully trimmed condition.

**5.8. Pilot-Induced Oscillation (PIO).** Overcontrolling pitch corrections can result in a PIO, especially at high airspeeds. During a PIO, control inputs lag behind the aerodynamic forces acting on the aircraft, and flight deviations will actually increase as you try to correct them. To avoid this potentially dangerous situation, make smooth control inputs and apply the following basic techniques:

5.8.1. **High-Altitude PIO.** When encountering a PIO at high altitude, release the control stick and allow the inherent aerodynamic stability to recover the aircraft.

5.8.2. **Low-Altitude PIO.** When encountering a PIO at low altitude, freeze the control stick slightly aft of neutral and allow the aircraft to climb. Correctly handling a PIO is especially critical during landing. If you encounter a PIO during landing, do not continue your landing attempt. Freeze the control stick and go around.

***Section 5B—Stall and Slow-Flight Training***

**5.9. General:**

5.9.1. Stall maneuvers and slow flight enable you to recognize attitudes, seat pressures, and the control feel that signals unsafe flight conditions. A thorough knowledge of these maneuvers will allow you to fly an airplane safely at maximum performance.

5.9.2. Before performing stalls or slow flight, ensure your loose equipment is stowed, the boost pump is operating, and the area is cleared for other aircraft. If maneuvers are flown in a series, you are not required to check these items between individual maneuvers, but you must still clear the area for other traffic.

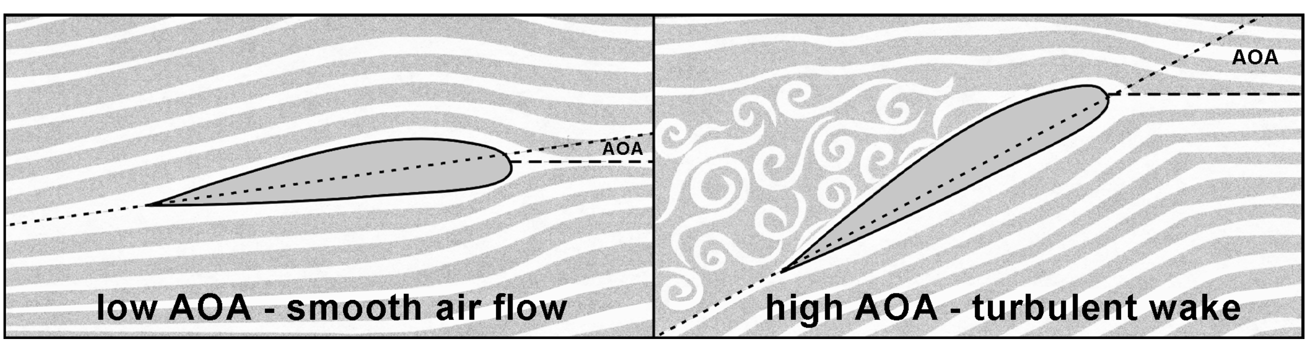
5.9.3. A stall is best defined as a condition where airflow over the top of the wing becomes separated from the surface of the wing. When this occurs, a turbulent wake develops on and behind the wing and the aircraft suffers a drastic reduction in lift. We are interested in this phenomenon because when the stall occurs, continued flight in the normal sense is no longer possible. If the stall condition is allowed to fully develop, the controls lose their effectiveness and sudden pitching and rolling motions occur. As the stall progresses, control effectiveness is lost in the following order: aileron, elevator, and rudder. During stall recovery, control effectiveness is regained in the reverse order: rudder, elevator, and aileron. Obviously, a stall at low altitude is dangerous because considerable altitude may be lost during recovery. The following material outlines the conditions leading to a stall, stall warning, and stall recovery.

**5.10. Conditions Leading to a Stall:**

5.10.1. **Cause of a Stall:**

5.10.1.1. There is one cause for a stall—exceeding the critical AOA. Remember, the AOA is the angle between the chord line and the relative wind. **Figure 5.1.** shows that a high AOA leads to airflow separation and the formation of a wake of turbulent air behind the wing. Separation begins at a certain AOA. A further increase in AOA will cause separation on most of the top surface of the wing.

**Figure 5.1. Angle of Attack (AOA).**




5.10.1.2. An airplane can stall at any airspeed, attitude, or power setting if you demand (with the elevators) an AOA above the critical value. If the airspeed is low, the stall will occur with light seat pressure and low Gs. If the airspeed is high, you will feel considerable Gs and seat pressure when the AOA is sufficient to cause a stall. **Table 5.1.** shows the relationship between Gs and stalling airspeed for an average gross weight (5,400 pound aircraft) with clean configuration.

**Table 5.1. Stall Speed for Varying G-Loading.**

| ITEM | A<br>Aircraft G | B<br>Stall Speed (KIAS) |
|---|---|---|
| **1** | 0 | 0 |
| **2** | 1/4 | 39 |
| **3** | 1/2 | 56 |
| **4** | 3/4 | 67 |
| **5** | 1 | 79 |
| **6** | 2 | 112 |
| **7** | 3 | 137 |
| **8** | 4 | 158 |

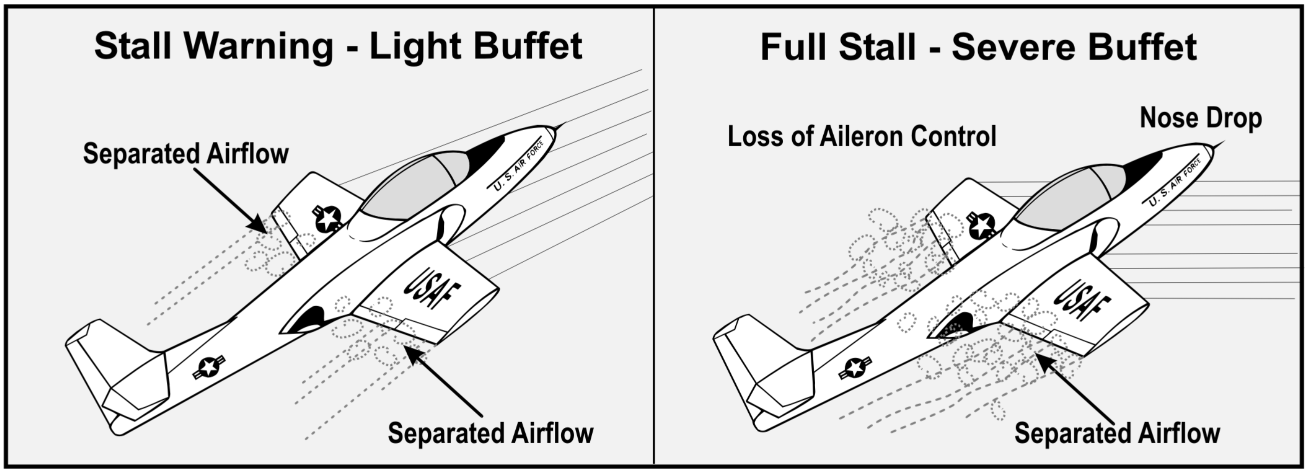
5.10.1.3. Although you need not memorize the stall speeds in **Table 5.1.**, you should note the direct relationship between Gs (seat pressure) and stalling indicated airspeed. The one-G stall is the level flight stall. Stalls occurring with more than one G are often referred to as high-speed stalls or accelerated stalls.

5.10.2. **How To Detect an Impending Stall.** To become a proficient pilot, you must recognize flight conditions that cause stalls and know how to apply the necessary corrective action. You must learn to recognize an approaching stall by both sight and feel. An impending stall can be recognized by abnormal nose-high attitudes and decreasing airspeed. During turns and when pulling Gs, you can see the rapid motion of the nose as excessive back stick pressure is applied. You can feel the control pressures become light and less effective at low airspeeds. During rapid or steep turns, you can feel the excessive pressure that is forcing you into the seat as well as the excessive pressure you are applying to the controls.

5.10.3. **Stall Warning:**

5.10.3.1. In a clean configuration, the T-37 provides a stall warning in the form of buffet. This is easily understood by referring to **Figure 5.2.** As the stall begins, the smooth airflow starts to separate from the wing in a small region near the wing root. The resulting turbulent wake strikes the tail and shakes the controls. This shaking or buffeting indicates the need to reduce the AOA to prevent a full stall.

**Figure 5.2. Stall Warning.**




5.10.3.2. The full stall is reached at an AOA slightly higher than the angle where buffet begins to be noticed (**Figure 5.2.**). The separation has spread over most of the top rear portion of the wing. Tests confirm that as this happens in the T-37, the airflow over the tail surface becomes so disrupted the elevator can no longer hold up the nose. Thus, a sudden decrease in pitch takes place, which is often referred to as nose drop. Nose drop is easily noticed in the low G, high pitch attitude stalls. During level flight stalls and accelerated stalls, nose drop is not so apparent. These stalls are best characterized by very heavy buffet, loss of aileron effectiveness, and rolling motions.

5.10.3.3. When the flaps of the T-37 are lowered, the stalling characteristics of the wing change. Both the stalling AOA and stalling speed are reduced. Also, when the flaps are down, the wing wake does not give a buffet warning of an impending stall. For this reason, the aircraft is equipped with a spoiler system that provides an artificial buffet warning approximately 4 to 10 knots before stall is reached.

**5.11. Stall Recovery.** The T-37 has excellent stall recovery characteristics. The elevator is effective enough to reduce the AOA during the most severe stalls. Aileron control becomes marginal during a full stall, but rudder control is adequate to provide directional control except in the most severe stalls. To recover from a stall or to alleviate approach-to-stall indications, apply the following stall recovery procedures: (***NOTE:*** Do not think of these procedures as steps, one followed by another. Instead, apply them simultaneously because they will all aid in your recovery.)

5.11.1. Reduce back stick pressure to decrease the AOA. Stick forces required to eliminate a stall will differ with every stall. Therefore, do not push forward on the stick to a predetermined point. At the same time, use the rudder to help level the wings to reduce the stall speed and advance the power to military as the speed brake is retracted to increase airspeed. As you feel the aircraft regain flying airspeed, return to level flight.

5.11.2. Reducing the back stick pressure to decrease the AOA will restore lift. Thus, the aircraft will be immediately brought out of a stalled condition and returned to flying condition, although you may still be in a descent. If the wings are severely stalled, the use of aileron is ineffective and will aggravate the stalled condition, regardless of the finesse with which the aileron is applied. Use ailerons with coordinated rudder to level the wings after the stall is broken.

5.11.3. Because the throttles are your only direct control over thrust, you must have maximum thrust to expedite the return to level flight by increasing the airspeed. When time is critical, as in low-altitude, thrust-deficient situations, rapid throttle movement is the most efficient procedure to achieve maximum engine acceleration. Acceleration time is approximately 40 percent less when accelerating from 50 percent rpm to military power versus idle to military power.

5.11.4. A stall recovery is not complete until the aircraft is returned to level flight. Avoid attempting too rapid a recovery, which will result in a secondary stall. Strive to develop a feel for flying the aircraft out of a stalled condition with a minimum loss of altitude.

**5.12. Power-On Stalls.** Power-on stalls are designed to teach you to recognize and recover from a nose-high attitude, full stall. You will recover from this stall when control effectiveness is lost. Control effectiveness is lost when the nose drops or an unplanned rolling motion takes place. Full back stick pressure is not needed before initiating recovery, and the exact point where the full stall is reached is not considered a point of emphasis. It is important, however, for you to see how an airplane behaves if recovery from the stall is not made at the first buffet indication. Adjust the throttles to 90 percent rpm prior to the first indication of the stall and clear the area. Pay particular attention to the area above and in front of your aircraft. ***NOTE:*** It is not necessary to clear before each individual stall maneuver unless you pause too long between maneuvers and fly out of the area you have previously cleared.

5.12.1. **Straight-Ahead Stall:**

5.12.1.1. To execute a straight-ahead, power-on stall, raise the nose to a pitch attitude between 15 and 50 degrees. Your IP will point out the outside references to use. Slowly and smoothly increase back stick pressure to hold this attitude until stall occurs. Keep the wings level with aileron pressure.

5.12.1.2. Recover by using stick forces as necessary to decrease the AOA and smoothly advance the throttles to military power. Apply coordinated rudder and aileron pressure to level the wings. Notice how large a pitch change is necessary to recover. Allow the nose to lower until you feel positive pressure on the controls, indicating the aircraft is regaining flying airspeed. Cross-check the airspeed and recover with minimum loss of altitude without encountering a secondary stall. The maneuver is complete when you have returned to level flight.

5.12.1.3. At lower pitch attitudes (between 15 and 30 degrees), the aircraft will stall at a relatively high airspeed. Shortly after you lower the nose, the aircraft will regain flying airspeed. At higher pitch attitudes (between 30 and 50 degrees), the stall speed will be slower and a greater pitch change is necessary to regain flying airspeed.

5.12.2. **Turning Stall.** The turning stall is executed in much the same manner as the straight-ahead stall. The pitch and power are the same, but the bank angle is 20 to 30 degrees in either direction. From straight-and-level flight attitude, set the pitch attitude between 15 and 50 degrees and establish the desired bank angle. Hold this attitude with elevator pressure until the stall occurs (usually indicated by nose drop or unplanned roll). Then recover straight ahead as you did in the straight-ahead stall. A precision entry is not as important as proper recognition and recovery from full-stalled conditions. **Table 5.2.** illustrates the effects of angle of bank on stall speed for a 6,400-pound aircraft with full flaps.

**Table 5.2. Stall Speed for Varying Bank Angles.**

| ITEM | A<br>Angle of Bank (in degrees) | B<br>Stall Speed (KIAS) (note) |
|---|---|---|
| 1 | 0 | 72 |
| 2 | 30 | 77 |
| 3 | 45 | 86 |
| 4 | 60 | 102 |
| 5 | 70 | 123 |
| 6 | 80 | 173 |

***NOTE:*** For power-on stall speeds (approximately 85 percent), subtract 4 knots.

**5.13. Traffic Pattern Stall.** You will practice traffic pattern stalls to become proficient in recognizing and recovering from stall conditions that could occur in the traffic pattern. The emphasis is on recognizing the approach to stall and the use of recovery procedures—not on how the stall series is set up or the flow from one stall to the other. Above approximately 90 KIAS, the spoilers will not extend during configured stalls. Buffeting is the best indication of an approach to stall. If a stall indication actually occurs in the traffic pattern, make no attempt to comply with the normal ground track. Recover the aircraft by using the following procedures to safely regain aircraft control:

5.13.1. **Break Stall.** On a simulated initial, adjust power to maintain 200 KIAS. Execute the break (clear the area) and reduce power as you would in the traffic pattern. After the turn is well established, steadily increase bank and back stick pressure until you recognize an approach-to-stall indication. At this point, execute an immediate recovery by simultaneously retracting the speed brake (if used) and using stick forces as necessary to decrease the AOA. Adjust the angle of bank as necessary and continue the turn to approximately the 180-degree point, simulating a downwind leg. The setup should be as realistic as possible. Large altitude deviations could prevent timely stall recognition and recovery.

5.13.2. **Overshooting Final Turn Stall.** On the simulated downwind leg, configure for a normal overhead pattern. Approaching 120 KIAS, initiate a normal final turn. Ensure the speed brake is out. After the turn is established, lower the nose and steadily increase bank and back stick pressure until you recognize an approach-to-stall indication. With the flaps extended 25 percent or more and airspeed greater than 90 knots, the spoilers will not extend to give an artificial stall warning during an accelerated stall. However, speed brake buffet will become more pronounced as AOA is increased. Be aware of this increased buffet and recognize it as an approach-to-stall indication. Recover by simultaneously using stick forces as necessary to decrease the AOA, advancing the power to military, retracting the speed brake, and leveling the wings. Return to level flight as soon as possible. Do not lose any more altitude than necessary.

5.13.3. **Undershooting Final Turn Stall.** In level flight at 120 KIAS minimum, reduce the power as you would on a downwind leg, reconfigure for a normal pattern (to include extending the speed brake), and begin a normal final turn. After establishing the turn, raise the nose slightly and shallow out the bank. Continue to turn until you recognize an approach-to-stall indication. Recovery is the same as for the overshooting final turn stall except airspeed will be lower and it will take longer to return the aircraft to level flight.

5.13.4. **Landing Attitude Stall:**

5.13.4.1. Extend the speed brake, establish a 100-knot simulated final approach, reduce the power to idle, and execute a normal roundout for landing. Hold the landing attitude constant until you recognize an approach-to-stall indication. At that point, execute a normal stall recovery by simultaneously advancing the power to military, retracting the speed brake, and using stick forces as necessary to decrease AOA.

5.13.4.2. After completing the first instructional unit requiring traffic pattern stalls, the break stall is optional. You may start from a simulated downwind position, but you are still required to clear the area. The sequence of the turning stalls is unimportant. Your IP has the option of having you fly only one of the turning stalls during the series. Additionally, he or she may demonstrate the approach-to-stall characteristics in various configurations used in the traffic pattern.

5.13.5. **No-Flap Stall.** You will also practice no-flap traffic pattern stalls. In performing the stalls without flaps, use the same configuration, airspeeds, and power settings as in the no-flap landing pattern. While performing these stalls, be aware of the differences in aircraft buffet, pitch attitudes, and stalling airspeeds. Be careful not to exceed the gear-down limiting airspeed during stall recoveries.

**5.14. Secondary Stall:**

5.14.1. A secondary stall is a form of an accelerated stall caused by excessive elevator control. It is called a secondary stall because it occurs after a partial recovery from a preceding stall. A secondary stall is caused by attempting to hasten a stall recovery when the aircraft has not regained sufficient flying speed.

5.14.2. This stall demonstration is designed to show you what will happen if you rush the return to level flight after a stall or spin recovery. It will also teach you the value of smooth back stick pressure at critical airspeed and the importance of allowing an aircraft to begin flying before completing a stall recovery. The secondary stall is usually demonstrated after a partial recovery from a power-on stall.

5.14.3. Clear the area and perform a normal power-on stall. When the stall occurs, initiate a recovery. Then steadily bring the stick back as if you were trying to rush the return to level flight. Continue to increase back stick pressure until the aircraft buffets and the nose stops tracking. Note that the throttles are full forward when the secondary stall is actually entered. When this occurs, use stick forces as for a normal stall recovery.

**5.15. Slow Flight:**

5.15.1. **Slow-Flight Practice:**

5.15.1.1. Slow flight will acquaint you with the characteristics of the aircraft at minimum flying speeds and will demonstrate the importance of smooth control application. You will practice slow flight to develop your feel for the aircraft and your ability to use the controls correctly. This will improve your proficiency in performing low airspeed maneuvers.

5.15.1.2. You may enter slow flight after the traffic pattern stalls or by reducing the airspeed and configuring for the maneuver. When the airspeed is below 150 KIAS, lower the landing gear and make all gear-down checks. Lower the flaps when the airspeed is below 135 KIAS. Use of the speed brake is optional. Continue to maintain altitude while the airspeed decreases. When the airspeed has decreased to 75 to 80 KIAS, adjust the power to maintain airspeed and altitude. Trim the aircraft as needed throughout these changing flight conditions. You may practice slow flight, using the no-flap configuration and 90 to 95 KIAS.

5.15.2. **Slow-Flight Demonstration.** Your IP will demonstrate the following handling characteristics of the T-37 at minimum flying speeds, and he or she will have you fly some of these to build your proficiency in the aircraft. These demonstrations will help you recognize attitudes and characteristics leading to unsafe flight conditions. During slow-flight demonstrations, recover at the first indication of the approach to stall by alleviating the condition that caused the stall (decreasing the AOA, lowering the flaps, or decreasing the bank). However, this is not the primary method of stall recovery and is only used to enhance the effectiveness of the slow-flight demonstration. If a stall or approach-to-stall indication occurs at any other time or if the stall condition is not immediately alleviated, initiate a normal stall recovery. Excessively rough control movement at minimum airspeed or a delay in initiating recovery action after a stall or an approach-to-stall indication is recognized may result in an inadvertent spin.

5.15.2.1. **Straight-and-Level Flight.** To maintain straight-and-level flight, pitch attitude must increase to maintain altitude and power must increase to maintain airspeed.

5.15.2.2. **Control Effectiveness.** The aircraft will react more slowly to control inputs. Also, it will take more displacement of the control surfaces to achieve the desired aircraft response.

5.15.2.3. **Adverse Yaw.** Additional displacement of ailerons is required at slow airspeed to achieve the same aircraft response as at normal cruise airspeeds. This creates more drag and a noticeable yaw away from your direction of turn. Use coordinated rudder to correct adverse yaw.

5.15.2.4. **Turns.** The aircraft rate of turn is determined by the angle of bank and airspeed. The slower an aircraft moves through the air, the greater the rate of turn for any given angle of bank.

5.15.2.5. **Steep Turns.** At minimum flying speed, the increased wing-loading in a steep turn will cause a stall. This is clearly demonstrated by smoothly increasing bank while attempting to maintain altitude. Recover at the first indication of an approach to stall.

5.15.2.6. **Increasing Pitch Attitude.** This demonstration illustrates again the small margin between slow flight and stall. Any attempt to increase the pitch attitude will quickly result in a stall with or without effective stall warning, depending on the abruptness and magnitude of the pitch change. From straight-and-level slow flight, raise the nose slightly without increasing power. Notice how quickly the airspeed dissipates and stall warning begins. Lower the nose and regain slow flight airspeed at the first indication of the approach to stall.

5.15.2.7. **Raising the Flaps.** From full-flap slow flight, raise the flaps to the 50-percent position and maintain altitude. The aircraft will accelerate as a result of the reduced drag. Reestablish slow flight airspeed by returning the flaps full down and adjusting power, if necessary. Next, fully retract the flaps. To maintain altitude, the pitch attitude must be increased. As a result of the lower lifting capability (coefficient of lift) and low airspeed, the aircraft will stall. Recover at the first indication of the approach to stall by lowering the flaps or by a stall recovery.

5.15.2.8. **Coordination Exercise.** Coordinated flight during slow flight requires proper application of aileron, elevator, rudder, and power. While practicing slow flight coordination exercises, use approximately 15-degree banked turns, turning approximately 20 degrees to each side of a central reference point.

*Section 5C—Recoveries From Abnormal Flight*

**5.16. Recovery Procedures.** Throughout your flying career, but particularly during pilot training, you will occasionally find that maneuvers will not go as planned because of improper flight procedures and/or disorientation. You may arrive at a flight attitude and airspeed where you could lose aircraft control unless you initiate proper recovery procedures. This is especially true when flying aerobatic maneuvers. The key to recovery is early recognition of an improperly flown maneuver. When you recognize a deteriorating situation, apply the appropriate recovery procedures. Do not delay the recovery in an attempt to salvage a poorly flown maneuver.

5.16.1. **Cockpit Checks.** Before practicing these recoveries, ensure your loose equipment is stowed, the fuel boost pump is operating, and the area is cleared. If recoveries will be flown in a series, you do not have to check these items between individual recoveries.

5.16.2. **Recovery Setup Guidelines:**

5.16.2.1. During any abnormal flight recovery setup, IP vigilance is paramount. Do not compromise safe flight during IP demonstration or student performance of recovery training. In all situations where transfer of aircraft control is involved, follow the procedures in paragraph **1.6.**

5.16.2.2. Abnormal flight recovery training should be thought of in three phases of proficiency. These phases are not necessarily linked to a particular block of training, but are linked to the student's flying abilities and situational awareness. These three phases are:

5.16.2.2.1. Initially, the IP will demonstrate and fly the complete setup and recovery while delivering appropriate verbal instruction. Once the student has seen the recovery demonstrated and has a basic grasp of why the recovery training is performed, the IP will begin setting up recovery situations for the student and talking him or her through the recovery procedures.

5.16.2.2.2. When the student shows proficiency in the recovery procedures, the IP will then begin setting up observable situations requiring an abnormal flight recovery. When the setup is completely developed, the IP will transfer control of the aircraft to the student, using the verbal command "You have the aircraft—recover." The student will take the aircraft and recover from the abnormal attitude.

5.16.2.2.3. Once the student has seen all the different types of setups and can confidently and proficiently recover from various situations, the IP will set up the abnormal flight recoveries randomly throughout the area profile. Once the setup is complete, the IP will direct the student to take the aircraft with "You have the aircraft." The student will take the aircraft with proper transfer procedures and recover in the appropriate manner.

5.16.2.3. Once a student learns the correct stick and throttle inputs, building the judgment and ability to recognize abnormal flight and recognize the need to accomplish an abnormal flight recovery becomes paramount. The IP should concentrate on developing the student's situational awareness.

**5.17. Recovery From Inverted Flight.** The correct procedure to recover from inverted flight is to roll in the shortest direction to an upright attitude. When possible, maintain a fairly constant pitch attitude during the recovery. If you have low airspeed, let the nose of the aircraft lower while performing the rollback to the level-flight attitude. This prevents a stall and a potential excessive loss of altitude. Your IP will give you the opportunity to practice this recovery technique. He or she will fly the aircraft into an inverted attitude and then let you make the recovery. This will be practiced at various airspeeds. The correct recovery technique is a coordinated rollback (avoiding negative Gs) to level flight, not a split-S.

**5.18. 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 a sound recovery technique:

5.18.1. Recover from a nose-low attitude with smooth back stick pressure as you roll to a wings-level attitude. Do not apply back stick pressure unless the wings are less than 90 degrees to the horizon. Start the recovery before the airspeed approaches the aircraft limitations. Any time you are in a nose-low recovery situation with airspeed rapidly increasing, adjust the throttles to idle, extend the speed brake as required, and return the aircraft to level flight.

5.18.2. Other situations may occur with low airspeed and shallow pitch attitudes. In these instances, you may modify the recovery procedures to return to level flight with flying airspeed. Recovery should not involve the use of maximum allowable G forces unless the altitude available for recovery is critical. (Severe damage to the aircraft may result if design G limits are exceeded.) Increased wing-loading is identified by the increased seat pressure present when back stick pressure is applied. Airspeed and G-loading may increase during the pullout. Remember to perform a proper anti-G strain (paragraph **5.6.1.**).

5.18.3. Recover from a nose-low attitude smoothly without excessive airspeed or loss of altitude. When practicing a nose-low maneuver, do not exceed maximum allowable airspeed (275 KIAS). Remember, the airspeed does not stop increasing as you begin raising the nose. It may increase until just before level flight is attained. If you exceed limiting structural airspeed, abort the mission and make an entry in the AFTO Form 781. This writeup will result in an overall inspection of the aircraft's structure.

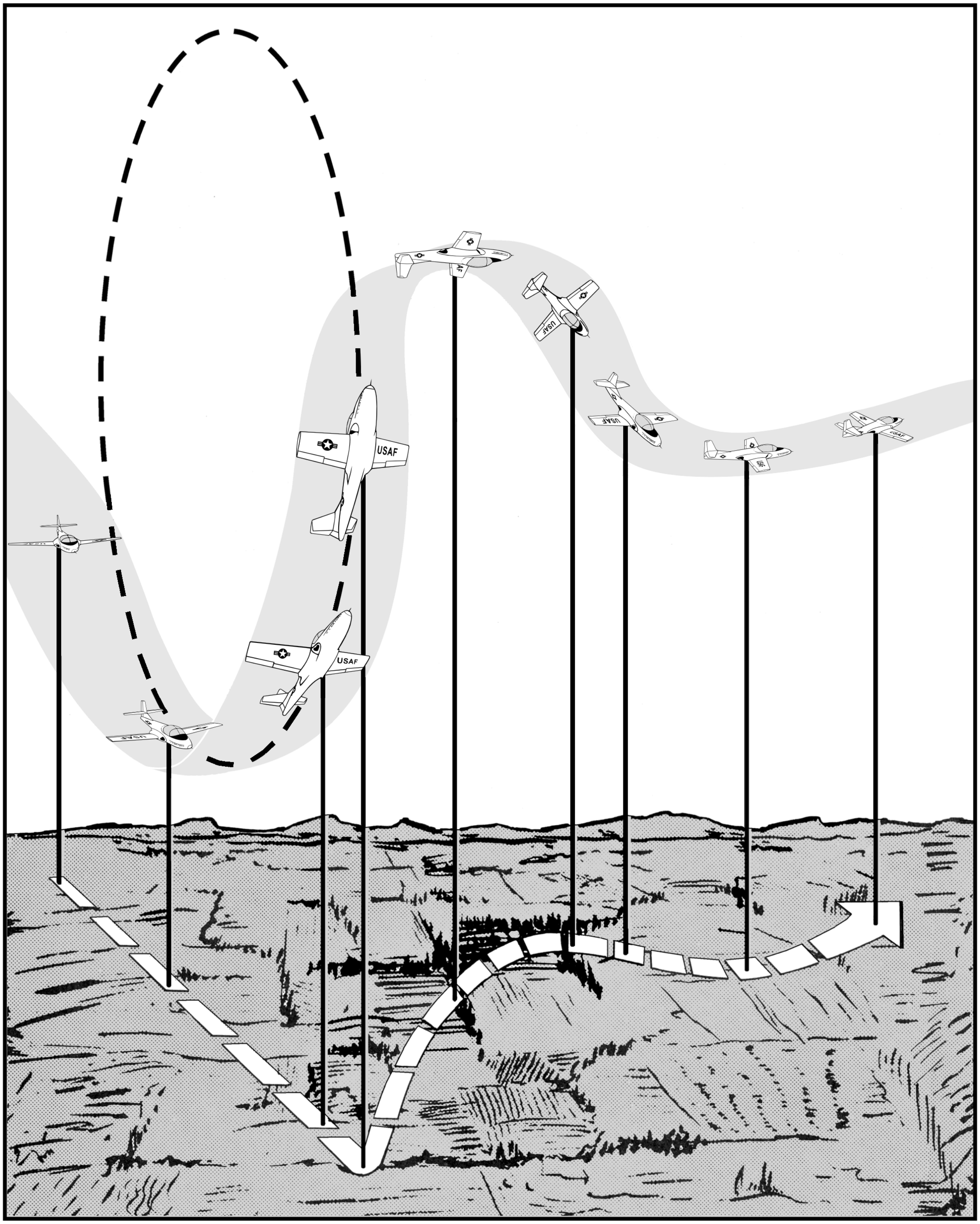
5.18.4. There is a potential for excessive altitude loss in any high-speed dive recovery. If the aircraft has progressed to a very high-speed dive, it is imperative to use idle power and the speed brake for recovery. If airspeed increases to a point where the aircraft exhibits longitudinal instability, use idle power, speed brake, and back stick pressure to prevent additional nose-down movements and excessive airspeed. If the critical Mach is exceeded, you must decrease airspeed before a recovery is made.

**5.19. Nose-High Recoveries:**

5.19.1. You will intentionally fly the T-37 through nose-high flight attitudes many times during aerobatic practice. Occasionally, because of improper control, 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 aircraft may enter an aggravated stall, which could result in a spin.

5.19.2. The objective of the nose-high recovery is to fly the aircraft to level flight as soon as possible without stalling. To do this, adjust power to military and initiate a coordinated roll with back stick pressure to bring the nose of the aircraft down to the nearest horizon. Depending on the initial airspeed and aircraft attitude, a wings-level, inverted attitude may be reached. As the nose approaches the horizon, roll to an upright attitude (**Figure 5.3.**). Depending on the airspeed, you may need to delay the rollout until the nose is definitely below the horizon. Attempt to avoid negative Gs.

**Figure 5.3. Nose-High Recovery.**



5.19.3. During nose-high situations when aircraft airspeed is too low or dissipating rapidly, normal recovery control inputs may not be possible without approaching or encountering a stalled condition. Under these conditions or during disorienting nose-high situations, use an unloaded recovery to return the aircraft to level flight. This is done by simultaneously advancing the throttles to military and neutralizing the flight controls.

5.19.4. After the controls are neutralized, expect airspeed to dissipate and the nose to lower as the aircraft seeks to regain flying airspeed. Initially, aircraft control authority will be minimal. However, as airspeed increases during the dive, control inputs will become more effective. Allow the nose to lower until you feel positive pressures on the controls. You may need to lower the nose near vertical during this stage of the recovery. Upon regaining flying airspeed, recover the aircraft to level flight. Keep in mind that an unloaded recovery may result in considerable altitude loss.

5.19.5. Initially, your IP will have you practice both techniques for recovery. As you gain proficiency, he or she will allow you to decide on the best technique for a given situation. At times you may 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.

**5.20. Runaway Trim Demonstration:**

5.20.1. This demonstration is designed to make you proficient in recognizing runaway trim conditions and to familiarize you with the handling characteristics of the aircraft with full trim deflection. Your IP will have you fly at cruise airspeed in straight-and-level flight while inducing full aileron trim deflection. After noting the control pressures necessary to maintain wings-level flight, slow to 110 to 150 KIAS and compare the control pressures at this reduced airspeed.

5.20.2. After the aircraft is retrimmed for straight-and-level flight at cruise airspeed, repeat the demonstration using full elevator trim deflection. As your proficiency increases, your IP will induce simulated runaway trim conditions while you are flying at various attitudes and airspeeds between 100 and 200 KIAS. You will be required to recognize the runaway trim condition, maintain aircraft control, and take proper actions.

***Section 5D—Aerobatics***

**5.21. Performing Aerobatic Maneuvers:**

5.21.1. Aerobatic maneuvers help you develop and perfect your technique for operating an aircraft to obtain maximum flight performance. These maneuvers should be smoothly executed and explore the entire performance envelope of the aircraft. You will learn aerobatic maneuvers to help you develop a more sensitive feel for the aircraft and to improve your ability to coordinate the flight controls and remain oriented, regardless of attitude. You will also learn to put the aircraft where you want it.

5.21.2. Learning to perform aerobatics skillfully will increase your confidence, familiarize you with all attitudes of flight, and increase your ability to fly an aircraft throughout a wide performance range. Aerobatics will also teach you to feel at ease when your body is oriented at any angle. You will realize you can think, plan, observe, and perform as easily inverted as upright.

5.21.3. Training emphasis will be on smoothness and proper nose track during the maneuver rather than on meeting exact entry parameters. Do your part to prevent loss of consciousness (LOC) episodes by avoiding unexpected, rapid, or abrupt control inputs when you are flying the aircraft.

5.21.4. Normally, you should use the specified entry parameters for aerobatic maneuvers, but you may make small adjustments to entry airspeeds and power settings when this would enhance energy planning or expedite the profile flow (**Table 5.3.**).

**Table 5.3. Summary of Entry Airspeeds and Power Settings for Aerobatics.**

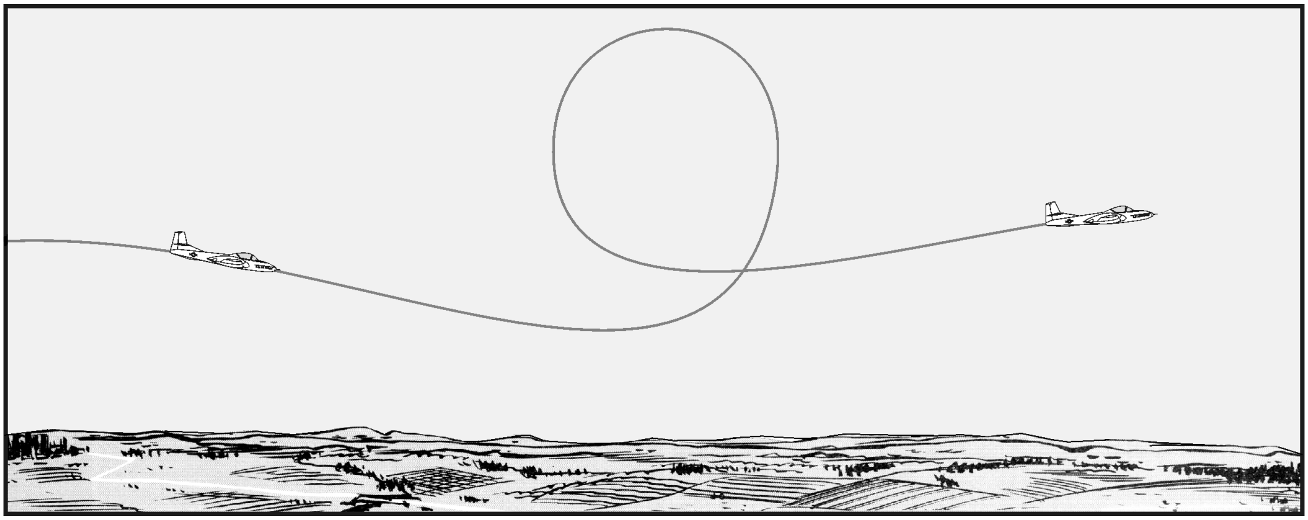
| ITEM | A | B | C |
|---|---|---|---|
| | **Maneuver** | **Airspeed (KIAS)** | **Power Setting** |
| **1** | Split-S (paragraph **5.24.**) | 120 | Idle to 90 percent |
| **2** | Aileron Roll (paragraph **5.23.**) | 220 | 90 percent rpm |
| **3** | Barrel Roll (paragraph **5.26.**) | | |
| **4** | Lazy Eight (paragraph **5.28.**) | | |
| **5** | Cloverleaf (paragraph **5.27.**) | | Military |
| **6** | Chandelle (paragraph **5.25.**) | | |
| **7** | Loop (paragraph **5.22.**) | 250 | |
| **8** | Immelmann (paragraph **5.29.**) | | |
| **9** | Cuban Eight (paragraph **5.30.**) | | |

5.21.5. Continually strive for precision and maximum use of outside references when flying these maneuvers. Normally, your left hand is on the throttles and your right hand is on the control stick. Avoid the use of a two-handed stick technique to maintain a wings-level attitude. Conscientious practice of these maneuvers will pay big dividends in providing you knowledge of control pressures, timing, and planning, all of which are necessary for precision flying. The minimum altitude for entry or recovery from aerobatic maneuvers is 5,000 feet above the terrain.

5.21.6. Before performing these maneuvers, ensure loose equipment is stowed, the fuel boost pump is operating, and the area is cleared. If flown in a series, you do not have to check these items between individual maneuvers. Simply ensure the area is clear and attain the entry airspeed for the maneuver.

**5.22. Loop.** The loop is a 360-degree turn in the vertical plane (**Figure 5.4.**). Because it is executed in a single plane, the elevator is the principle control surface used. The ailerons and rudder are used for coordination and directional control. The objective of the maneuver is to maintain a constant nose track.

**Figure 5.4. Loop.**



5.22.1. To remain oriented, select a road or section line for a ground reference. Align the aircraft with the reference and keep it aligned throughout the loop. Adjust the throttles to military and attain the entry airspeed of 250 KIAS.

5.22.2. Increase back stick pressure to pull the nose up at a constant rate. If you pull up too fast, you may exceed the critical AOA and stall. If you pull up too slowly, your airspeed will be slow over the top and you may stall. Centrifugal force will cause you to feel a definite seat pressure. Use this seat pressure (initially about 3 Gs on the accelerometer) to determine the correct rate of movement of the nose. (For example, if there is very little seat pressure, your pullup is too slow.)

5.22.3. Maintain the initial rate of nose movement throughout the maneuver by adjusting back stick pressure. As airspeed is depleted in the pullup, less back stick pressure is required to maintain a constant rate of nose movement. Use aileron and rudder pressure to keep the wings level throughout the maneuver.

5.22.4. When you can no longer see the horizon ahead, look at the wingtips and keep them equidistant from the horizon. After passing the vertical flight position, tilt your head back and watch for the horizon to appear. Use the horizon to maintain a wings-level attitude. Locate the reference on the ground that you used to begin the maneuver.

5.22.5. As the inverted position is attained, release some back stick pressure in order to maintain a constant rate of nose movement. Use aileron pressure as needed to keep the wings level. As the nose passes through the horizon and the aircraft reenters a dive, increase back stick pressure to return to a level-flight attitude. Throughout the last half of the maneuver, use the ground reference to maintain the desired vertical plane. It is not necessary to complete the maneuver at entry altitude or airspeed.

**5.23. Aileron Roll.** The aileron roll is a coordinated 360-degree roll performed in either direction. Adjust the throttles to 90 percent rpm, and attain the entry airspeed of 220 KIAS. Smoothly raise the nose to 20 to 30 degrees pitch attitude, relax back stick pressure, and initiate the roll by applying aileron and coordinated rudder pressure. After the aircraft begins the roll, continue coordinated control pressure to maintain the desired rate of roll. Make no attempt to keep the nose on a point. As you approach the wings-level attitude, gradually release aileron and rudder pressure to ensure a smooth, coordinated return to wings level.

**5.24. Split-S:**

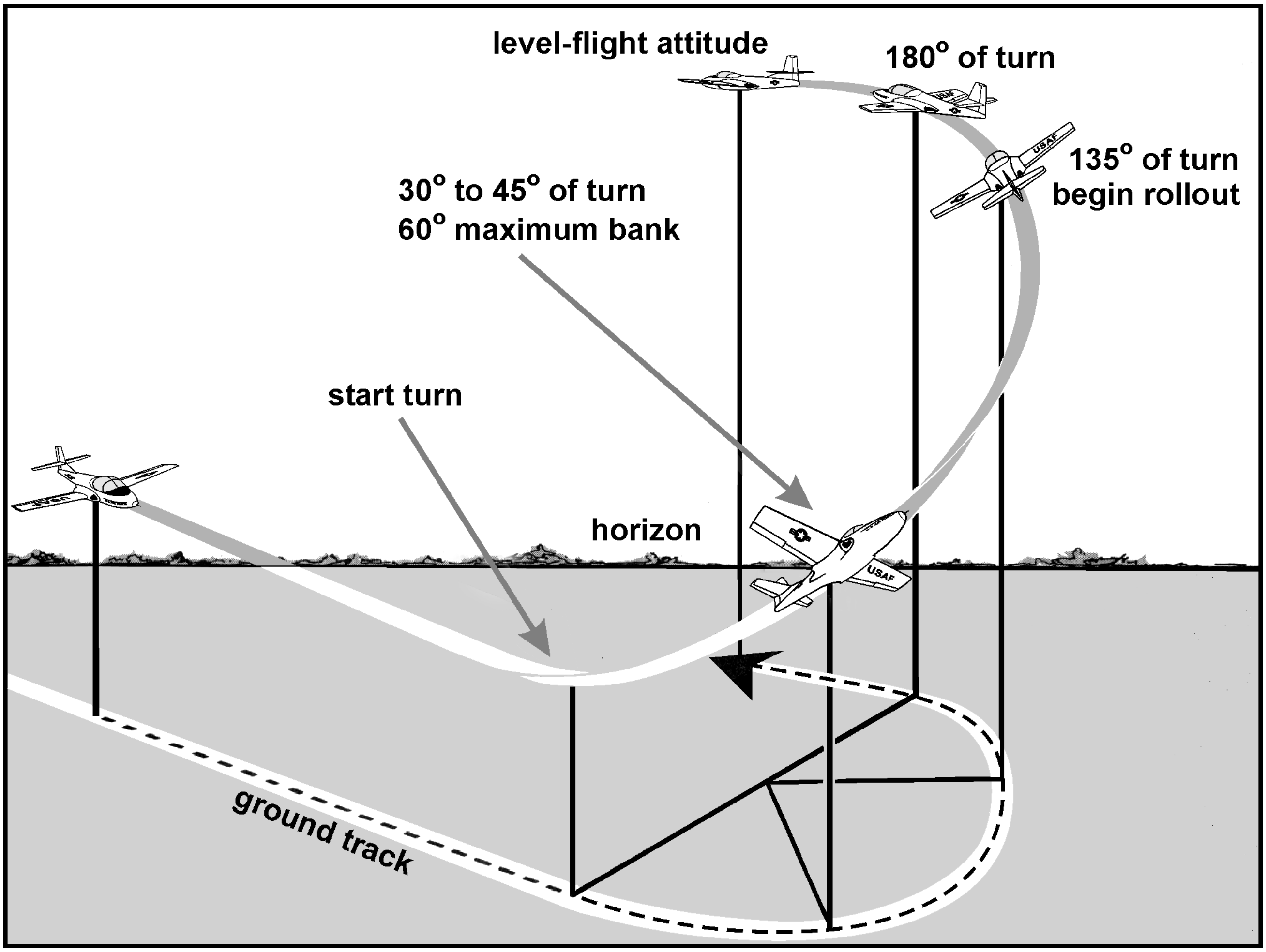
5.24.1. The split-S demonstrates how much altitude is lost if recovery from inverted flight is attempted in this manner. It is basically the same as the last half of a loop except you are max-performing the aircraft. Clear the area, keeping in mind that the aircraft climbs during entry and descends during recovery.

5.24.2. From straight-and-level flight, set power between idle and 90 percent and simultaneously raise the nose to a 20 to 30 degrees pitch attitude. When the airspeed approaches 120 KIAS, roll the aircraft to the wings-level, inverted attitude. From this attitude, apply back stick pressure to bring the nose through the horizon. Hold maximum back stick pressure without stalling the aircraft.

5.24.3. The speed brake is optional throughout the maneuver. Airspeed and G-loading will increase during the pullout. (Remember to perform a proper anti-G strain.) The maneuver is complete when the aircraft returns to level flight.

**5.25. Chandelle.** The chandelle is a precision 180-degree steep-climbing turn with a maximum gain of altitude (**Figure 5.5.**). Use military power for the maneuver.

**Figure 5.5. Chandelle.**




5.25.1. Look in the direction of the turn and clear while performing the maneuver. Enter the maneuver with the nose approximately 15 degrees below the horizon. When the airspeed reaches 220 KIAS, simultaneously blend rudder, aileron, and elevator pressure to begin a climbing turn. Allow the bank to keep increasing and the nose track to keep rising at a uniform rate. The nose should describe a straight line diagonal to the horizon.

5.25.2. The nose of the aircraft should pass through the horizon between 30 to 45 degrees of turn and, at this point, the aircraft should reach a maximum bank angle of 60 degrees.

5.25.3. Check the amount of turn by using outside references. Time the bank-and-pitch increase so that when the aircraft passes through level flight, your bank is approximately 60 degrees. (Cross-check the attitude indicator and outside references.) At this point, the vertical component of lift decreases, which requires considerably more back stick pressure to keep the nose rising at a uniform rate. Continue to observe the amount of turn by checking outside references. As soon as the 135-degree point in the turn is reached, start the rollout.

5.25.4. Allow the nose to continue to rise at a uniform rate. Some lift is gained by decreasing the angle of bank, and some lift is lost by decreasing the airspeed. These variables require constant changes in control pressures to keep the nose rising at a constant rate.

5.25.5. Continue to observe the amount of turn remaining before reaching the 180-degree point by checking outside references. Time the rollout so the wings become level and the nose reaches the highest pitch attitude at the 180-degree point. Hold this pitch attitude momentarily. Cross-check outside references to maintain your heading. Lower the nose to level flight for the existing airspeed. Airspeed should be above a stall and sufficient to maintain altitude.

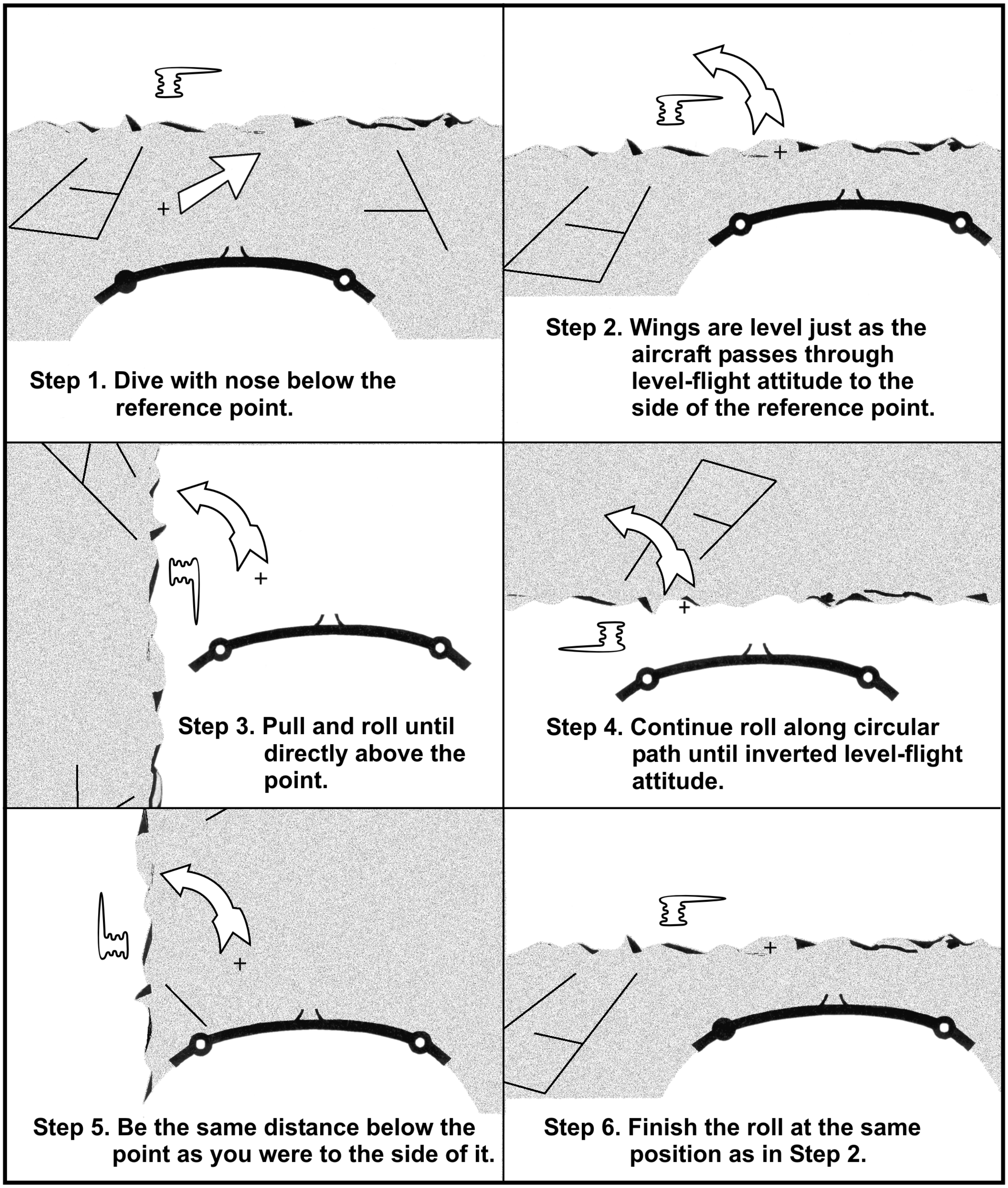
5.25.6. If the rate of climb is too fast, the aircraft will approach a stall before turning 180 degrees and the maneuver must be discontinued. If the rate of pitch change is too slow, the 180-degree point may be reached before the maximum pitch attitude is attained. If you plan to pull up fast, roll in fast. If you plan to pull up more slowly, roll in slowly.

5.25.7. One point must be emphasized—<u>when starting the maneuver, the rate of roll in is faster than the rate of pullup</u>. The result is a greater change in bank than in pitch from the beginning to the completion of the maneuver. The bank will increase to 60 degrees and then back to level. The total pitch change may only be 55 or 60 degrees The nose should describe a straight diagonal line to the horizon from the lowest point at the beginning of the maneuver to the highest point at the 180-degree position.

5.25.8. The maneuver should be timed so the nose will not have to be lowered to prevent a stall before the wings are leveled. After leveling the wings, complete the maneuver by lowering the nose to level flight before a stall occurs.

**5.26. Barrel Roll.** A barrel roll (**Figure 5.6.**) is a coordinated roll in which the nose of the aircraft describes a circle around a point on the horizon. Maintain definite seat pressure throughout the roll. Practice the barrel roll in both directions. There is little or no net loss or gain of altitude from the maneuver.

**Figure 5.6. View of Barrel Roll Around a Cloud.**




5.26.1. Select a reference point on or near the horizon—a cloud or a landmark. Attain the entry airspeed of 220 KIAS by diving the aircraft while clearing. Attain this airspeed with the nose of the aircraft below the reference point. Use 90-percent power during the maneuver.

5.26.2. Begin a coordinated turn in the opposite direction of the desired roll. Keep the aircraft nose below level flight until it has turned 20 to 30 degrees to the side of the reference point. Then begin rolling out of the initial turn and allow the nose to rise so the wings are level just as the aircraft passes through a level-flight attitude. At this point, the distance to the side of the reference point depends on the speed of the rollout. This distance should remain the same throughout the barrel roll.

5.26.3. From level flight, continue with coordinated stick and rudder pressure, causing the climb and bank to increase. As the wings reach the vertical attitude, the aircraft should be at its highest pitch directly above the reference point. After you pass this position, relax some of the back stick pressure, but continue the roll by blending in more aileron pressure. If you hold the same amount of back stick pressure as you did in the first quarter of the roll, you will put the nose down too fast in relation to the horizon because gravity is now assisting lift (downward). Plan the roll so the wings become level just as the aircraft reaches the inverted level-flight attitude.

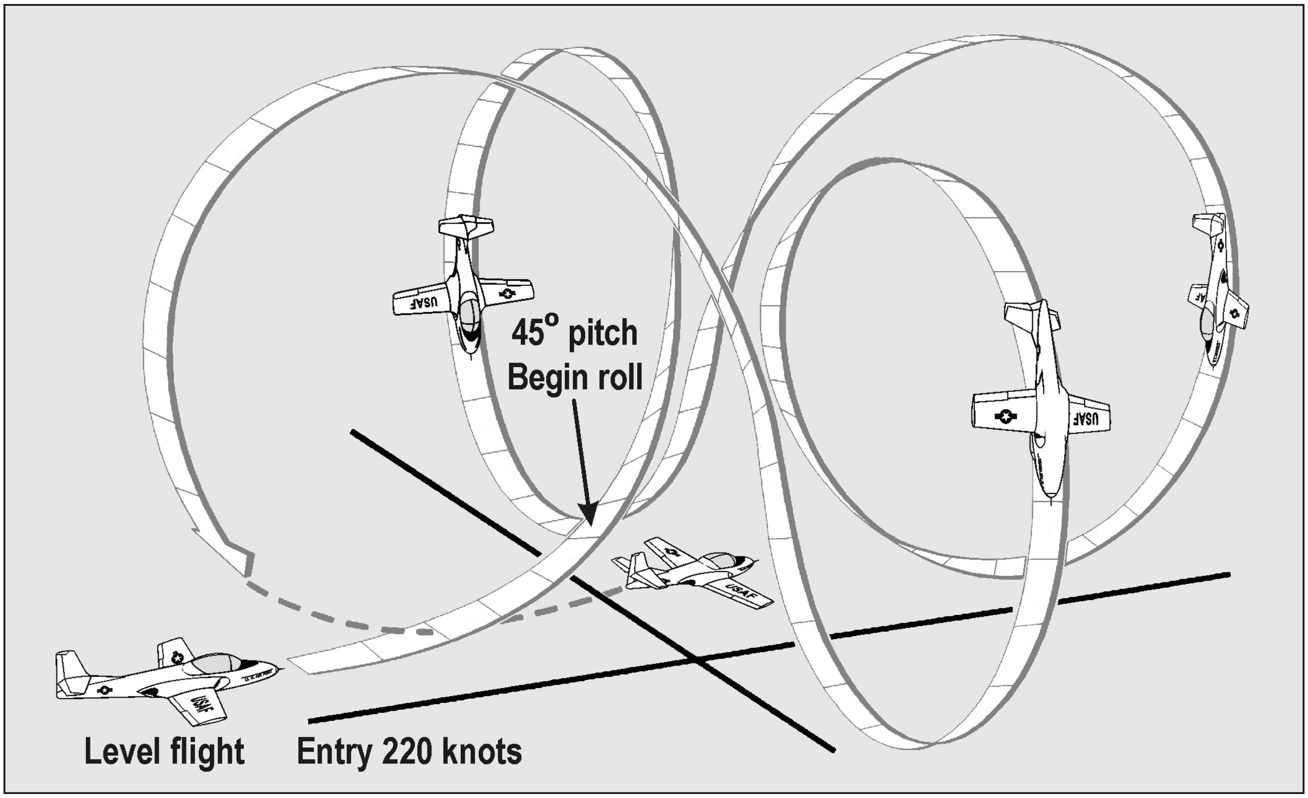
5.26.4. The aircraft nose track should now be the same distance on the opposite side of the reference point as it was at the beginning of the maneuver. The aircraft nose should have described a semicircle about the reference point. As the aircraft passes this position, continue the roll and begin applying increased elevator pressure.

5.26.5. As the wings again reach the vertical attitude at the bottom of the maneuver, the nose track should continue to be an arc of a circle with the reference point at its center. In this last quarter of the roll, begin to blend in more elevator and maintain coordinated control pressures to continue the roll so the nose track completes the circle around the reference point while positive seat pressures are held throughout the roll. The reason for blending in additional aileron pressure at the highest point of the roll is to maintain a constant rate of roll. Because the nose is rising continuously up to this point and the airspeed is decreasing, the aileron deflection is less effective than it was at the beginning of the maneuver. This means the rate of roll will slow down unless more aileron surface is presented to the relative wind. The rate of roll is held constant by the added aileron pressure.

5.26.6. These control effects apply to any rolling aerobatic maneuver, although they may be modified. It is the ailerons that roll the aircraft, and you should maintain a constant rate of roll throughout the maneuver. Do not over control with the rudder; use it only to maintain coordination. Throughout the maneuver, maintain coordinated flight and definite seat pressures.

**5.27. Cloverleaf.** The cloverleaf is composed of four identical maneuvers, each begun 90 degrees from the preceding one (**Figure 5.7.**). The top part of this maneuver is similar to the recovery from vertical flight. The lower part resembles a loop. This maneuver will help develop your timing, planning, and coordination, using outside reference.

**Figure 5.7. Cloverleaf.**




5.27.1. Perform the cloverleaf smoothly, without rapid rates of roll or excessive G forces. If possible, choose an area with section lines for easy reference. To begin the cloverleaf, adjust the throttles to military and attain the entry airspeed of 220 KIAS as the aircraft reaches level flight. The initial part of the maneuver is a straight pullup similar to a loop except for airspeed and lower G-loading.

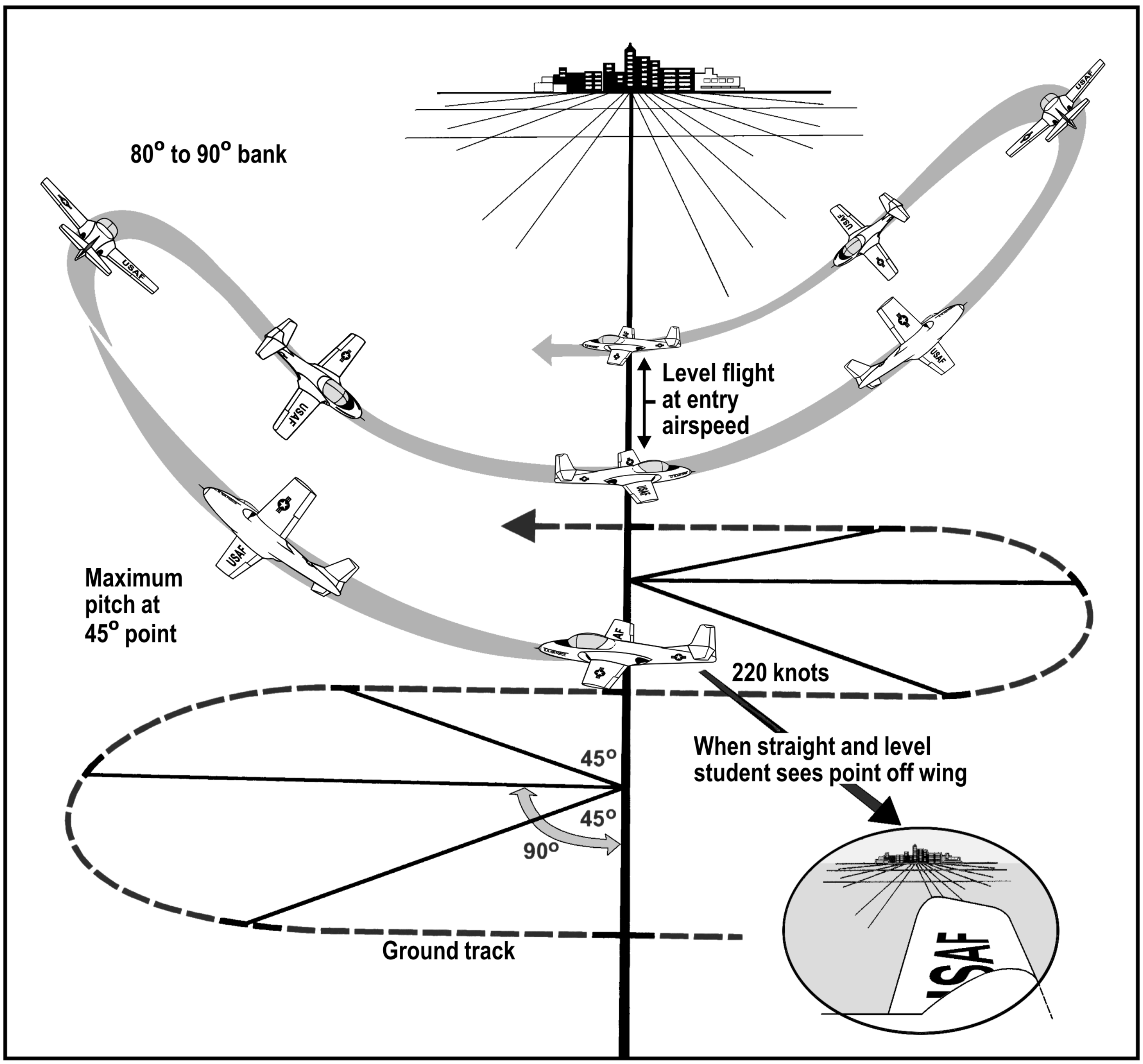
5.27.2. Pick your reference point 90 degrees from the nose. Start a climb and keep checking this point as you progress through the climb. As the aircraft reaches 45 degrees of pitch, begin a coordinated roll toward the 90-degree reference point. Allow the nose to continue climbing during the roll so the maneuver is fairly slow and lazy. Your first objective is to climb and roll so the nose passes through the reference point with the aircraft at wings level, inverted, and at a relatively low airspeed. (Do not stare at the airspeed indicator, but check it as you pass through your selected point.)

5.27.3. As the aircraft is brought through the 90-degree point, keep the wings level and pull through the bottom of the maneuver. Plan the pull to reach level flight with 220 KIAS. To avoid excessive Gs at the bottom of the pull, apply more back stick pressure as soon as the nose track descends below the horizon and hold sufficient back stick pressure to keep the airspeed from building up too quickly during the initial part of the pullout. You may have to release some back stick pressure in order to reach entry airspeed. If you let the airspeed build up too fast, you will probably exceed 220 KIAS and find yourself pulling high G forces in the pullout. Use increased back stick pressure early. Do it smoothly and avoid the buffet range. Buffet will not hurt the aircraft, but it is poor technique.

5.27.4. Having completed one quarter of the maneuver, again select a point 90 degrees from the nose and repeat the maneuver just described. Four complete loops in the same direction make the cloverleaf.

**5.28. Lazy Eight.** A lazy eight is basically a coordination exercise. It is a slow, lazy maneuver where the nose track of the aircraft describes a figure eight lying on its side at the horizon. The horizon line bisects this figure eight lengthwise. The maneuver includes a 180-degree change of direction and reversal, and it requires a continuous change of pitch and bank (**Figure 5.8.**).

**Figure 5.8. Lazy Eight.**




5.28.1. To execute the lazy eight, you must use constantly changing control pressure. This is due to the changing bank, pitch attitudes, and airspeeds. As an aid to making symmetrical loops, select a prominent point on the horizon or a ground reference such as a section line or road from which you can mentally project an imaginary intersection at the horizon. The more references you use, the easier it will be to perform good lazy eights and remain oriented in the area.

5.28.2. Look in the direction of the turn and clear while performing the maneuver. In straight-and-level flight with 220 KIAS airspeed and 90 percent rpm, select the desired reference point on the horizon. Align the aircraft so the reference point is directly off a wingtip. Blend aileron, rudder, and elevator pressures simultaneously to start a gradual climbing turn in the direction of the reference point.

5.28.3. The initial bank is very shallow to prevent turning too fast. As the nose is raised, the airspeed decreases, causing the rate of turn to increase. Also, as the bank is increased, the rate of turn will increase. Time the turn and pullup so the nose reaches the highest pitch attitude when the aircraft has turned 45 degrees or halfway to the reference point. Use outside references and the attitude indicator to cross-check these pitch-and-bank attitudes.

5.28.4. Do not hold the nose in this attitude, but lower it slowly to the horizon and toward the reference point. Continue to increase your bank to attain approximately 90 degrees as the nose reaches the horizon. Cross-check outside references and the attitude indicator for bank. The level-flight pitch reference point should reach the horizon at the 90-degree point. Keep a check on the progress of the turn by checking outside references.

5.28.5. The lowest airspeed will be encountered just as the nose reaches the horizon (approximately 100 knots below entry airspeed). Do not stop the nose at the horizon, but fly the aircraft into a descending turn so the nose track describes the same size loop below the horizon as it did above the horizon. When the nose track passes through the horizon, begin to decrease the bank gradually. When the aircraft has turned 135 degrees, the nose should have reached its lowest attitude. The bank should diminish during the descending turn at about the same rate as it increased in the climbing turn.

5.28.6. At the 135-degree point, 45 degrees of turn remain before the aircraft reaches a level-flight attitude. Continue blending sufficient stick and rudder pressure to simultaneously raise the nose and level the wings. Monitor the progress of the turn by checking your outside reference point. Plan to arrive at the 180-degree point in level flight with entry airspeed. The wings should become level as the aircraft reaches the level-flight attitude at the 180-degree point. ***NOTE:*** The beginning and ending of the maneuver are the only times the wings are in level-flight attitude.

5.28.7. Having completed half of the eight, the opposite wing is now toward the reference point and the nose at the 180-degree point, with entry airspeed. Do not hesitate in straight-and-level flight, but begin another climbing turn in the direction of the reference point. This turn is opposite to the one used at the start of the maneuver. Fly the second 180-degree turn like the first.

5.28.8. Complete the maneuver with the aircraft headed in the original direction. Complete the maneuver in a slow, smooth, lazy manner without hesitation and with constantly changing control pressures and flight attitudes. Try to use outside references to fly a precise nose track that results in a symmetrical maneuver.

**5.29. Immelmann.** The Immelmann is a half loop followed by a half roll, all flown in the same vertical plane.

5.29.1. To begin the Immelmann, adjust the throttles to military and select a ground reference, as explained in paragraph **5.22.1.** for the loop.

5.29.2. Enter a dive to gain airspeed. Then pull up to level flight with the entry airspeed of 250 KIAS. Continue the movement of the nose by increasing back stick pressure. Maintain a constant rate of movement of the nose throughout the pullup (initially about 3 Gs on the accelerometer). Maintain wings level with coordinated flight controls.

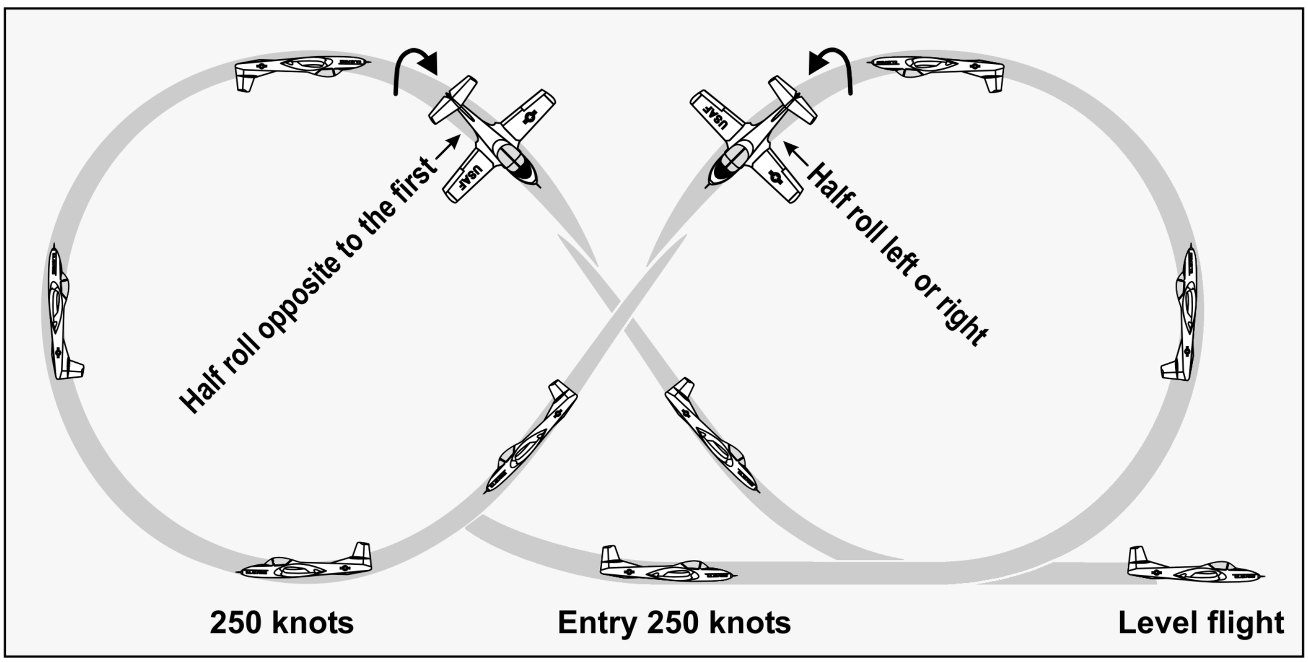
5.29.3. As the aircraft reaches a point approximately 20 degrees above the horizon inverted, apply aileron in either direction to initiate a roll to level flight. Through the first portion of the roll, the rudder should be opposite to applied aileron pressure. The rudder will be reversed and coordinated in the same direction as applied aileron in the last portion of the roll.

5.29.4. During the first half of the roll, relax some back stick pressure to keep the nose track in the same vertical plane. Increase this back stick pressure again as the level-flight attitude is approached because the nose will want to drop as the airspeed decreases. Increase the blended rudder pressure during the last part of the rollout to hold the nose in the vertical plane.

5.29.5. The maneuver is complete after a momentary pause in level flight following the rollout.

**5.30. Cuban Eight.** Each half of this maneuver is a slightly modified combination of the loop and the Immelmann. It is approximately the first five-eighths of a loop followed by a half roll. It is then repeated in the opposite direction (**Figure 5.9.**).

**Figure 5.9. Cuban Eight.**




5.30.1. Adjust the throttles to military and begin the maneuver by making a normal loop entry at 250 KIAS. Proceed over the top. After passing through inverted level flight, relax back stick pressure approaching 45 degrees below the horizon and execute a half roll in either direction. Use rudder pressure as in the Immelmann (paragraph **5.29.**) to hold the aircraft on the desired heading. Release elevator pressure to keep the nose track in the same vertical plane.

5.30.2. After completing the half roll, plan your pullup to attain 250 KIAS when passing through level flight. Continue the pullup into another loop entry. The second half of the Cuban eight is identical to the first except the roll is in the opposite direction.

5.30.3. The maneuver is complete when you attain level flight at entry airspeed.

***Section 5E—Spins***

**5.31. Spin Training:**

5.31.1. A spin is an aggravated stall resulting in autorotation. The aircraft describes a corkscrew path in a downward direction. Although both wings are stalled, one wing has more lift than the other. Gravity forces the aircraft down, rolling and yawing in a spiral path. Spin training will increase your confidence in the aircraft and improve your ability to orient yourself in any attitude.

5.31.2. Two conditions are necessary for the aircraft to spin, stall and yaw. Therefore, any time the aircraft is stalled, one of the conditions necessary for a spin exists. If the rudder is displaced from neutral during a stall, rotation will result. An important thing to remember throughout your training is that if controls are held neutral and the aircraft is not allowed to stall, it will not enter a spin or aggravated condition regardless of airspeed.

5.31.3. The aircraft will give sufficient warning of a spin. It is very easy to recognize a stall and an approach to a spin. Your IP will emphasize the conditions that could result in a spin and give you concentrated practice in spin prevention.

5.31.4. To avoid inadvertent engine shutdown while performing a spin recovery or spin prevention from an intentional or unintentional spin, remove your hand from the throttles after the power has been checked in idle. You may resume control of the throttles after the spinning stops and the dive recovery has been initiated.

**5.32. Stability Demonstration:**

5.32.1. This maneuver demonstrates that the aircraft will not enter a spin except from an aggravated stall. The first requirement for an aircraft to spin is a stall. As long as the aircraft is not allowed to stall, it will not enter a spin. Perform the pre-stall checks, adjust throttles to 90 percent, and clear the area. Raise the nose to a 70-degree pitch attitude. Your IP will point out the references used to maintain this attitude.

5.32.2. Control the direction of flight with the rudder and keep the wings level with the ailerons. Hold this attitude constant until flying airspeed is depleted (below 50 KIAS). Initiate the recovery by neutralizing all controls. Allow the nose to drop (approximately as low as it was high during the setup) until you feel positive pressures on the controls. (This is also the spin recovery cone.) This indicates the aircraft is regaining flying airspeed. Recover to level flight without stalling the aircraft.

5.32.3. The maneuver is complete when you have returned to level flight.

**5.33. Intentional Spin Entry:**

5.33.1. Before entering any intentional spin, do the pre-spin checks and adhere to the spin restrictions and TRs in AFI 11-2T-37, Volume 3. Use power as required during the initial part of the pullup for spin entry. However, if any power setting above idle is used during the pullup, retard the power to idle before or at the first stall indication. Establish a nose-high pitch attitude of 15 to 50 degrees. When more than 30 degrees of pitch is used, establish a 20- to 30-degree bank in the direction of the spin before the stall occurs.

5.33.2. At the first stall indication, slowly and smoothly apply back stick and rudder in the desired direction of the spin. When the aircraft begins to stall, move the stick at a rate that will maintain a constant pitch attitude until the stick is all the way back. Apply the rudder at a rate so full rudder occurs simultaneously with full back stick. Make sure you use full travel of the stick and rudder and hold the controls firmly against the stops with ailerons neutral.

5.33.3. As the aircraft becomes fully stalled, a variety of pitch oscillations may occur (depending on pitch attitude, direction, and fuel weight at entry). As the aircraft progresses into a fully developed spin, these pitch oscillations dampen out. There is not a definite number of turns, pitch attitude, rate of rotation, or airspeed that can be used to describe a fully developed spin in all cases. You will learn to recognize a fully developed spin through demonstration, practice, and knowledge of spins. Normally, the following will help you recognize a fully developed spin: the nose remains below the horizon, but not necessarily at a constant pitch attitude; the rate of rotation is almost constant; and the airspeed oscillates slightly (usually below 50 KIAS).

5.33.4. From a fully developed spin, the aircraft will progress into a stabilized spin if the controls are held against the stops. There is not a definite number of turns, pitch attitude, or airspeed to describe a stabilized spin. A stabilized spin is normally characterized by a steady airspeed, constant rate of rotation, and constant pitch attitude (approximately 40 to 45 degrees nose low). The altitude loss is approximately 550 feet per turn in a stabilized spin, and the duration of one turn is approximately 3 seconds.

**5.34. Normal Spin Recovery:**

5.34.1. Enter an intentional spin. As soon as the aircraft has progressed into a fully developed spin, proceed with the spin recovery procedures. (Do not wait for the spin to stabilize because this will result in excessive loss of altitude.)

5.34.2. Physically check that the throttles are in idle, rudder and ailerons are neutral, and stick is full aft.

5.34.3. Determine the direction of rotation, using the turn needle and outside references. Immediately after determining the direction of rotation, abruptly apply full rudder opposite the direction of the spin (opposite the turn needle) and hold. Do not wait for prominent landmarks before applying recovery rudder.

5.34.4. One turn after applying recovery rudder, abruptly move the stick full forward. As the nose pitches down near the vertical, neutralize the elevator while continuing to hold the rudder until spinning has stopped. Do not hold the stick against the front stop after the nose has reached the recovery cone because doing so may cause the aircraft to transit through the recovery cone and into a negative G stall, which could result in an inverted spin. However, do not allow the stick to move aft of neutral until recovery is effected. After the rotation is definitely stopped, neutralize the rudder and recover from the ensuing dive.

5.34.5. Do not bounce the stick off the forward stop or ease the stick forward, assuming the aircraft will recover. The primary objective is a positive recovery, not a smooth one.

**5.35. Spin Prevention:**

5.35.1. The spin prevention procedure is similar to a power-on stall recovery except the aircraft has started to rotate. This maneuver is designed to teach you to recognize and recover from a developing spin condition. It will also show you what may occur when stall recovery or spin prevention procedures are delayed. Your IP will have you initiate spin prevention procedures at varying degrees of rotation, but before stabilization.

5.35.2. Perform an intentional spin entry. Before stabilization, initiate the spin prevention by simultaneously using stick forces as necessary to break the stall, applying the rudder as necessary to eliminate the yaw, and physically checking the throttles in idle. Use ailerons to stop the roll only after the stall is broken. Then return the aircraft to level flight.

5.35.3. The degree of control deflection necessary to prevent the spin depends on how far the spin has developed. In some cases, full control deflection may be required. Do not use abrupt control movements, but use the controls positively. As the controls are applied, the rate of rotation may increase until the controls become effective. Applying stick forces as necessary to eliminate all stall indications is imperative because any degree of stall will reduce the possibility of a successful spin prevention.

5.35.4. If full prevention controls (rudder and elevator) are applied, the nose remains below the horizon, and the rotation stabilizes at an increased rate, the spin has developed too far for spin-prevention procedures to be effective. Consequently, a spin recovery will be necessary.

5.35.5. Spin prevention procedures are most effective when employed at the early stages of spin development. Stall and yaw conditions are easily controlled, rotation is slow, and the recovery is almost instantaneous. However, aircraft response to spin-prevention control inputs becomes slower as the spin nears full development. When this happens, increased time is necessary for the controls to become effective, rotation is more pronounced, and the nose may lower to the vertical attitude. At this point, a successful recovery is usually imminent. However, if the rotation stabilizes at an increased rate, the spin has developed too far for an effective spin prevention.

**5.36. Inadvertent Spins:**

5.36.1. It is important to realize that inadvertent spin entries are often more disorienting and oscillatory than planned entries. Also, the parameters in paragraphs **5.33.3.** and **5.33.4.** for rotation rates, descent rates, and pitch attitudes apply only to stabilized normal erect spins. Depending on control position, inadvertent spins may be accelerated and these parameters can vary. However, the spin prevention and spin recovery procedures are extremely reliable. Spin prevention will fail only if the spin is excessively accelerated due to control position and delayed initiation or due to slow control applications. The spin recovery procedure will always be effective if you perform it properly.

5.36.2. If you suspect an inadvertent spin, immediately employ spin prevention procedures. Control pressures may differ from those experienced during practice spin preventions because of the position of elevator trim or aircraft configuration. Therefore, be sure to use sufficient deflection to break the stall, control the yaw, and stop the roll. Inadvertent spin entries can result in severe pilot disorientation. In these situations, spin recovery procedures should be immediately employed. Under these conditions, using spin-recovery procedures will ensure a positive recovery and be more effective than a spin prevention.

5.36.3. If a landing configuration spin is inadvertently entered, immediately apply spin prevention procedures. If full prevention controls (rudder and elevator) have been applied, the nose remains below the horizon, and the rotation stabilizes at an increased rate, execute the spin recovery. Gear and flaps should be retracted as soon as possible after rotation stops to prevent excessive structural loads.

# Chapter 6

# TRAFFIC PATTERN AND LANDING

**6.1. General Guidelines.** You will do most of your T-37 flying at the home base and auxiliary field. Due to the number of aircraft operating at these locations, you must conform to established procedures and a standardized traffic pattern. The runway is the primary reference in the traffic pattern. Your IP will provide ground references at these fields to fly the patterns for existing conditions. You must learn how to adjust for winds and how to determine universal references that will work at any field. Use these references as aids in developing the judgment required to accurately estimate distances and glide path. The radio calls in this chapter are standard calls in the joint specialized undergraduate pilot training (JSUPT) environment. When not flying in this environment, use local procedures or standard Air Force terminology, as appropriate.

**6.2. Letdown:**

6.2.1. The letdown is primarily used to descend to traffic pattern altitude. Plan the letdown to enter the traffic pattern or to comply with approach directives.

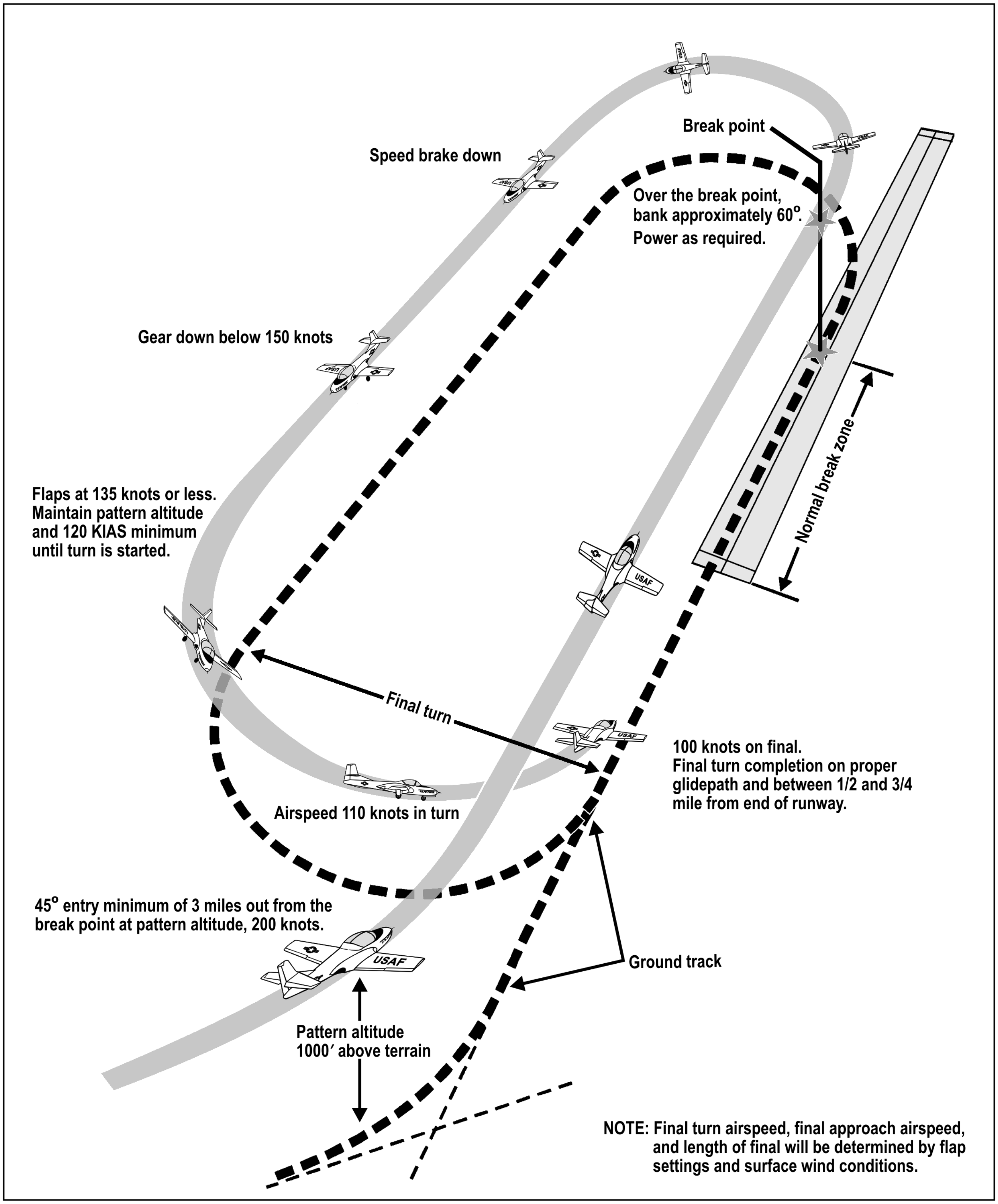
6.2.2. To begin a letdown, simultaneously lower the nose and adjust the power as necessary. The speed brake is optional. The airspeed in the letdown is normally 200 to 250 KIAS or as directed by approach control (within safe limits). This allows you to concentrate on the outside references and clearing during the descent.

6.2.3. An excellent technique to aid clearing during a VMC letdown is to use clearing turns. This also helps control descent rates. Your IP will demonstrate the proper letdown techniques.

6.2.4. A good lead point will allow you to accomplish a smooth leveloff at the desired altitude. One technique for determining a lead point is to use approximately 10 percent of the VVI. As you approach the leveloff altitude, gradually bring the nose of the aircraft to the level-flight attitude, trim the aircraft, and adjust the power and speed brake as necessary.

**6.3. Standard Overhead Pattern.** The 360-degree standard overhead pattern is used to safely and properly handle a maximum number of aircraft with minimum congestion (**Figure 6.1.**). The pattern should be adjusted for existing wind conditions.

**Figure 6.1. Normal Traffic Pattern.**



6.3.1. **Before Traffic Entry.** Before entering the traffic pattern, determine the landing direction by monitoring the appropriate radio frequency and watching other aircraft. If you are not sure of the direction of traffic, obtain landing instructions from the RSU, tower, or other controlling agencies. When the RSU or tower broadcasts runway winds, keep this information in mind because it directly affects how you fly the traffic pattern. Local regulations define traffic pattern entry procedures. You must adequately clear while descending to enter traffic.

6.3.2. **Initial Approach:**

6.3.2.1. When turning onto initial, plan the rollout so your ground track is aligned with the runway centerline or as directed. Initial altitude is normally 1,000 feet above the terrain and airspeed is 200 KIAS. Call "initial" to the controlling agency as directed and state your fuel remaining if you plan a full stop. Also call "no flap" or "zero flap" if practicing these types of landings.

6.3.2.2. The break is normally performed between approach end and 3,000 feet down the runway. The exact point of the break is affected by existing wind conditions and traffic saturation. When a T-37 on a straight-in approach is between 5 and 2 miles, do not initiate the break unless the controller allows you to do so because the two aircraft would be a conflict on final.

6.3.2.3. To accomplish the break, smoothly roll into a bank of approximately 60 degrees. The angle of bank and amount of back stick pressure will vary according to wind conditions. Adjust the throttles as required to slow the aircraft to 120 to 150 KIAS. Continue the level turn and roll out on the downwind with the necessary drift correction to maintain a flightpath parallel to the runway. During normal overhead patterns, lower the speed brake when rolling out on the inside downwind. However, strong headwinds or spacing requirements may require speed brake extension in the break.

6.3.3. **Downwind Leg:**

6.3.3.1. As you roll out on the downwind, extend the speed brake (if it is not already down). When the airspeed is 150 KIAS or below, lower the landing gear and make all gear-down checks. Use power as necessary to maintain airspeed and altitude.

6.3.3.2. The minimum airspeed on the downwind leg is 120 KIAS. As airspeed decreases to 120 KIAS, you will have to retrim the aircraft and increase the pitch attitude to maintain level flight (horizon line approximately one-quarter up the windscreen). With the speed brake and gear extended, approximately 82 percent rpm on both engines will maintain 120 KIAS.

6.3.3.3. After the gear is lowered and checked down and airspeed is 135 KIAS or below, place the wing flap lever in the down position before you begin the final turn. Check the indicator to ensure the flaps have started to lower. Fly normal patterns, using full flaps.

6.3.3.4. Do not start the final turn in the following cases: (1) if there is another aircraft in the final turn and not in sight, (2) if there is a straight-in inside of 2 miles and not in sight, or (3) if you cannot maintain normal pattern size and safe spacing. If you do not have the aircraft in front of you in sight, break out from the downwind leg, using local procedures.

6.3.4. **Final Turn:**

6.3.4.1. The final turn begins as you initiate the turn from the downwind leg. The turn is complete when the wings are level on final approach. Plan the final turn to roll out on final approach with a 4-degree glidepath. This equates to approximately 300 feet above the terrain at 3/4 mile from the approach end of the runway. The rollout on final can vary between 1/2 to 3/4 mile from the runway. Adjust the altitude lost during the final turn to establish a good glidepath.

6.3.4.2. Adjust the turn point for the existing wind condition. If a strong tailwind exists on downwind, remember that this will blow the aircraft from the approach end and a long final will result if the turn is started at the normal position. Before beginning the final turn, pick a specific rollout point on the ground. Begin your turn to final to arrive wings level on final over this point.

6.3.4.3. Starting the final turn, simultaneously lower the nose of the aircraft to approximately 2/3 ground and 1/3 sky and roll into approximately 30 degrees of bank. When the bank and pitch are set, the horizon should be in the upper one-third of the windscreen.

6.3.4.4. After starting the final turn, slow to 110 KIAS and trim the aircraft. Make a gear-down call to the controlling agency as soon as safely possible after confirming your configuration.

6.3.4.5. In the final turn, divide your attention between the airspeed indicator, rollout point, and runway. Visualize and project your descent angle around the final turn, over the rollout point, and down the final approach. The descent angle, projected to the ground, will be to a point just short of the intended touchdown point.

6.3.4.6. Because of crosswinds, it may be necessary to vary bank angle in the final turn. You may increase the bank up to 45 degrees, but remember that the stall speed of the aircraft will increase. If you have any doubt about the safety of continuing the approach, go around.

6.3.5. **Final Approach:**

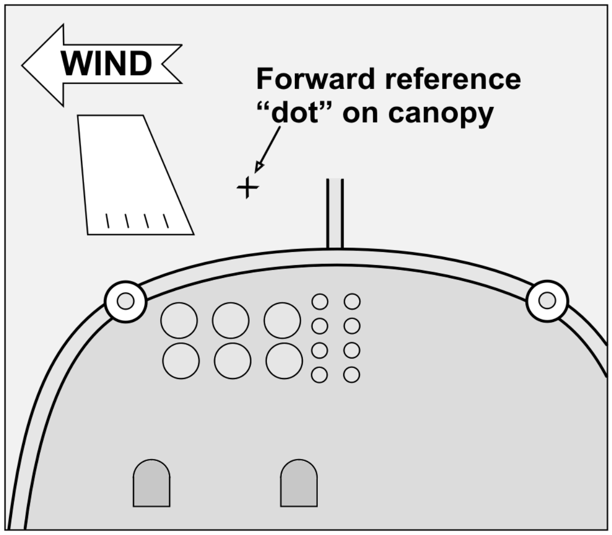
6.3.5.1. The final approach begins when the wings are level after the final turn. On final approach, slow to and maintain 100 KIAS and trim. Check your spacing with the aircraft ahead of you on final approach. If it appears you will not be able to land with proper spacing, anticipate the need to go around and make a timely decision.

6.3.5.2. After rolling out on final and aligned with the runway, you have three objectives: (1) to maintain runway alignment, (2) to maintain final approach airspeed, and (3) to maintain a smooth, constant glidepath (aimpoint) to roundout and touchdown.

6.3.5.3. The pitch attitude on final approach is slightly shallower than the pitch attitude in the final turn. Consequently, you must raise the nose of the aircraft to establish the correct glidepath. A good final approach pitch reference is the runway threshold halfway up the windscreen. Plan to maintain a minimum of 50 percent rpm on final.

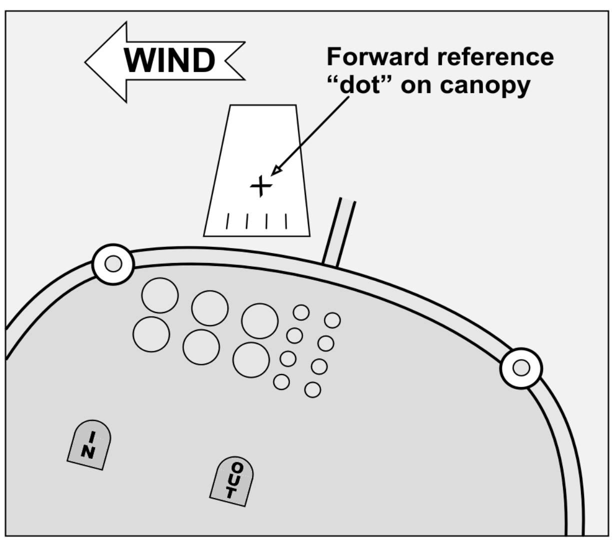
6.3.5.4. On final approach, as in the final turn, the aircraft is affected by wind; but the flightpath must coincide with the desired ground track. Because there is almost always a wind condition that is less than optimum (blowing straight down the runway), you may need to compensate to maintain runway alignment. There are two ways to do this—the wing-low method and the crab method. In the T-37, use the crab method as you roll out on final. Then transition to the wing-low method. The normal inclination is to automatically roll out of the final turn with a crab into the wind (**Figure 6.2.**).

**Figure 6.2. Crab Into the Wind.**




6.3.5.5. Rolling out on final with a crab into the wind indicates how much control deflection is needed for transition to the wing-low method. Set up the wing-low crosswind approach shown in Figure 6.3. (The T-37 landing gear struts are not stressed to continually withstand the side loads imposed by a crab landing.)

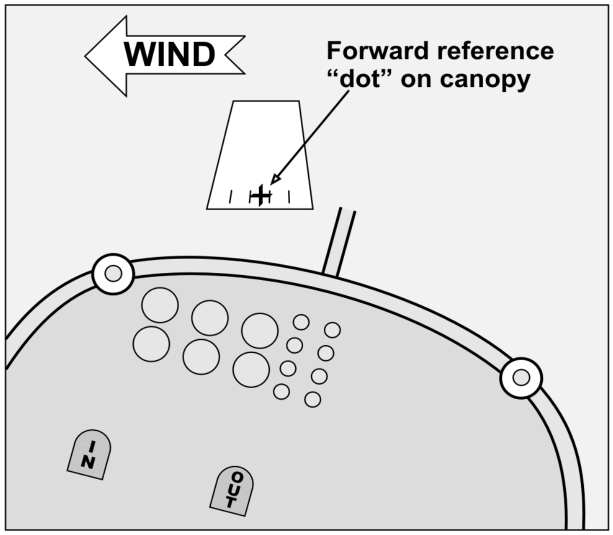
**Figure 6.3. Wing-Low Approach.**




6.3.5.6. The proper method for using crosswind controls is to apply sufficient rudder deflection to align the longitudinal axis of the aircraft with the runway. Use the ailerons as necessary to keep the flightpath aligned with the runway. Maintain airspeed by increasing the power to compensate for the increased drag caused by crosswind controls.

6.3.5.7. The most difficult objective is visualizing a constant glidepath to the roundout and touchdown position. In the normal landing configuration (full flaps), the T-37 flight attitude is such that the aircraft is aimed (putting the level flight horizon reference) at a position (aimpoint) short of the intended touchdown point (**Figure 6.4.**). You should aim short of the intended touchdown point because of the delay during the roundout.

**Figure 6.4. Aiming Short of Touchdown Point.**




6.3.5.8. Plan to touch down within the first 1,000 feet of the runway. This does not mean that routinely landing in the first few feet or 1,000 feet down the runway is acceptable. Your main objective is to strive for a touchdown with the proper landing attitude at a point on the runway that provides an adequate safety margin against landing short, yet allows the aircraft to easily stop within the available runway. In determining your aimpoint, consider all factors (wind, runway length, aircraft weight, flap setting, etc.).

6.3.5.9. Frequently check the airspeed on final approach. Because the T-37 engines accelerate slowly, plan the pattern to maintain a minimum of 50 percent rpm on final until the landing is ensured.

6.3.5.10. If you land in a gusty wind condition, use half flaps and increase final approach airspeed to 110 KIAS. Half flaps provide better control. The aircraft may float farther than normal before touchdown because of the configuration and extra airspeed.

6.3.5.11. There are several differences between a heavyweight and lightweight aircraft during final approach. Although minimum airspeeds remain the same, lift requirements change with differences in aircraft gross weights (fuel on board), as follows:

6.3.5.11.1. A heavyweight aircraft has a higher lift requirement and will develop a sink rate quicker than a lighter aircraft. This sink rate can only be stopped with combined corrections of pitch and power.

6.3.5.11.2. At heavier weights, the added lift requirement increases the amount of time between power application and the effect of this power application in stopping the sink rate. In addition, the higher stall speed will decrease the time lapse between a pitch increase and the actual stall. In the T-37, stopping a sink rate is a problem due to slow engine acceleration. During a no flap, the power setting will be lower than during a normal pattern due to the decrease in drag devices. This is important because, when the power is back, it takes longer for the engines to accelerate when the throttle is moved forward.

6.3.5.12. Adhere to minimum airspeeds, plan the pattern to avoid high sink rates, and recognize extra time is required to stop a sink rate as it develops on final.

**6.4. Normal Landings.** To better understand the factors affecting your judgment and technique, the landing is divided into three phases; roundout, touchdown, and landing roll, as follows:

6.4.1. **Roundout:**

6.4.1.1. During the roundout, decrease the rate of descent as you approach touchdown. Smoothly continue back stick pressure to increase the pitch attitude until the proper landing attitude is reached. When making a roundout, you are decreasing the airspeed so the aircraft will settle gently onto the runway. Retard the throttles to the idle position at or before touchdown.

6.4.1.2. The rate of descent will affect the height at which you start the roundout. Make the roundout proportionate to the apparent rate of descent. Your IP will show you the height at which to start a roundout with different rates of descent.

6.4.1.3. Throughout the roundout, be aware of the effects of crosswinds. If crosswinds exist, you must use crosswind controls throughout the roundout. As the airspeed decreases to just above the stall, you may need additional aileron and rudder deflection. If the control surfaces are deflected out of their normal streamlined position, they will add drag, airspeed will dissipate much faster, and stall speed will increase. Use caution during gusty wind conditions for rapidly changing wind direction and velocity. Timely control inputs are needed to maintain directional control.

6.4.1.4. Power can be used effectively during the roundout to compensate for errors in judgment. Any time the controls feel mushy or you feel approach-to-stall indications you learned from traffic pattern stall training, apply power and execute a go-around. This will cushion any ensuing touchdown. If it appears that you are going to land excessively long, advance the power and go around.

6.4.2. **Touchdown:**

6.4.2.1. A touchdown is the gentle settling of the aircraft onto the runway in the landing attitude. Continue to hold any crosswind control deflection used during the roundout. If you do not, the aircraft will crab into the wind and you will touch down in a crab. When using crosswind controls, expect one main gear to touch down before the other.

6.4.2.2. If crosswinds are not significant, maintain the landing attitude after touchdown. This will require increasing back stick pressure as airspeed dissipates. Leave flaps down and speed brake and thrust attenuators extended to take advantage of increased drag and reduced thrust.

6.4.2.3. Lower the nosewheel to the runway while there is still sufficient elevator control and before reaching minimum nosewheel touchdown speed. Avoid lowering the nosewheel abruptly. If it contacts the runway on touchdown, leave it there. Attempts to lift it off at high speeds may cause the aircraft to become airborne with a dangerously high AOA.

6.4.2.4. If power was used during the roundout to decrease the rate of descent or prevent a stall, retard the throttle to idle upon touchdown so the aircraft will stay on the ground.

6.4.3. **Landing Roll:**

6.4.3.1. After the nosewheel is on the runway, retract the speed brake unless maximum braking is desired. Initially maintain directional control with rudder and/or brakes.

6.4.3.2. Normally, avoid nosewheel steering until the aircraft has slowed to normal taxi speed. When you engage the nosewheel steering, center the rudder pedals before depressing the nosewheel steering button. At high airspeeds, nosewheel steering is extremely sensitive and easily overcontrolled. Before reaching taxi speed, use nosewheel steering only if you are unable to maintain directional control with the rudder and brakes on the landing roll. If you encounter nosewheel shimmy during the landing roll, continue to apply forward stick pressure to place more weight on the nose gear.

6.4.3.3. Familiarize yourself with the factors that influence the controllability of the aircraft after the landing. Some of these factors are the center of gravity, strong crosswinds, a low strut, and a slippery runway. As you slow down, your flight controls lose their effectiveness, thus increasing the effect of the crosswind. The T-37 has more surface area behind the main landing gear than in front. After the aircraft is on the ground, the main landing gear is the fulcrum point, and the impact of the crosswind on the side area will cause the airplane to act as a weather vane and turn into the wind. You can see how important it is to use the rudder and/or brakes to maintain directional control during the landing roll.

6.4.3.4. You must also use aileron to prevent the crosswind from lifting the upwind wing. If you use too much aileron, the other wing will start to rise. However, at the time rudder effectiveness is lost, full aileron deflection may be necessary.

6.4.3.5. During any ground roll, you can change direction by applying pressure on a single brake or uneven pressure on both brakes. You must use caution when applying the brakes to avoid overcontrolling. To use the brakes, slide your feet up on the rudder pedals so toe pressure can be applied to the top of the pedals. If rudder pressure is being held at the time the brakes are needed, try to hold the rudder pedals in position as you slide your feet up. The brakes work independently of the rudder pedal position. For instance, it is quite possible to hold the right rudder and the left brake, although such a requirement is not likely.

6.4.3.6. Later in the landing roll, use the brakes to slow the aircraft. Apply smooth and continuous pressure until the aircraft slows to taxi speed. Do not brake to a near halt and then taxi with power for the remainder of the landing roll. Nosewheel steering is not normally necessary until the aircraft has slowed to normal taxi speed. Center the rudder pedals before depressing the nosewheel steering button.

6.4.3.7. At the end of the landing roll, clear behind you and turn off the runway onto the taxiway. It is permissible to raise the speed brake during the rollout, but do not complete any other checklist items until you are clear of the runway. Concentrate on maintaining directional control and slowing the aircraft to a safe taxi speed.

6.4.3.8. While taxiing to the parking area, you may shut down the ramp-side engine. When an engine is shut down, check the hydraulic pressure. If hydraulic pressure is lost, stop the aircraft on the taxiway, shut the other engine down, and have the gear safety pins installed before the aircraft is towed to the parking area.

**6.5. Touch-and-Go Landings:**

6.5.1. For touch-and-go landings, simultaneously retract the speed brake and smoothly apply power as soon as the main gear touches down. Hold the nosewheel off as long as airspeed does not decrease below nosewheel touchdown speed. Maintain directional control with rudders. Lower the nose slightly from the landing attitude to the takeoff attitude as the throttles are advanced. Coordinate pitch and power so the aircraft will not become airborne prematurely with too low an airspeed. Do not allow the aircraft to leave the ground before the engines are completely spooled up. After becoming safely airborne, perform the after-takeoff checklist.

6.5.2. If it appears you are going to land long, advance power and go around. Because the T-37 accelerates slowly, the aircraft may continue to settle and touch down. In this event, do not try to hold the aircraft off the runway in a nose-high attitude. Maintain a landing attitude and allow a normal touchdown.

6.5.3. If you have trimmed the elevator properly on final approach, the back trim will tend to fly the aircraft off as flying speed is attained. You may have to use forward stick pressure to compensate for the tendency of the nose to pitch up, but the force is not strong. Do not retrim the elevator during the ground roll.

**6.6. Single-Engine Procedures.** Your IP will give you simulated single-engine practice by placing one throttle in the idle position. You will call out and simulate the necessary procedures as directed by your IP. Minimum single-engine airspeed is 100 KIAS with the gear down and wing flaps extended 50 percent or less. However, maintain 110 KIAS on final approach to provide better controllability and allow for more airspeed in case a go-around becomes necessary.

6.6.1. **Simulated Single-Engine Pattern and Landing:**

6.6.1.1. Execute the break and retard the throttle to slow the aircraft. Continue a level turn to the downwind leg. The speed brake is not normally used. However, it can be used as required to control airspeed. If it is extended, the thrust attenuators would remain out throughout the pattern. Using the speed brake in a single-engine situation adds drag at a time when thrust is critical.

6.6.1.2. Roll out on the downwind leg and establish a drift correction if necessary. With airspeed below 150 KIAS, place the landing gear handle down. Continue to maintain altitude and make all gear down checks. Use power as necessary to maintain altitude and a minimum of 120 KIAS on downwind until the final turn is initiated. Rudder pressure may be necessary to maintain coordinated flight due to unequal thrust. The downwind leg is slightly wider than in the normal pattern to allow for the increased glide ratio resulting from half flaps and the absence of the speed brake in the final turn. After the gear is down and checked, place the wing flap handle to 50 percent at an airspeed of 135 KIAS or less before initiating the final turn.

6.6.1.3. Complete the final turn as you would for a standard overhead pattern. As you begin the final turn, adjust the throttle as necessary and set the pitch attitude and bank angle. The airspeed will gradually decrease to 110 KIAS as the final turn progresses. Maintain 110 KIAS in the final turn and on final approach. It is important to maintain the proper pitch attitude to reach the desired final glidepath.

6.6.1.4. As you roll out on final approach, adjust the pitch attitude to place the runway threshold in the middle of the windscreen (as you did on the normal final approach) and add rudder to maintain runway alignment. With a low power setting and only one engine, you must anticipate the need for power and lead your throttle inputs to maintain the desired airspeed. Plan to maintain a minimum of 50 percent rpm on final.

6.6.1.5. During an actual single-engine recovery, power required on the good engine throughout the final turn and approach may be higher than in a simulated single-engine landing.

6.6.1.6. Use half flaps for single-engine patterns and landings. You may use the speed brake on final approach after the landing is ensured. Also, you may use full flaps after landing is ensured to prevent landing long. Remember, as power is reduced for landing, the rudder pressure used to maintain runway alignment must normally be decreased. Changes in rudder pressure can occur quite rapidly if you reduce power abruptly.

6.6.1.7. Plan the simulated single-engine touchdown in the first 1,000 feet (like in the normal pattern). However, ensure the emphasis is on the proper touchdown attitude rather than a fast landing in the first 1,000 feet. A touchdown on speed (proper touchdown attitude) within the first 1,500 feet of the runway is acceptable under normal circumstances.

6.6.1.8. Touch-and-go landings are authorized from simulated single-engine approaches if power is applied to both engines after touchdown.

6.6.2. **Single-Engine Go-Around:**

6.6.2.1. Although this maneuver will not be practiced, your IP will discuss the correct technique. The importance of an early decision cannot be overemphasized because of the greatly reduced performance with only one engine available.

6.6.2.2. During a go-around initiated below 300 feet above the terrain, it is probable that the aircraft will contact the runway regardless of your intentions. It is imperative you retract the speed brake immediately (in accordance with boldface procedures) upon deciding to go around. You must use the rudder to maintain coordinated flight during the go-around. Additionally, slowing to 100 KIAS may reduce the decent rate allowing you to clean up the aircraft faster. Be careful and remember that the minimum single-engine airspeed is 100 KIAS. Your aim is to reduce drag which enhances your ability to reduce the descent rate and/or accelerate.

### 6.7. No-Flap Pattern and Landing:

6.7.1. The no-flap pattern is flown to simulate the loss of hydraulic pressure. The procedures for entry, initial approach, and the break are the same as in the normal overhead pattern, except you should call no flap on initial or when established on closed downwind.

6.7.2. The downwind leg is longer and wider than in the normal pattern. When the airspeed reaches 150 KIAS or less, lower the gear and perform all gear down checks. Adjust the throttles as necessary to maintain a minimum of 120 KIAS until you start the final turn. Initiate the turn by adjusting both throttles as necessary and setting the proper pitch attitude and bank angle. The horizon will be approximately in the middle of the windscreen. Airspeed will gradually decrease to 110 KIAS. (When above 1,400 pounds of fuel, maintain a minimum of 120 KIAS in the final turn.)

6.7.3. Plan the final turn to rollout on final with a good glidepath. Rolling out on final, you will have to increase the pitch attitude slightly to place the runway threshold approximately in the lower one-third of the windscreen. The no-flap glidepath is shallower than a normal glidepath. It is approximately 3 degrees, which equates to approximately 300 feet above ground level (AGL) at 1 mile from the approach end of the runway. The rollout on final can vary between ¾ to 1 mile from the runway.

Adjust the altitude lost during the final turn to establish a good glidepath. Also adjust the starting point for the final turn for wind. A longer final approach is necessary to compensate for reduced drag. Adjust power as necessary to maintain 110 KIAS (120 KIAS final turn when above 1,400 pounds of fuel) during the final turn and on final approach. Plan to maintain a minimum of 50 percent rpm on final.

6.7.4. Do not set up a long nose-high, dragged-in approach. The most important thing is airspeed control. Remember, stall speed increases with no flaps and/or high fuel weights.

6.7.5. Plan the final approach so you cross the end of the runway a few feet above the ground. Retard the throttles to idle when the landing is ensured. The aircraft will float longer and the landing attitude will be slightly more nose-high compared to a landing with flaps. Plan your no-flap touchdown in the first 1,500 feet of the runway with a proper touchdown attitude. Use caution as you round out and touch down during no-flap landings. If an excessive flare is used, you might land on the aircraft's tail skid or encounter a stall. This will occur if the aircraft's pitch is raised to a point where the glare shield reaches the horizon as you look over the nose of the aircraft.

**6.8. Landing on Alternate Sides of the Runway.** When landing on alternate sides, plan to land near the center of the runway. The side of the runway closest to your turn off the runway is known as the "cold" side; the side away from the turn off is the "hot" side. If traffic permits and the approach and landing for a touch-and-go or full stop will not affect spacing criteria, you may land in the center of the runway.

**6.9. Go-Around.** Sometimes during traffic pattern and landing practice, you will find yourself poorly positioned. In this case, discontinue your approach for reasons of safety and execute a go-around. Although you can abort an approach at any point, a go-around is usually executed from the final approach or roundout. The sooner a poor landing condition is recognized and the go-around is started, the safer you will be. Do not wait until the last second to make a decision, and do not try to salvage a bad approach. Ideally, there should be little need for a runway supervisor to direct a go-around. You should execute a go-around when a dangerous condition is encountered. Examples of dangerous conditions are low final turns, overshot final turns, wake turbulence, distracted attention, and other aircraft too close.

6.9.1. **Final Approach or Landing Go-Around:**

6.9.1.1. The correct method for executing a go-around from the final approach or landing phase is to simultaneously advance the throttles to military power and retract the speed brake. Depending on your airspeed, you may need to advance the throttles to a power setting less than military to prevent overspeeding the flaps and landing lights. When you are sure you will remain airborne and have reached 100 KIAS, retract the landing gear and (if applicable) turn off the landing lights.

6.9.1.2. After ballooning or bouncing, a second touchdown may occur. Under these conditions, you might consider delaying gear retraction. Remember to call "gear clear" on dual sorties. When the gear handle is up and a minimum airspeed of 110 KIAS is attained, raise the flaps. As the flaps retract, raise the nose slightly to offset any tendency of the aircraft to sink. Clear the runway if necessary to avoid overtaking an aircraft ahead of you. (***EXCEPTION:*** It is not necessary to clear the runway during a go-around if the runway is clear of other aircraft.)

6.9.1.3. After attaining a safe altitude and airspeed, smoothly roll into a shallow banked, coordinated turn and turn approximately 20 degrees. When you are well clear of the runway, execute another turn to realign yourself with the runway. The direction of these clearing turns will depend on local procedures at your base.

6.9.1.4. Allow the aircraft to accelerate to 150 to 200 KIAS, and climb or descend to 500 feet above the terrain during the go-around until you are beyond the departure end of the runway or as directed locally.

6.9.2. **Final Turn Go-Around:**

6.9.2.1. The procedures for a go-around from the final turn are usually performed after rolling out on final approach. In the final turn, use power as necessary to maintain a safe airspeed. Monitor your airspeed closely to avoid overspeeding the gear and flaps. If a go-around to the inside of the normal pattern is required, use extreme caution. Attempts to tighten a turn without proper consideration for power and airspeed could lead to a stall. Never break out from the final turn.

6.9.2.2. Avoid deconfiguring the aircraft until rolling out on final. Do not sacrifice aircraft control in the final turn to change gear or flap settings.

6.9.2.3. Raising the flaps in the final turn increases stall airspeed and decreases stall margin. Above 90 KIAS, the spoilers will not extend during a configured stall. Without spoilers, you will have no approach-to-stall indications.

6.9.2.4. Do not exceed 45 degrees of bank during a go-around from the final turn to maintain ground track. Ground track consideration is secondary to maintaining aircraft control. Many pilots have made the fatal mistake of increasing bank and back stick pressure excessively to avoid overshooting the runway. The result is a stall and potentially a departure from controlled flight without sufficient altitude to recover. If you find yourself overshooting the runway, never increase bank more than 45 degrees in an attempt to expedite the go-around. If you encounter approach-to-stall indications, immediately initiate recovery procedures.

6.9.3. **Straight Through on Initial.** If it is necessary to discontinue a pattern before the break, continue straight through on initial at 1,000 feet above the ground and 200 KIAS or as directed locally. At the departure end of the runway or as directed locally, turn to crosswind. Clear below for aircraft on the takeoff leg or pulling up into closed traffic and for aircraft already established on closed downwind.

6.9.4. **Breaking Out From an Overhead Pattern.** If it is necessary to discontinue an overhead pattern, follow the local procedures for leaving traffic. If you see a dangerous situation developing, do not wait to be directed to break out. Use your initiative and judgment and exit traffic immediately. If you are directed to leave traffic, follow instructions without hesitation. Use caution when breaking out from the downwind leg because you will have slow airspeed and may have the gear and/or flaps extended.

**6.10. Straight-In Approach.** Use the straight-in approach when conditions require a landing with minimum maneuvering. Examples of these conditions are structural damage, an open nose-access door, or an unlocked canopy. Your IP will demonstrate the straight-in approach and have you practice it with and without flaps, as follows:

6.10.1. Notify the runway supervisor or tower as directed locally and obtain permission for the approach.

6.10.2. Arrive at the designated entry point at 500 feet above the terrain, if not otherwise specified.

6.10.3. Before you are 2 miles from the runway, lower the gear, lower flaps as desired, turn landing lights on, and establish approach airspeed.

6.10.4. During a normal straight-in approach, lower the speed brake and start the descent to establish a normal glidepath (100 KIAS). Continue as you would on a normal final approach.

6.10.5. During a no-flap straight-in approach, reduce power as necessary and start the descent to establish a no-flap glidepath (110 KIAS). Continue as you would on a no-flap final approach.

**6.11. Crosswind and Gusty Wind Landings:**

6.11.1. Winds in the pattern may require changes in airspeeds and configurations. These changes depend on wind speed, direction, and/or gust. Use the flight crew checklist or RSU's directions to determine the recommended flap settings (**Table 6.1.**).

**Table 6.1. T 37 Flap Settings and Airspeeds.**

<table>
<tr><th rowspan="2">ITEM</th><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th></tr>
<tr><th>Type Pattern</th><th>NWLO<br>65 – 85</th><th>NWLO<br>86 – 95</th><th>NWLO<br>96 – 100</th><th>Gusty Winds</th></tr>
<tr><td>1</td><td>Normal</td><td>100 percent flaps<br>110 final turn<br>100 final</td><td rowspan="2">50 percent flaps<br>110 final turn<br>110 final</td><td rowspan="2">0 percent flaps<br>120 final turn<br>120 final</td><td>50 percent flaps<br>110 final turn<br>110 final</td></tr>
<tr><td>2</td><td>Single Engine</td><td>50 percent flaps<br>110 final turn<br>110 final</td><td>50 percent flaps<br>120 final turn<br>120 final</td></tr>
<tr><td>3</td><td>No Flap</td><td>0 percent flaps<br>110 final turn<br>110 final</td><td>0 percent flaps<br>110 final turn<br>110 final</td><td rowspan="2">0 percent flaps<br>120 final turn<br>120 final</td><td rowspan="2">0 percent flaps<br>120 final turn<br>120 final</td></tr>
<tr><td>4</td><td>No Flap<br>(>1400 lbs of fuel)</td><td>0 percent flaps<br>120 final turn<br>110 final</td><td>0 percent flaps<br>120 final turn<br>110 final</td></tr>
</table>

6.11.2. Plan the final turn to roll out on final between ½ to ¾ mile, using half or full flaps. Under no-flap or zero-flap conditions, plan to roll out on final between ¾ to 1 mile. Establish crosswind controls on final to maintain runway alignment. Maintain airspeed by readjusting the power to compensate for the increased drag caused by the effects of cross controls. Continue to use these controls through the flare and touchdown.

6.11.3. Touch down in a nose-high attitude and smoothly lower the nose to the runway above the computed nosewheel touchdown airspeed. Maintain aileron deflection into the wind throughout the landing roll. Larger control deflections are required as airspeed decreases.

6.11.4. Initially, maintain directional control with rudder and/or brakes. Nosewheel steering is not normally necessary until the aircraft has slowed to normal taxi speed. When you engage the nosewheel steering, center the rudder pedals before depressing the nosewheel steering button. At high airspeeds, nosewheel steering is extremely sensitive and easily overcontrolled. Before reaching taxi speed, use nosewheel steering only if you are unable to maintain directional control with the rudder and brakes on the landing roll.

**6.12. Closed Traffic:**

6.12.1. The closed traffic pattern was devised to get the aircraft on the ground, using a minimum amount of fuel. You may accomplish a closed traffic pattern from an initial takeoff, a touch-and-go landing, or a go-around.

6.12.2. At a minimum of 150 KIAS and no sooner than the locally designated point, request clearance for a closed traffic pattern. Do not initiate the pattern with a straight-in approach reported between 5 and 2 miles, unless cleared by the controller.

6.12.3. When you have received clearance, clear the area and start a climbing turn to the downwind leg. Plan your pullup, using approximately 60 degrees of bank, so the downwind leg is displaced at approximately the same distance from the runway it would be after a break. Minimum airspeed during the pullup is 150 KIAS; maximum bank in the pullup is 90 degrees.

6.12.4. When you roll out on the downwind leg, make a call to the RSU or tower. If you plan a full-stop landing, state your fuel remaining. Indicate you are flying a no-flap pattern or a practice zero-flap pattern, as applicable. Clear and continue with normal approach and landing procedures. (Lower the speed brake, gear, and flaps at the same points as in a normal pattern.) If the controller instructs you to break out, follow the local procedures for leaving traffic from an inside downwind.

**6.13. Low Closed Traffic:**

6.13.1. This pattern was devised to allow practice circling approaches in the local traffic pattern. The prerequisites for requesting a low-closed traffic pattern are the same as for a normal closed traffic. Radio procedures are the same except you will add the word “low” to your request. Perform low closed patterns only between official sunrise and sunset.

6.13.2. Plan the pullup to attain the desired lateral downwind position (wingtip on the runway) at approximately 500 feet AGL. Use normal closed traffic procedures during the pullup and on downwind. ***NOTE:*** Because the downwind altitude is lower, the power and pitch requirements are different.

6.13.3. Lower gear and half flaps on downwind and maintain 110 KIAS while circling to land. (Landing lights are optional.) Extend additional flaps and speed brake on base or final, as desired, using normal circling procedures. With a crosswind or gusty wind conditions, configure by using flap settings and airspeeds used on final during contact conditions.

**6.14. Final Turn Radio Call.** This call is an important part of the traffic pattern procedure. It tells the controller where you are. Transmit the gear-down call as soon as safely possible after starting the final turn. Add single-engine, no-flap, zero-flap, and/or full-stop, if applicable. No response from the controller means you are cleared to continue with the requested approach, but be alert for other instructions from the RSU or tower. Regardless of the type of approach flown (overhead, straight-in, precision, or nonprecision), Do NOT make a gear-down call until the gear is DOWN AND LOCKED.

**6.15. Final Turn Irregularities.** Up to this point, explanations of the final turn have been mainly devoted to ideal situations in which the final turn was executed correctly. However, there are several errors you might make while developing final turn proficiency so you must be thoroughly familiar with the causes, effects, and proper corrections for these situations, as follows:

6.15.1. **Overshooting Final Turn:**

6.15.1.1. There are several causes of overshooting final turns. The most common ones are overshooting winds and/or a tightly spaced inside downwind. The best way to prevent this situation is to pay close attention to the winds the RSU controller calls when you enter the pattern and plan your inside downwind spacing accordingly. Also, it is a good idea to fly your first pattern of the day with conservative spacing until you can determine how the winds are actually affecting your aircraft. Plan your spacing based on using 30 degrees of bank. Forty-five (45) degrees is the MAXIMUM bank angle allowed in the final turn. This is because stall speed increases dramatically with increasing bank angle. If it becomes apparent that more than 45 degrees of bank is required for proper alignment on final, initiate a go around while maintaining 45 degrees of bank or less.

6.15.1.2. Another situation that could lead to an overshooting final turn is channelizing your attention inside the cockpit. Initially in your T-37 training, you may find yourself very busy trying to maintain a composite cross-check, complete a confirmation check, and make a "gear down" radio call, in addition to flying a proper final turn. If you spend too much time focusing inside the cockpit, you may lose track of your progression through the final turn and inadvertently end up overshooting. The important thing to remember is to ALWAYS remain aware of your position relative to the runway. Your IP will give you techniques on how to divide your attention appropriately between in-cockpit tasks and the more critical task of clearing outside the airplane. The slow-airspeed, low-altitude environment of the final turn is no place to go heads down in the cockpit for any extended amount of time.

6.15.1.3. Another common error student pilots have made is mistaking a parallel runway for the runway of intended landing. The danger of this situation is that you may find yourself overshooting the correct runway by the time you realize you are flying to the wrong runway. This mistake can be aggravated when flying right patterns requiring you to look cross-cockpit to judge inside downwind spacing. Your IP can give you techniques to help maintain proper spacing on inside downwind and keep the proper runway in your composite cross-check during the final turn. If you routinely fly at a base with parallel runways, be aware of the potential for confusion.

6.15.1.4. In any case, if you find yourself in an overshooting final turn, how you react is critical. Many pilots have made the fatal mistake of increasing bank and back stick pressure excessively to avoid overshooting the runway. The result is a stall, and potentially a departure from controlled flight without sufficient altitude for recovery. If you find yourself overshooting the runway, NEVER increase bank more than 45 degrees in an attempt to save the approach or expedite a go-around. If you encounter approach-to-stall indications, IMMEDIATELY initiate recovery procedures.

6.15.2. **Undershooting Final Turn:**

6.15.2.1. The most common causes of undershooting a final turn are undershooting winds and/or a widely spaced inside downwind. Again, the best way to prevent this is to pay close attention to the winds the RSU controller calls when you enter the pattern and plan your inside downwind spacing accordingly.

6.15.2.2. If the undershoot is severe enough, initiate a go-around early to maintain safe flying airspeed and prevent conflicts with other properly spaced aircraft in the pattern. The only way to correct an undershooting final turn without angling into the runway is to decrease bank and raise the nose of the aircraft while simultaneously increasing power. If you decrease bank and raise the nose without adding power, your airspeed will decrease and you could find yourself approaching a traffic pattern stall.

6.15.2.3. If you encounter approach-to-stall indication, <u>IMMEDIATELY</u> initiate recovery procedures.

6.15.3. **Diving Final Turn:**

6.15.3.1. Diving final turns are usually the result of an improper pitch picture off the perch or too low a power setting. If you find yourself in a diving final turn, early recognition of what correction applies to your aircraft is essential for flying a safe, correct pattern.

6.15.3.2. Selecting a low power setting and setting the proper pitch picture results in decreasing airspeed. In this situation, trying to gain airspeed by lowering the nose will result in a diving final turn. The correct remedial action is to add power and reestablish the proper pitch attitude. If you set too low a pitch picture with a proper power setting off the perch, you will find yourself in diving final turn with airspeed increasing. If you attempt to correct this situation by only reducing power, you may fix the airspeed problem, but you will maintain a diving final turn. The solution in this instance is to raise the nose and reestablish the proper power setting. The best way to avoid a diving final turn is to set the proper pitch and power setting coming off the perch.

6.15.4. **Level Final Turn:**

6.15.4.1. Level final turns are usually the result of an improper pitch attitude or too high a power setting off the perch. If you set a higher than normal pitch with the same power setting used for a correct final turn, you will notice your airspeed decreasing. To correct this problem, first try to fix your airspeed by lowering your pitch. This situation can be dangerous if not corrected because it can lead to an undershooting or nose-high traffic pattern stall.

6.15.4.2. If you encounter approach-to-stall indications, <u>IMMEDIATELY</u> initiate recovery procedures. Another possible cause of a level final turn is setting the power too high and trying to maintain airspeed with pitch alone. In this case, reduce power and reestablish the proper pitch setting. Again, the best way to avoid a level final turn is to set the proper power setting and pitch picture coming off the perch.

**6.16. Landing Irregularities.** As with the final turn, the explanations of landings have been mainly devoted to ideal situations in which landings were executed correctly. In the landing phase, there are also several errors you might make while developing landing proficiency so you must be thoroughly familiar with the causes, effects, and proper recoveries from these situations, as follows:

6.16.1. **Low Final Approach:**

6.16.1.1. There are different ways to get below the desired flightpath. You can start the final turn too late, place the final turn too far from the runway while maintaining normal pitch and descent rates, or dive the aircraft through the final turn. The result is excessive altitude loss and a final approach below the desired approach path. This situation, called a dragged-in final approach, requires additional power to fly the aircraft to the runway and should be avoided.

6.16.1.2. A dragged-in final approach is dangerous because you may misjudge the extra power needed to fly in this attitude. Once you have become accustomed to the amount of power normally required on final, habit may cause you to use only this amount. With inadequate power in this nose-high, level-flight condition, the aircraft may stall. Dragging the aircraft in with a dangerously nose-high attitude is not the proper solution for the error in judgment you made in the final turn.

6.16.1.3. Adjust pitch and power as soon as you start getting low on final approach. Then readjust pitch and power when you are back on the proper glide slope. If you have any doubt about the approach (if it looks wrong or feels wrong), go around.

6.16.2. **Steep Final Approach.** This approach is caused by placing the final turn too close to the runway, starting the final turn too early, or keeping the nose too high in the final turn. If the final approach is continued, a high descent rate with a low power setting will result. This low power setting, coupled with the pitch change required to intercept the normal glidepath, will result in a rapid decrease in airspeed and a high sink rate. If you do not correct early or go around, this power deficient situation could result in a very firm touchdown or a stall.

6.16.3. **Too Slow on Approach.** When you fly too slow on the final approach, your perception of the proper glidepath and roundout height may be inaccurate. The point to begin the roundout is lower with low airspeed and requires more precise judgment. Also, the aircraft may stall, depending on the pitch attitude, flap setting, and/or control inputs, especially if the wind is gusty. When you are slow on final, you have much less margin for error. When you recognize a slow approach, make the same recovery as for a low final approach. Apply power at an altitude high enough to reestablish the correct airspeed and attitude or go around.

6.16.4. **Rounding Out Too High:**

6.16.4.1. Sometimes when the ground stops moving toward you, your roundout has been too rapid and you are too high above the runway. To compensate for this, maintain a constant pitch attitude by releasing a slight amount of back stick pressure until the airspeed diminishes slightly and the aircraft again starts descending. Then continue the roundout.

6.16.4.2. Use this technique only when you have adequate airspeed and runway. If you have reached a landing attitude and are still well above the ground, do not wait for the aircraft to start descending again. Go around and plan another approach. Remember, when the landing attitude is attained, the aircraft is rapidly approaching a stall. As the airspeed decreases, you are approaching the critical AOA.

6.16.4.3. You have learned that as the nose is lowered to a descending attitude, the pitch change causes lift to decrease momentarily. This is also true during a roundout. Do not lower the nose to increase the rate of descent when you are fairly close to the runway. The momentary decrease in lift may cause the aircraft to land on the nosewheel, which could collapse. Go around any time that you feel the need to lower the nose excessively to avoid a stall during the roundout. The need for substantial lowering of the nose is an indication you are too high above the ground and approaching a stall.

6.16.4.4. Any time you approach a stalling condition after ballooning or bouncing, apply full power, adjust your pitch attitude, and go around. It is unsafe to continue the landing. However, if you have applied power to go around and the aircraft continues to settle, do not try to hold it off by raising the nose above the landing attitude. Hold the landing attitude and let the aircraft touch down if it wants to. The contact will be moderate if you have added power, and you will be safely airborne again shortly.

6.16.5. **Rounding Out Too Late or Too Rapidly.** If you are late in starting the roundout and pull the stick back too rapidly in an effort to prevent a touchdown, you can cause an accelerated stall. This is a dangerous situation that may cause an extremely hard landing on the main gear. This situation may or may not be controllable, depending on the airspeed. If it does occurs, immediate use of power will increase thrust, lift, and controllability and will enable you to recover and go around. The important things to remember in this situation are: (1) do not panic, (2) recognize the problem, and (3) do something immediately—that is, add power and control the aircraft. In your recovery, hold the landing attitude. Your main gear will probably contact the ground a second time; but if you have initiated recovery properly, your second contact will normally be moderate.

6.16.6. **Porpoising:**

6.16.6.1. Porpoising is a condition encountered during landing, where the aircraft bounces back and forth between the nosewheel and main gear. It is caused by a landing attitude at touchdown which brings the nosewheel in contact with the runway before the main gear touchdown. It will most likely occur when landing is attempted with an incorrect landing attitude and at an excessive airspeed. If immediate corrective action is not initiated, the porpoise will progress to a violent, unstable pitch oscillation. Because repeated heavy impacts of the aircraft on the runway will ultimately result in structural damage to the landing gear and airframe, a proper landing attitude immediately before touchdown is imperative to prevent porpoising.

6.16.6.2. If you begin to porpoise, immediately position the controls to establish a nose-high attitude sufficient to prevent the nosewheel from contacting the runway. Maintain this attitude while simultaneously advance the throttles to military. Do not attempt to counteract each bounce with opposite stick movement. The combined reaction time of pilot and aircraft is such that this control movement will aggravate the porpoise. Repositioning and holding the controls (restricting movement) will dampen out the oscillation. The addition of power will increase control effectiveness by increasing airspeed. It will also allow the aircraft to become safely airborne.

6.16.6.3. If a go-around is initiated after porpoising, do not raise the landing gear. Structural damage can occur during porpoising, which may prevent the landing gear from being lowered on the following landing attempt.

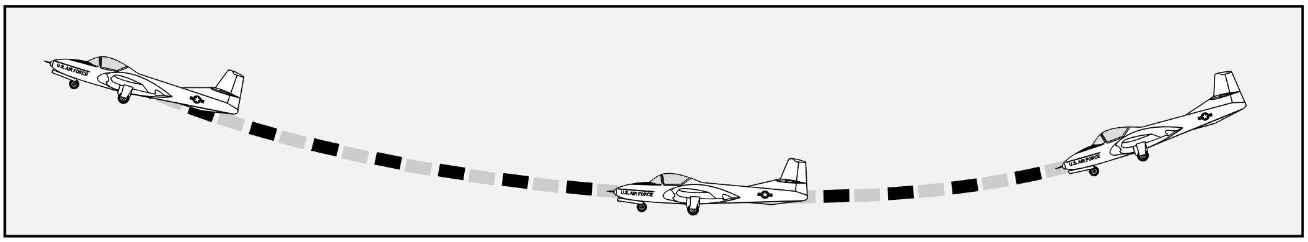
6.16.6.4. If porpoising occurs during an actual single-engine landing, do not increase power on the good engine. The unequal thrust will make directional control difficult. Position and hold the controls to establish a normal landing attitude. Do not attempt to counteract each bounce with opposite stick movement.

6.16.7. **Floating.** When you misjudge the final approach (for example, reduce the power too late, use too much power on final, or fail to use the flaps properly), your tendency is to dive toward the end of the runway in an attempt to land. When you dive, the airspeed increases. This causes you to float and possibly balloon or bounce, and you will be well down the runway before landing. To correct a slight problem of floating, gradually adjust (increase) the pitch attitude as airspeed drops and landing speed is approached. The recovery from floating will depend on the amount of floating and runway remaining. Avoid prolonged floating, especially in strong crosswinds. If you have any doubt about the recovery, execute a go-around.

6.16.8. **Ballooning:**

6.16.8.1. Several factors will cause an aircraft to balloon. One factor is rounding out too rapidly (**Figure 6.5.**). Another is raising the nose to the landing attitude before lift has decreased sufficiently. The altitude gained will depend on the airspeed or the rate at which the pitch attitude is increased.

**Figure 6.5. Ballooning Results From Rounding Out Too Rapidly.**



6.16.8.2. When ballooning is slight, you may complete the landing. Maintain direction, hold a constant landing attitude, and let the aircraft settle onto the runway. Use rudder pressure to keep the aircraft straight as it settles onto the runway. When ballooning is pronounced, go around. Do not attempt to salvage the landing.

6.16.8.3. Be extremely cautious of ballooning in crosswinds. If you do not maintain the wing-low crosswind correction until touchdown, the aircraft will probably balloon more because of the added lift as you level the wings. This puts you in double jeopardy because you will start drifting once you level the wings. Be sure to keep the appropriate wing down in a crosswind and maintain direction with the opposite rudder. If you balloon slightly, you may need to lower the wing even further to compensate for the relative increase of drift component at the lower airspeed. Again, if you have any doubt, go around.

6.16.9. **Bouncing:**

6.16.9.1. Bouncing is very similar to ballooning. What is different is the cause. If the aircraft strikes the runway hard, it will bounce into the air. The height it reaches depends on the force with which it strikes the runway and the amount of back stick pressure held. This height also depends on the speed at the point of touchdown. The aircraft may bounce if it makes contact with the ground before the landing attitude is attained. A common error is to apply excessive back stick pressure when you realize (too late) that the aircraft is settling too fast, but are not yet in the landing attitude. In attempting to correct the first mistake, you increase the pitch attitude too late—just as the bounce occurs. Both actions tend to force the aircraft aloft again.

6.16.9.2. The corrective action for a bounce is the same as ballooning, and it depends on the severity of the bounce. When the bounce is slight and there is no great change in pitch attitude, continue with the landing. Maintain direction and smoothly adjust the pitch to the landing attitude just before touchdown. When a bounce is severe (you feel the aircraft rising rapidly), go around immediately. Simultaneously apply power, maintain direction, and lower the nose to a safe pitch attitude. Follow through with the go-around even if another bounce occurs. Do not attempt a landing from a bad bounce.

6.16.9.3. Because airspeed diminishes very rapidly as the aircraft rises, a stall may occur before a landing is made. Expect to contact the ground or bounce a second time during a proper recovery. The second bounce will not be as severe.

6.16.9.4. Use extreme caution any time you bounce in a crosswind. When one wheel strikes the runway, the other wheel will touch down immediately afterwards, the crosswind correction will be lost, and the aircraft will drift. You should reestablish crosswind controls to stop the drift and either continue the landing or go around, depending on your situation.

6.16.10. **Landing in a Drift or Crab:**

6.16.10.1. At times you may find yourself correcting for drift by crabbing on the final approach. If you round out and touch down while the aircraft is drifting or in a crab, it will contact the runway moving sideways. This will impose extreme side loads on the landing gear and may cause material failure.

6.16.10.2. After crabbing into the wind, the proper method of correcting for drift on the final approach is the wing-low method. This will allow you to keep the longitudinal axis aligned with the runway throughout the final approach and landing.

6.16.10.3. During final approach, roundout, and touchdown in a crosswind, the path or track of the aircraft over the ground is a straight line in the same direction as the runway, and the fuselage of the aircraft should remain lined up with the runway throughout. (In other words, do not angle toward the runway or cock the nose.) Failure to apply sufficient wing-low crosswind corrections will result in landing with a drift, in a crab, or a combination of both.

6.16.11. **Wing Rising After Touchdown:**

6.16.11.1. During crosswind landings, a wing may rise during the landing roll. Depending on the amount of crosswind and degree of corrective action, you could lose directional control.

6.16.11.2. When an aircraft is rolling along the ground in a crosswind, the upwind wing is receiving greater impact of air pressure than the downwind wing because the fuselage blocks the wind over the downwind wing. This causes a lift differential. The wind also strikes the fuselage on the upwind side. This causes a rolling moment about the downwind main landing gear, which may further assist the raising of the upwind wing. When the effects of these two factors are great enough, one wing may rise even though directional control is maintained. If no correction is applied, one wing will rise enough to cause the other one to strike the ground.

6.16.11.3. Use rudder, brakes, and/or nosewheel steering to maintain directional control; use ailerons to keep the wings level. If a wing starts to rise during the landing roll, immediately apply more aileron toward the high wing and continue to maintain direction. The sooner aileron is applied, the more effective it is. The further you allow a wing to rise before taking any corrective action, the more aircraft surface is exposed to the impact pressure of the crosswind.

6.16.11.4. There is a situation where a wing comes up and there is also a loss of directional control. Not only are the same factors attempting to raise the wing, but the crosswind is also acting on the fuselage surface behind the main wheels and swerving the aircraft into the wind. Again, you should apply aileron to lower the high wing and stop the swerve with the most effective control. When the wings are approximately level, maintain directional control until the aircraft has slowed to taxi speed or has stopped.

# Chapter 7

# NIGHT FLYING

## 7.1. Introduction:

7.1.1. Night flying is a very important phase of pilot training. Do you remember how surprisingly easy it was to learn to drive an automobile at night? The transition from day to night flying is just as easy. You will find that most of the same techniques and procedures used in day flying will apply at night. Generally speaking, any apprehension you might have about night flying will result from restrictions placed on your visibility. Once you overcome the feeling of discomfort because of visual limitations, you should have very little difficulty flying at night.

7.1.2. Before night flying, you should be familiar with the location and positions of all switches and controls to include cockpit lights switches. The ability to locate switches and controls should become second nature to you through practice in a synthetic trainer, simulator, or parked aircraft. Determine which switches might be mistakenly or accidentally actuated. Also determine whether such a mistake could create a problem. If so, spend some extra time learning the correct switches in this area.

7.1.3. The traffic pattern during night flying is the same as the day pattern, but some of the visual checks and procedures used in daytime are more difficult at night. Orientation with the ground and other aircraft is harder to maintain. Tension is quite normal because flying an aircraft at night is a new and different sensation. For example, you may notice lights reflecting on your canopy due to glare from your instrument or cockpit lights. Do not confuse these with lights of other aircraft. Once you realize the things that appear strange at night are really quite normal, you will have overcome your biggest obstacle to successful night flying.

7.1.4. Night flying will demand more of you than day flying. You must be constantly alert for other aircraft in the area. You may have to rely on your instruments to determine the attitude of the aircraft. Know your cockpit procedures for taxiing as well as for flying. This will eliminate confusion and the need for turning up the cockpit lights unnecessarily.

## 7.2. Spatial Disorientation:

7.2.1. You are much more susceptible to spatial disorientation at night than during the day. Also, depth perception at night is not completely reliable.

7.2.2. Before takeoff, always study a map of the field. Get a good mental picture of the takeoff runway and taxiways leading to it. Too often pilots on a strange field at night take wrong turns, thus losing time and creating confusion.

7.2.3. Always carry an operable flashlight. If there is electrical failure, a flashlight is your only means of checking instruments or maps.

7.2.4. The T-37 lighting system consists of red and white lights for the cockpit and instrument panel. These lights are used on the instrument panel separately or in combination, and they can be adjusted for intensity. Adjusting instrument lights to the minimum necessary to read the instruments will avoid eyestrain and keep canopy reflections to a minimum. Remember, once your eyes are adapted to the dark, even a momentary glance at bright lights destroys their adaptation. With bright instrument lights, you are unable to distinguish objects outside the cockpit until your eyes readjust.

**7.3. Inspections and Checks.** In addition to the normal daytime exterior check, perform the following:

7.3.1. Ensure all required exterior and interior lights are operational (AFI 11-202, Volume 3.

7.3.2. Ensure all transparencies are clean. Scratches and dirt cause reflection. Ask the ground crew to wipe off any spots on the windshield and instrument panel.

7.3.3. Keep the cockpit lights turned down to a comfortable level, including those controlled by the warning light's dimming switch. This is especially important during traffic pattern operation because canopy glare and bright lights can seriously restrict visibility when clearing is most important.

7.3.4. Know the location of all important switches by touch to avoid operating the wrong one in a dim or dark cockpit. The same applies to all control levers. The flap lever and landing lights are items required at a critical time in the landing pattern. Know their locations by touch. Also know the location of the flap indication without searching for it.

7.3.5. Store your flashlight in a readily accessible place.

**7.4. Taxiing.** Judgment of speed and depth is poorer at night. Allow for this and follow procedures with extra care. Always taxi more slowly at night to compensate for the reduced visibility. Although the taxi light is normally used for night taxiing, use the landing lights when necessary. The anticollision beacon may also be used to increase your visibility to other aircraft while taxiing. Taxi on established taxi lines. If you are taxiing toward a landing runway, use caution with your taxi lights. Do not blind the pilots of landing aircraft.

**7.5. Takeoff.** Line up on the centerline of the runway and perform a static takeoff. Before releasing the brakes, turn on the taxi or landing lights and complete the lineup checklist. After releasing the brakes, look down the runway—<u>not</u> to one side—at the runway lights. On night takeoffs, there is a tendency to fly the aircraft back onto the runway so do not retract the gear in a hurry. Be sure to confirm "gear clear." If you become disoriented, resort immediately to instrument flight and use the instrument takeoff procedures. If you resume outside visual reference, use extreme caution because of deception and broken continuity in unlighted areas. You need not be alarmed by loss of references on takeoff if you transition confidently to your instruments, maintaining a positive pitch attitude on the attitude indicator and a positive rate of climb on the VVI.

**7.6. Area Orientation:**

7.6.1. Your IP will show you the local flying area, prominent landmarks, familiar cities or towns, and any points of interest that may help to keep you oriented. He or she will also point out local hazards at night and minimum safe altitudes for local night operations.

7.6.2. There are several methods to compensate for the lack of visual references at night. Two of these are using a reduced descent rate and reading out altitudes over the intercom when descending for a leveloff close to the ground.

7.6.3. Use extra care in reading the altimeter at night because your actual height above the ground is difficult to visually confirm. Many accidents have resulted from pilots who have misinterpreted altimeter readings; constantly guard against this error. Careful interpretation of altimeter indications is an absolute necessity for safe night flying.

7.6.4. After you are comfortably adjusted to night flying, your IP will place the aircraft in an unusual attitude. You will then recover from the unusual attitude and return the aircraft to level flight using instruments only. If you become disoriented, you must trust your instruments. Causes and hazards of spatial disorientation are listed in AFMAN 11-217, Volume 1, and they must be clearly understood by all aircrews before night flying.

**7.7. Landings:**

7.7.1. The importance of using the before-landing checklist on night landings and of making sure the gear is down and locked before turning onto final cannot be overstressed. After rolling wings level on final, concentrate on the descent and plan to touch down within the first 1,000 feet of the runway. Keep your eyes moving. Do not stare at any bright lights on the ground and do not stare at the runway threshold. Instead, look at the entire runway to maintain your depth perception. It is easy to confuse a moving light with a stationary one.

7.7.2. Plan to touch down on the centerline of the runway. Turn on the landing lights after rolling out on final. On touch-and-go landings, turn off the landing lights after retracting the gear and before retracting the flaps. The landing lights do not turn off until they are fully retracted. The movement of the light beam as it drops away from view may cause a climbing sensation. Therefore, after turning off the landing light switch, monitor your instruments closely.

7.7.3. When flying in the traffic pattern or other congested areas, be especially vigilant for other aircraft. Constantly look around for aircraft lights.

# Chapter 8

# FORMATION

*Section 8A—General*

## 8.1. Introduction:

8.1.1. The purpose of flying formation is to provide the mutual support required to accomplish a given mission. The effectiveness of a formation mission is highly dependent on solid flight discipline. This originates in mission preparation and is displayed in the formation briefing by flight lead or another designated flight member. During the briefing, the flight lead formally describes the mission and establishes the rules of conduct for all flight members during ground operations and in-flight maneuvers.

8.1.2. Flight discipline is displayed when each flight member adheres to these rules of conduct throughout the mission until debriefing. Uncompromising flight discipline is absolutely essential for successful mission execution. More than any other type of flying, formation provides the best environment for building confidence and for teaching self-reliance, self-discipline, and the proper application of aggressiveness in military flying.

8.1.3. Aggressiveness is a state of mind, an attitude not to be confused with speed of flight control movement or reckless abandon. Aggressiveness is knowing the rules and parameters, recognizing deviations, and making expeditious, controlled corrections. T-37 formation training teaches you the basic techniques and procedures. You must be disciplined and aggressive, and you must trust lead. Throughout this manual, you as the wingman are directed to "stabilize" in a particular position before continuing the maneuver. However, "stabilized" does not mean "stopped"; it means in control and able to complete the maneuver safely within your capabilities. The ability to fly good formation does not come easily.

## 8.2. Responsibilities:

8.2.1. **Collision Avoidance:**

8.2.1.1. Flightpath deconfliction is the most fundamental and important tenet of formation flying. It requires the full and constant attention of flight leads and wingmen, whether cruising in route formation or maneuvering tactically. When there is a potential for conflict or loss of sight, immediate action with precise communications is required to prevent a midair collision.

8.2.1.2. When referring to aircraft within the formation, use the terminology "blind" or "visual" as appropriate. When referring to aircraft from outside the formation, use the terminology "no joy" (when you do not have visual contact) or "tally ho" (when you do have visual contact).

8.2.1.3. Wingmen are expected to maintain visual contact with their lead and are responsible for element deconfliction until they call "blind" or "padlocked." (A "padlocked" call indicates the pilot cannot take his or her eyes off an aircraft or ground target without losing sight.) Additionally, wingmen must call "blind" if they lose sight or cannot maintain visual contact.

8.2.1.4. Likewise, leads are expected to monitor their wingmen and talk the wingman's eyes back onto lead if the wingman is blind. Most importantly, if lead is also blind, he or she must effect immediate altitude deconfliction and, if necessary, call "knock-it-off" if safety is becoming an issue.

8.2.1.5. The following factors contribute significantly to the potential for a midair collision:

8.2.1.5.1. Failure of lead to properly clear or visually monitor the wingman during a critical phase of flight, such as during a rejoin or trail. As lead, you must monitor your wingman, looking at him or her directly or using the mirror. Be directive or take evasive action if your wingman loses sight of you. If you lose sight of your wingman and are uncertain of his or her position, query him or her.

8.2.1.5.2. Failure to execute lost wingman procedures promptly and correctly if visual contact is lost in IMC. While flying in IMC, if the wingman cannot maintain the normal fingertip position (using normal visual references) or loses sight of lead, he or she will immediately follow the appropriate lost wingman procedures (paragraph **8.6.6.**).

8.2.1.5.3. Failure to recognize excessive overtake. Learn to judge closure and detect overshoots. The airspeed indicator can be a vital aid. During rejoins, compare your airspeed with the prebriefed or announced airspeed. If you are directly in trail, move laterally to gain greater perspective of closure rate and provide a safe margin for breakout or overshoot. Use power and/or speed brake as necessary.

8.2.1.5.4. Failure to maintain lateral or vertical separation. This generally applies to turning or straight-ahead rejoins. Always maintain lateral or vertical separation until closure rates are under control and you reach the route position.

8.2.1.5.5. Failure to call "blind" and maneuver in the safest direction when visual contact is lost. As the wingman, if you lose sight of lead for any reason (other than in IMC), call "blind." If deconfliction is questionable or there is no timely acknowledgement of the "blind" call from lead, break out of formation. Do not delay your breakout by attempting to regain visual contact. Break in a safe direction (away from the last known position or flightpath of lead) to gain immediate separation. Call your breakout over the radio and do not attempt to rejoin until directed by lead.

8.2.1.5.6. Failure to consider the effects of wingtip vortices. Wingman fly into vortices when they get too close during fingertip maneuvers or crossunders. The resulting control difficulties are very dangerous. If wingmen encounter vortices, they must control the aircraft and move back out or break out as necessary.

8.2.2. **Lead:**

8.2.2.1. The three most important aspects of leading a formation are clearing, planning, and monitoring the wingman. Execute each maneuver with skill and precision, allowing the wingman to maintain position without difficulty. Never become so overly conscious of smoothness that precision or safety is compromised. It is far more important to fly your aircraft safely with minor excursions from perfect performance than to fly super smooth and be a liability to the flight.

8.2.2.2. Plan all maneuvers to keep the flight well within the assigned working area. Select a power setting to manage your energy state in a similar manner to contact flying. High performance and high G maneuvers require smooth and deliberate control inputs to keep your wingman from exceeding G limitations while attempting to maintain formation position. You must also monitor the wingman to ensure he or she is in position before the next maneuver. Before directing a maneuver, always consider the wingman's position and ability to safely perform such a maneuver.

8.2.3. **Wingman.** The three basic aspects of being a wingman are maintaining position, mutual support, and formation integrity. Initially, you will spend most of your time learning to maintain position, but you should develop the other skills that are an integral part of being a formation wingman. In a mutual support role, you can also help clear for the formation by scanning the area you can see beyond lead. Do this by using all of lead's aircraft as a reference; do not focus on just one spot. If you need to tell lead about a conflict, give your call sign, traffic's clock position (prefaced with side), elevation (low, level, or high), and an approximate distance. For example, transmit, "Reno 21, traffic right 2 o'clock, slightly high, 3 miles." Although procedural differences exist between operational units and from aircraft to aircraft, basic wingman responsibilities include:

8.2.3.1. Keeping lead in sight at all times.

8.2.3.2. Being aware of the departure, recovery, and en route altitudes and routing so he or she can assume the lead at any time.

8.2.3.3. Monitoring lead for system malfunctions and proper configurations and assisting, as possible, during emergencies.

8.2.3.4. Monitoring the radios and assisting lead if necessary.

8.2.3.5. Maintaining a constant awareness of the potential for a midair collision.

8.2.3.6. Trusting lead and following directions.

**8.3. Radio Procedures:**

8.3.1. Communications are a good indicator of flight discipline. All radio calls, to the flight as a whole or to an outside agency, should begin with the full call sign. Because the T-37 has limited radio capability, aircrews should attempt to minimize and combine radio calls on common-use frequencies to reduce radio congestion. When using a discrete interplane frequency, using the radio may simplify and expedite safe and effective mission accomplishment. Lead must ensure calls are clear and concise, combining calls when practical.

8.3.2. Unless briefed otherwise, the wingman should change radio channels only when directed by lead and only after all flight members have acknowledged. When directing a radio channel change, lead may elect to use the "go" or "push" command. If using the "go" command (for example, "Reno, go channel 5"), the wingman will respond "2" before switching frequencies. If using the "push" command (for example, "Reno, push channel 5"), the wingman will switch frequencies without making a response until being checked in on the new frequency. Normally, when in fingertip formation, wingmen will automatically move to the route position when lead directs a channel change, and they will return to the fingertip position after being checked in on the new frequency. If in any position wider than fingertip, wingmen will remain in that position unless directed otherwise by lead. If in IMC, wingmen will maintain fingertip spacing and use the crew concept to accomplish channel changes. (The crewmember flying talks on the radio, and the crewmember not flying accomplishes the channel change.)

8.3.3. Aircrews of each aircraft in the formation will be assigned a call sign. For example, Captain X and his student sign out as Reno 01, and Captain Y and her student sign out as Reno 02. No two airborne formations will have the same word call sign (for example "Reno," "Vega," "Cheeta," etc.).

Regardless of flight lead's position during takeoff, he or she will always use the call sign with the lowest numeric designator. In this case, flight lead would be Reno 01. Flight lead may also use 11, 21, 31, etc., depending on the local wingman's call sign procedures. In a four-ship formation, the deputy lead will always use the numeric call sign ending with the number 3.

8.3.4. The flight lead may be in any position on takeoff, landings, and area work to optimize training; but he or she will always be responsible for the safe and effective accomplishment of the mission. The call signs received when the formation signed out will be used any time the formation breaks up. In the above example, when in formation, Captain Y will acknowledge radio calls with her position number, but will use Reno 02 if the formation breaks up with no intention of getting back together. For radio calls within the formation, only the word call sign will be used as follows: for lead, "Reno, ops check," for wingman, "2."

8.3.5. When a member of the formation has total radio failure, the aircraft with the inoperative radio (no radio [NORDO]) will normally be given or retain the wing position. The flight member with the operative radio will lead the NORDO aircraft into the overhead pattern, notify the RSU or tower, and make a low approach to the landing runway. The NORDO aircraft will fly the pattern and land. If weather prevents an overhead pattern, lead will prebrief a straight-in or instrument approach as appropriate for the weather. When the lead aircraft clears the wingman off with a visual signal, the wingman will assume landing clearance, transition visually to the runway, and land normally.

8.3.6. Flight members who experience total radio failure while in close formation should maneuver within route parameters, attract the attention of another flight member, and give the appropriate visual signals. The mission should be terminated as soon as practical and the NORDO aircraft led to the base of intended landing.

8.3.7. If flying other than close formation when radio failure occurs and a planned rejoin will not shortly follow, the NORDO aircraft should cautiously attempt to rejoin no closer than route position. It should rock its wings (attention in the air), but not complete the rejoin until receiving a rejoin signal. Once joined, the NORDO aircraft will give the appropriate visual signals. The mission should be terminated as soon as practical and the NORDO aircraft led to the base of intended landing.

**8.4. Visual Signals.** Visual signals are used during formation flying when radio transmissions are inappropriate or difficult to make. Visual signals are described in AFI 11-205, *Aircraft Cockpit and Formation Flight Signals,* or this manual. Any nonstandard visual signals will be briefed before they are used. As the wingman, when lead gives a signal, acknowledge it by nodding your head. If you do not understand or are unsure of a signal, do not acknowledge. Lead will repeat the signal until an acknowledgment is received from you. Use the radios, if necessary, to avoid confusion or when more practical.

**8.5. In-Flight Checks:**

8.5.1. **General.** The "fuel check" visual signal is normally used to initiate all checks when not using a radio call. Lead and the wingman will check fuel and perform any checklist appropriate for the phase of flight (ops, descent, etc.). If forced to turn during a check, lead should call the turn and ensure the wingman is attentive before turning. The wingman resumes the check after the turn is complete. In-flight checks are normally accomplished in the following manner:

8.5.1.1. **Lead.** As lead, initiate the check with either a radio call or visual signal. After directing the wingman to accomplish the appropriate checklist, perform your own checklist items. Allow enough time for the wingman to do the same. If forced to turn during a check, call the turn and ensure your wingman is attentive before turning. Check the wingman in with a visual signal (according to AFI 11-205) or a radio call. If using the radio, check in by transmitting a call sign and total fuel ("Reno 1 is 1,200.").

8.5.1.2. **Wingman.** As wingman, acknowledge lead's visual signal or radio call, move to route if check was initiated in fingertip, and perform the appropriate checklist items. Accomplish the check one item at a time, checking your position on lead between each item. Prioritize your tasks. If necessary during turns, fly the aircraft and resume the check after the turn is complete. Return to the fingertip position only after flight lead's check-in radio call or visual signal. During IMC, use the crew concept for completing in-flight checks. (The crewmember flying will fly the fingertip position, and the crewmember not flying will perform the check.) Check in with total fuel ("2's 600"). If you are within 50 pounds of lead's stated fuel, respond with "2's same."

8.5.2. **Ops Check.** This is a check of the fuel quantity and aircraft systems, which will be performed periodically during every mission. Lead will initiate the check with the appropriate visual signal or transmit, "Reno, ops check." The wingman will acknowledge the visual signal or radio call, as appropriate. Lead should monitor any abnormal fuel state reported by the wingman.

8.5.3. **Fuel and G Awareness:**

8.5.3.1. It is lead's responsibility to monitor the G-loading and fuel state of all members of the formation. He or she must also take appropriate action when any aircraft exceeds G limitations, reaches joker or bingo fuel, or reports an abnormal fuel condition. To fulfill this responsibility, lead must initiate a fuel and G check several times throughout the mission ("Reno 1 is 900, 4.2 Gs"). These checks are normally accomplished after the G awareness exercise and the extended trail exercise. It is the wingman's responsibility to monitor his or her own G-loading and fuel state and report joker or bingo fuel, as well as any abnormalities, to lead. The maximum G on the meter will be reported on each G check.

8.5.3.2. It is important to remember that any time a wingman is maneuvering behind lead (extended trail exercise, close trail, fighting wing, etc.), he or she must use caution to avoid areas of wake turbulence. This is especially important in lead's high or direct six o'clock. The more G lead pulls, the higher the probable turbulence area. Any time wake turbulence is encountered, the wingman should unload to approximately 1 G, exit the area of turbulence, and check the G meter. If the aircraft G limits have been exceeded, the formation will "knock-it-off" (as described in paragraph **8.6.2.**) and conduct a structural damage or controllability check, as required. In the case of an over-G, the G meter will not be reset until the aircraft can be looked at by a certified maintenance technician.

8.5.4. **FENCE Check.** "FENCE-in" is normally directed by lead when entering the MOA or military training route (MTR). "FENCE-out" will normally be accomplished when exiting the MOA or MTR. Items to accomplish will vary with the mission type. **FENCE** normally stands for **F** – Fire control, **E** – Emitters, **N** – NAVAIDs, **C** – Comm, and **E** – ECM. During your training in the T-37, "FENCE-in" will ensure you are prepared for area work. In this case, **FENCE** means **F** - Fuel, **E** - Engine, **N** - NAVAIDs, **C** - Comm or Checks (ops or descent, as appropriate), and **E** – Equipment. When exiting the MOA, "FENCE-out" prepares you for recovery.

8.5.5. **Battle Damage (BD) Check:**

8.5.5.1. When accomplished, lead initiates the BD check using a radio call or the "check mark" visual signal. Number 2 will look over one side of lead (high and low) and cross under to look at the other side. He or she must not sacrifice nose-tail separation in examining the other aircraft. Upon completion of the check, the wingman will return to the formation position from which the check was initiated (normally fingertip or route), but on the new side of lead. While inspecting lead, the wingman will look for any damage, leaks, missing panels, or any irregularities. ***NOTE:*** Peacetime maneuvering can cause these problems as well as combat maneuvering.

8.5.5.2. If lead is clean, the wingman passes a thumbs-up to lead. If lead is not clean, the wingman will use the radios to describe discrepancies. Lead then initiates a lead change, using visual signals or radios, and the wingman assumes the navigation lead only while clearing for the flight. Flight lead then inspects Number 2. When lead is finished, Number 2 passes the navigation lead back to lead.

8.5.5.3. When the lead aircraft contains two pilots, the option exists to conduct the BD check without changing leads. In this case, one pilot in the lead aircraft will inspect the wingman as the wingman maneuvers to inspect the leader, and the other pilot in the lead aircraft will clear the flightpath for the formation.

8.5.5.4. During the BD check, the aircraft fulfilling lead responsibilities must clear for the formation while the wingman maintains deconfliction within the formation. On a four-ship formation, lead directs either Number 2 or 4 to check the rest of the flight with a radio call. Numbers 3 and 4 or 2 and 3 maintain position while Number 4 checks each side of the formation and returns to the original position. When Number 4 is back in position, lead directs Number 2 to check Number 4.

**8.6. Formation Training Rules (TR).** AFI 11-214, *Air Operations Rules and Procedures,* defines TRs, and AFI 11-2T-37, Volume 3, includes a complete list of T-37-specific TRs. The following subparagraphs provide training rules applicable to T-37 formation flight:

8.6.1. **G-Awareness Exercise.** Aircrew will perform a G-awareness exercise as described in paragraph **5.6.3.** before flying any maneuver that may result in greater than 3 Gs. The exercise will be briefed and will emphasize wingman and flight lead deconfliction procedures while maintaining spatial and situational awareness throughout the maneuver. Aircrews must have sufficient visual cues to perform this maneuver. Flight leads should consider sun angle prior to the maneuver and anticipate possible loss of sight due to the sun. If poor weather conditions prevent safe accomplishment of the G-awareness exercise, flight lead will modify the flight mission profile and limit maneuvering accordingly.

8.6.1.1. Leads will ensure G-awareness exercise setup and maneuver parameters (formations, power settings, G-loading, airspeeds) are adequately covered during the mission briefing. Flight members are responsible for ensuring that briefed formation and aircraft parameters are met prior to execution of the G-awareness exercise. Flight members will adhere to the briefed G-awareness exercise parameters during the maneuver.

8.6.1.2. Flightpath deconfliction responsibilities during G-awareness maneuvers are no different than any other formation maneuvering and are the responsibility of all flight members. There are times when members of the formation will lose sight. It is the responsibility of leads during mission briefs to emphasize where loss of visual might occur and what wingmen responsibilities are for deconfliction at those times.

8.6.1.3. Wingmen are primarily responsible for deconfliction unless maneuvering places lead in the wingman's blind cone, in which case lead must accept responsibility for separation. Altitude stacks and formation contracts should be used to help ensure deconfliction while maneuvering. If visual contact is lost and flightpath deconfliction cannot be assured, the wingman will terminate the exercise, call blind, and maneuver away from the other aircraft's last known position.

8.6.1.4. Leads will ensure the airspace intended for conducting the G-awareness exercise is free from potential traffic conflicts. Leads will use air traffic control (ATC) services to the maximum extent practical to ensure the airspace is clear. The G-awareness exercise will be conducted in the following airspace in the order as listed:

8.6.1.4.1. In special use airspace.

8.6.1.4.2. Above 10,000 feet MSL outside special use airspace.

8.6.1.4.3. Inside the confines of military training routes (MTR) or low level training zones.

8.6.1.4.4. Below 10,000 feet MSL outside special use airspace.

8.6.2. **"Knock-It-Off" and "Terminate" Procedures:**

8.6.2.1. AFI 11-214 defines the use of "knock-it-off" and "terminate" calls to direct aircraft to cease tactical maneuvering. In the T-37 these calls will be used throughout formation maneuvering, and any formation member can make these calls. "Knock-it-off" will be used when safety of flight is a factor or when doubt or confusion exists. If danger is imminent, be directive when making the "knock-it-off" call.

8.6.2.2. Aircraft with radio failure will signal "knock-it-off" with a continuous wing rock. Another aircraft observing a continuous wing rock will transmit "knock-it-off" and provide required assistance. This radio call applies to all phases of flight and all types of formation maneuvers, and all formation members must acknowledge this call in turn; for example, "Reno, knock-it-off." Regardless of who made the "knock-it-off" call, lead will acknowledge with the call, "Reno 1, knock-it-off," followed by the wingman's call, "Reno 2, knock-it-off." The wingman should then await directions from lead.

8.6.2.3. When hearing a "knock-it-off" call, lead will continue the current maneuver with the current power setting until directing a rejoin. This will ensure he or she remains predictable and will aid in flightpath deconfliction, especially if any aircraft in the formation loses sight of the other aircraft. Ensuring flightpath deconfliction should be the primary concern for all aircraft. If any aircraft loses sight, the aircraft losing sight should make the appropriate "blind" radio call and all aircraft should follow lost sight procedures (paragraph **8.6.5.**). Upon hearing a "knock-it-off" call or observing a continuous wing rock, all participating aircraft will:

8.6.2.3.1. Clear the flightpath.

8.6.2.3.2. Cease maneuvering.

8.6.2.3.3. Acknowledge with a call sign or wing rock.

8.6.2.3.4. Obtain verbal clearance before resuming maneuvers.

8.6.2.4. "Knock-it-off" will be transmitted when any of the following situations occur:

8.6.2.4.1. The maneuver or exercise, if continued, would cause the formation to go out of the authorized area.

8.6.2.4.2. An unbriefed or unscheduled flight enters the working area and is detrimental to the safe conduct of the mission.

8.6.2.4.3. The minimum altitude or cloud clearance is approached (unless in a nonmaneuvering fingertip formation).

8.6.2.4.4. Situational awareness is lost.

8.6.2.4.5. A radio failure is recognized.

8.6.2.4.6. An aircraft is observed continually rocking its wings.

8.6.2.4.7. A member calls "knock-it-off."

8.6.2.4.8. A dangerous situation is developing.

8.6.2.4.9. Bingo fuel is inadvertently overflown and the fuel remaining requires traffic priority or direct routing to primary or alternate recovery base.

8.6.2.4.10. An over-G occurs.

8.6.2.5. "Terminate" actions are as follows:

8.6.2.5.1. The "terminate" call will be used to direct a specific aircraft or flight to cease maneuvering and proceed as briefed or directed. The term "terminate" will be used when safety of flight is not a factor. When the wingman has met the desired learning objectives or is outside the desired formation parameters (desired learning objectives are not achievable), but still has visual contact with lead and desires to resume maneuvering when attaining proper position, he or she will request "(*call sign*), terminate." Lead will acknowledge and, if desiring to continue the maneuver, smoothly transition to a shallow turn or level flight until the wingman has attained the desired formation parameters and transmitted, "(*call sign*), 2's in." At this point, lead may continue the present maneuver or direct the formation, as desired.

8.6.2.5.2. When hearing a "terminate" call, participating aircraft will cease maneuvering, clear the flightpath, acknowledge with their call sign, and proceed as briefed or directed. Termination calls will be acknowledged in the same manner as a "knock-it-off" call; for example, "Reno terminate," "Reno 1 terminate," then "Reno 2 terminate."

8.6.3. **The "Bubble."** Aircraft flying inside the 300-foot slant range "bubble" or forward of the 3/9 line during the extended trail exercise will call "knock-it-off" as described in paragraph **8.6.2.**

8.6.4. **Formation Breakout:**

8.6.4.1. The purpose of a breakout is to ensure immediate separation and avoid a midair collision. The wingman must break out of formation when (1) directed, (2) visual contact with lead is lost, causing a loss of situational awareness, (3) unable to rejoin to or remain in formation without crossing under or in front of lead, or (4) any time his or her presence constitutes a hazard to the formation. During a breakout, it is possible for crewmembers to lose sight. Both lead and the wingman must remain vigilant to ensure deconfliction and maintenance of situational awareness. ***NOTE:*** A breakout does not always require an abrupt, high-G turn away from lead. Some breakout situations may require minimal or no change to the flightpath to ensure safe separation.

8.6.4.2. If the wingman has initiated the breakout, it is his or her responsibility to maintain safe separation until the breakout is acknowledged by lead, who will confirm visual contact on the wingman or establish altitude separation. If lead directs the breakout, he or she is responsible for safe separation and deconfliction until the wingman acknowledges or regains visual contact or achieves altitude separation.

8.6.4.3. It is the wingman's responsibility to call "blind" if, during the formation breakout, he or she loses visual contact and/or situational awareness on lead. It is lead's responsibility to talk the wingman's eyes back onto lead after hearing the wingman's "blind" call. The following radio calls will be made, as appropriate:

8.6.4.3.1. When the wingman initiates the breakout, he or she will call "Reno 2 is breaking out."

8.6.4.3.2. If the wingman loses visual contact and/or situational awareness on lead, he or she will call "Reno 2 is blind, 17,000 feet."

8.6.4.3.3. If lead has the wingman in sight, he or she will call "Reno 2, roll out . . . visual is at your right four o'clock for 3,000 feet, slightly high."

8.6.4.3.4. The wingman will answer "Reno 2 visual."

8.6.4.3.5. Lead will then call " Reno 2, cleared to rejoin left/right side."

8.6.4.4. If lead is also blind, he or she will take immediate action to ensure altitude deconfliction, as follows:

8.6.4.4.1. When the wingman loses visual contact and/or situational awareness on lead, he or she will call "Reno 2 is blind, 17,000 feet."

8.6.4.4.2. Lead will then call "Reno 1 is blind, 15,000 feet."

8.6.4.4.3. From this point, lead will be directive with the wingman while attempting to reform the element:

8.6.4.5. When breaking out, the wingman will clear in the direction of the break. He or she will maneuver away from lead's last known position (or in the direction that ensures immediate separation), using power as required to maintain safe maneuvering airspeed and/or speed brake to expedite separation. When able, the wingman will inform lead that he or she has broken out ("Reno 2 is breaking out"). Lead will continue to fly predictably and, if the wingman is in sight, maneuver to maintain sight and deconflict flightpaths. Once safe separation is assured, the wingman may roll out to attempt to regain visual contact. ***NOTE:*** To prevent disorientation, the wingman must use caution when passing under lead or viewing lead through the top of the canopy.

8.6.4.6. If a wingman must break out of formation on final approach, he or she must remember that a rapid increase in back stick pressure can quickly result in a stall. Also, abrupt application of excessive rudder can cause the aircraft to roll past the desired bank angle, which can further aggravate the slow speed condition and reduce the chances of a successful recovery.

8.6.4.7. The wingman may encounter a hazardous situation in which an aggressive breakout is inappropriate. For example, if the aircraft drifts into a position dangerously close to lead, an aggressive breakout may possibly result in a collision. In this situation, the wingman should move away from lead, using smooth and positive control inputs as required.

8.6.4.8. Practice breakout procedures in VMC to prepare for actual situations you may encounter. The IP in either the lead or wing aircraft will initiate all practice breakouts. With the wingman in sight, lead will direct the practice breakout with the radio call, "Reno 2 break out." The wingman will execute the appropriate breakout maneuver and, after separation is established, make the radio call, “Reno 2 is breaking out.” At this point, all maneuvering and radio calls are identical to an actual breakout. The maneuver priorities must be establishing and maintaining safe separation, followed by establishing appropriate communications, and lastly reforming the flight.

8.6.5. **Lost Sight Procedures:**

8.6.5.1. In some cases, losing sight of the other aircraft does not require a breakout or lost wingman procedure because sufficient spacing already exists; for example, following a pitchout. However, if the other aircraft is not in sight when anticipated, the wingman will notify the other aircraft of the situation and state the current altitude; for example, “Reno 2 is blind, 17,000 feet.” If there is no timely acknowledgement of the “blind” call, the wingman will maneuver away from the last known position of the other flight member or element and alter his or her altitude. In some cases, heading or turn information may also be appropriate for this call.

8.6.5.2. If lead maneuvers into the sun, the wingman may lose sight. Although visual contact is usually regained within a few seconds, a momentarily “blind” condition could pose a great hazard for midair collision. A “sun-blind” condition is an actual lost-sight case, and the proper procedures must be applied immediately to ensure proper separation is maintained.

8.6.5.3. When the wingman is flying the extended trail exercise and loses sight of lead, he or she will break out of the formation as described in paragraph **8.6.4.** and call “blind.”

8.6.5.4. If the other aircrew has not lost sight, they will transmit that fact with a relative position to the “blind” aircraft; for example, “Reno 1, visual, right 3,000 feet, 2 o’clock, high.” If lead is the “blind” aircraft, but the wingman has lead in sight, lead has the option to direct a rejoin. In this case, the wingman will not rejoin closer than a route position until lead has called “visual.” If the wingman is “blind,” lead has him or her in sight, and the situation requires immediate aircraft separation, lead will maneuver to ensure separation between the two aircraft.

8.6.5.5. Lead will direct a rejoin only after the wingman has reached a position from which a safe rejoin is possible. The wingman should maintain a minimum of 1,000 feet of separation until directed to rejoin. As the wingman, if an excessive closure rate is apparent, break out or overshoot as appropriate to stay away from lead’s flightpath.

8.6.5.6. If both aircraft have lost sight of each other, lead will immediately ensure a minimum of 1,000 feet of altitude separation. If visual contact is still not regained, lead will take positive action to ensure flightpath deconfliction within the flight to include a “terminate” or “knock-it-off” radio call if necessary. Both aircrews will maintain this separation until making visual contact and initiating a rejoin or receiving clearance to recover separately.

8.6.6. **Lost Wingman Procedures.** Lost wingman procedures may not guarantee obstacle clearance. It is the responsibility of all the pilots in the formation to be aware of terrain and obstacles along their flightpath. Good judgment must be used when executing lost wingman procedures.

8.6.6.1. **Lost Wingman Actions:**

8.6.6.1.1. During actual weather conditions, the wingman may lose sight of the lead aircraft. The action taken depends on the phase of flight. The wingman should review pertinent procedures at each briefing where weather or other restrictions to visibility are known or anticipated for the flight.

8.6.6.1.2. In any lost wingman situation, immediate separation of aircraft is essential. On losing sight of lead or if unable to maintain position due to disorientation, the wingman will simultaneously execute the applicable lost wingman procedure while transitioning to instruments. Smooth application of control inputs is imperative to minimize the effects of spatial disorientation.

8.6.6.1.3. Additionally, the wingman will notify lead, who will coordinate with the controlling agency and request a separate clearance for the wingman. If required, the controlling agency can aid in ensuring positive separation.

8.6.6.1.4. Lead should immediately perform the appropriate procedure, acknowledge the lost wingman's radio call, and transmit lead's aircraft attitude, which will be acknowledged by the wingman. Lead should transmit other parameters such as heading, altitude, and airspeed as necessary to aid in maintaining safe separation.

8.6.6.2. **Lost Wingman (Two- or Three-Ship):**

8.6.6.2.1. **Wings-Level Flight (Climb, Descent, or Straight and Level).** The lost wingman will turn away, using 15 degrees of bank for 15 seconds. He or she will inform lead, resume course, and obtain a separate clearance.

8.6.6.2.2. **Turns (Climb, Descent, or Level).** When outside the turn, the lost wingman will reverse the direction of turn, using 15 degrees of bank for 15 seconds, and inform lead. He or she will roll out and continue straight ahead to ensure separation before resuming the turn and obtain a separate clearance. When inside the turn, the lost wingman will momentarily reduce power to ensure nose-tail separation and tell lead to roll out of the turn. Maintain angle of bank to ensure lateral separation; then obtain a separate clearance. Lead may resume turn only when separation is ensured. If in a three-ship flight with both aircraft on the same side of lead, refer to four-ship lost wingman procedures (paragraph 8.6.6.3).

8.6.6.2.3. **Precision and Nonprecision Final Approach.** The lost wingman will momentarily turn away from lead to ensure separation and start a climb to either the final approach fix or glide slope intercept altitude, as appropriate. While proceeding to the missed approach point, he or she will inform lead and obtain a separate clearance from approach control. Either comply with the new clearance received or fly the published missed approach, as appropriate.

8.6.6.2.4. **Missed Approach.** The lost wingman will momentarily turn away to ensure clearance, inform lead, and continue the published missed approach while climbing 500 feet above the missed approach altitude. The wingman will obtain a separate clearance from approach control.

**8.7. Practice Lost Wingman Procedures.** Lost wingman procedures will be practiced in VMC to prepare for actual situations encountered. Lead will direct practice of lost wingman procedures with the radio call, "Reno, go practice lost wingman." At this time, the wingman will execute the appropriate lost wingman procedures and acknowledge, "Reno 2 is practice lost wingman." The IP will monitor the lead aircraft to ensure adequate separation is maintained. After appropriate lost wingman procedures have been executed, the wingman has confirmed "visual" on lead, and permission for rejoin has been granted, lead will specify the type and direction of rejoin.

**8.8. Formation IMC Procedures:**

8.8.1. **Spatial Disorientation in Formation.** As lead of a formation, if you suspect your wingman is becoming spatially disoriented, transmit your current flight parameters. This may reduce or eliminate the sensations of spatial disorientation. As the wingman, you must remain aware of flight conditions to the maximum extent practical. If you become spatially disoriented, inform lead and request flight parameters if necessary. Lead will minimize maneuvering, transmit flight information and, if in IMC, attempt to acquire VMC. If disorientation persists, lead should attain straight-and-level flight, if possible, and consider passing the lead to the wingman if conditions will allow lead to maintain orientation and situational awareness while on the wing. If conditions do not allow this, the wingman should make every effort to maintain formation position. If unable to maintain formation position, the wingman will immediately transition to instruments while executing lost wingman procedures and notifying lead.

8.8.2. **Aircraft Strobe Lights.** At times, lead's strobe lights may become distracting, which could lead to spatial disorientation. The wingman will advise lead when this happens, and lead will turn the strobe lights off.

8.8.3. **Icing.** If the wingman is experiencing icing, he or she will notify lead. Lead will climb or descend to avoid cruising in icing conditions.

**8.9. Airborne Formation Aborts.** The primary reason for formation flying is mutual support. This also applies to noncombat hazards. If either member of the formation must return to the airfield prematurely, the other aircraft should normally return also and provide any assistance required. (The IP may make exceptions to this if the difficulty is routine and the field is in sight or if the weather conditions would complicate a safe formation return.)

**8.10. Emergency Procedures:**

8.10.1. Mutual support can be a great advantage in emergency situations. Emergency aircraft should use other aircraft in the formation to aide in a safe recovery. Safe separation of aircraft in formation is critical to safety. Caution should be used so application of appropriate checklists or recovery is not unnecessarily delayed in an attempt to maintain formation position.

8.10.2. In general, the lead should be offered to the aircraft with a malfunction. This will allow the affected aircraft to handle the emergency without the requirement to maintain position. The lead should be offered three times—(1) when the emergency occurs, (2) on recovery when below the weather and able to navigate VFR to the field, and (3) when on final with the field in sight.

8.10.3. After a midair collision, lead will coordinate separate clearances and chase ships.

8.10.4. If diversion is necessary with a NORDO aircraft on the wing, lead will show the pink pages in the IFG followed by the number of the diversion base. The wingman will repeat the number to acknowledge.

8.10.5. In VMC, the emergency aircraft will generally lead back to a straight in or overhead, as appropriate. In IMC, the emergency aircraft will generally lead back to an instrument approach unless it is unable to navigate. If weather or field conditions at the intended recovery runway are unknown, the "good" aircraft may be sent ahead as a "scout" to observe the airfield and report to the emergency aircraft.

8.10.6. During a physiological incident, the "bad" aircraft will typically lead back. The unaffected wingman will use caution and good judgment, especially if penetration of IMC is required.

8.10.7. If ejection is required, the wingman will act as the onsite commander (rescue combat air patrol [RESCAP] commander) until relieved. As a guide, the wingman will:

8.10.7.1. Monitor the ejection from a high offset position and set and check his or her bingo fuel.

8.10.7.2. Not descend below the last observed altitude of the parachutes if not visual.

8.10.7.3. Notify the controlling agency and inform them that he or she is the onsite commander.

8.10.7.4. Make contact with the downed pilots on 243.0 and then switch to 282.8.

8.10.7.5. Start coordination for search and rescue (SAR) support with other wing aircraft (especially T-6 and T-1 due to long loiter times).

8.10.7.6. Mark aircrew position with radial/DME, ground reference, or ident. Notify the supervisor of flying (SOF) about ejection location, number of parachutes, and loiter time.

8.10.7.7. Use SOF and ATC to restrict air traffic in the area.

8.10.7.8. Direct rescue crews onto the scene.

8.10.7.9. Return to base when relieved or when bingo fuel. Pass applicable information to the new RESCAP commander.

8.10.8. If either aircraft in the formation encounters a bird strike, aircrews must maintain separation between aircraft. If both aircraft are affected, lead will arrange for separate chase ships.

**8.11. Speed Brake Exercise.** Speed brake exercises are used to practice maintaining position when the speed brake is operated. The wingman will lower or raise the speed brake on a verbal or visual signal by lead. The wingman must anticipate a slight pitch change to avoid bobbing up and down.

## *Section 8B—Two-Ship Formation*

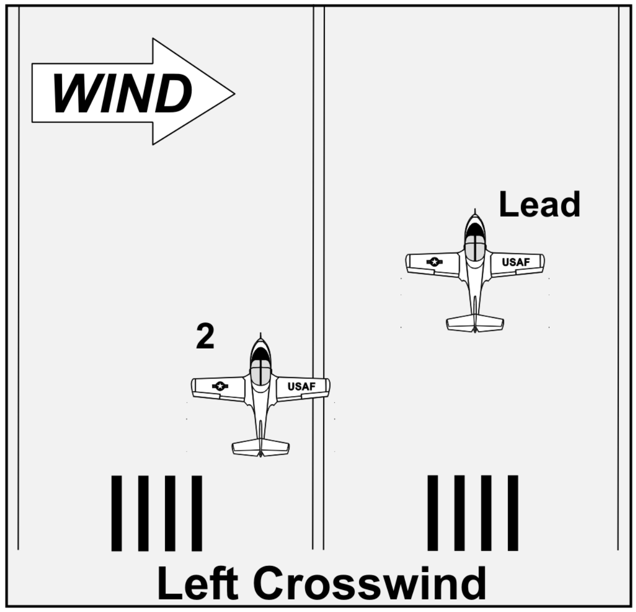
### 8.12. Engine Start, Taxi, and Takeoff:

8.12.1. If aircraft are parked together, the formation will start engines on a visual signal. If aircraft are parked separately, a prebriefed starting time will be used. Lead will be informed of any difficulties that may delay departure.

8.12.2. After engine start, lead will check the flight in on the radio. Wingmen will acknowledge with their formation position. After all flight members "sweep" the automated terminal information service (ATIS) and the flight checks in, lead will call for taxi clearance. The wingman will respond with "2" to signify he or she understands the clearance. If another aircrew attempts to taxi between members of the formation, lead will ask that aircrew to hold. The formation should have the right of way.

8.12.3. Lead will take the center of his or her half of the runway and taxi a sufficient distance down to allow the wingman room to maneuver into position. The wingman will line up on the fingertip line with a minimum of 10 feet of lateral wingtip clearance (**Figure 8.1.**). Lead will consider such factors as wind, weather, and direction of the turn out of traffic when determining the proper side to place the wingman. Lead will place the wingman on the upwind side for takeoff when the crosswind component exceeds 5 knots to keep the wingman from entering lead's wake turbulence in the event the wingman falls behind.

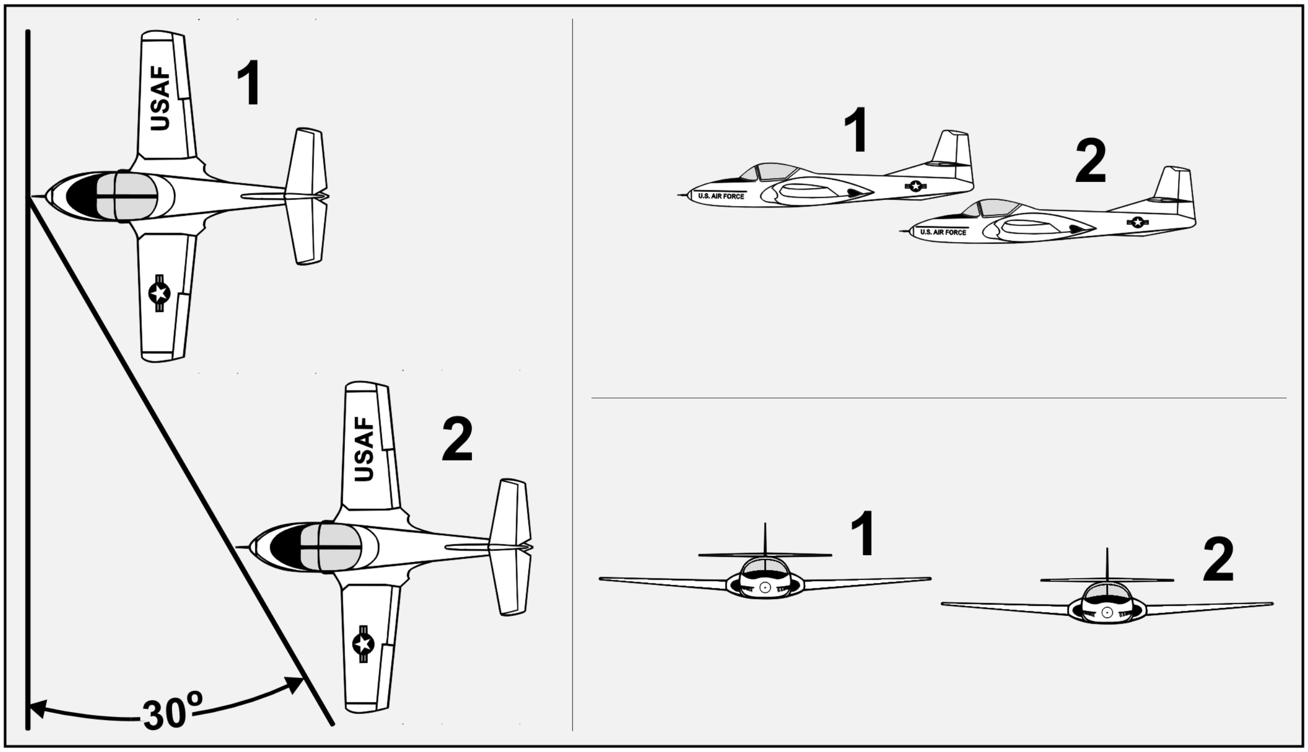
**Figure 8.1. Runway Lineup.**




8.12.4. For takeoff in the wing position, lead will look at the wingman and give the runup signal. At this time, the wingman will perform a lineup check and nod to lead when the check is complete. Lead will adjust throttles to 98 percent rpm to give the wingman a power advantage. Lead will signal for brake release with the downward motion of his or her head. As the wingman, use power as necessary to maintain position on the takeoff roll. Use peripheral vision to help detect any lateral movement on the runway. Use nosewheel steering to maintain directional control. Match lead's pitch attitude and stack level until the gear and flaps are raised.

8.12.5. When the formation is safely airborne with a minimum of 110 KIAS, lead will retract the gear and flaps. As the wingman, raise your gear when you see lead's gear begin to retract and you are sure you will remain airborne. If you are overrunning lead, you may delay retracting your gear. (Never raise your gear before lead.) When the gear handle is up, raise the flaps and assume the fingertip position (**Figure 8.2.**).

**Figure 8.2. Fingertip Position.**




8.12.6. Lead will maintain the takeoff attitude, allowing airspeed to increase. He or she will make the first turn at a minimum of 150 KIAS and a safe altitude.

8.12.7. If lead aborts the takeoff after the brake release, the wingman will normally continue the takeoff. For this reason, as the wingman, you must maintain proper wingtip clearance when lining up on the runway and throughout the takeoff. If the takeoff must be aborted, the aborting pilot must maintain lateral control of the aircraft, follow abort procedures, and, time permitting, call on the radio with intentions. The fact that one aircraft develops trouble when breaking ground and decides to abort does not make it necessary for both aircraft to do so.

8.12.8. After the formation is airborne, it may become difficult for the wingman to determine that lead is experiencing an in-flight emergency (loss of thrust, etc.), which requires an abort or emergency landing. If the wingman overruns lead, lead will direct the wingman to assume the lead. The wingman will select full military power and make a separate takeoff while maintaining his or her side of the runway. The original lead will be responsible for in-flight separation and direct appropriate measures to regain flight integrity or initiate lost wingman procedures. The original wingman will fly the briefed departure until instructed otherwise by the original lead.

8.12.9. As the wingman, if you drop behind on takeoff, you may not have sufficient airspeed to rotate with lead. In this case, cross-check your airspeed indicator and make your own takeoff. Rejoin on lead after becoming safely airborne.

8.12.10. As the wingman, if you must make a separate takeoff due to excessive crosswind or other factors, use a 10-second delay. (***NOTE:*** Maximum crosswind component for a formation takeoff is 13 knots [70 knots nosewheel liftoff or touchdown].) If standing water on the runway forces separate takeoffs, lead should move toward the center of the runway (still maintaining his or her side) after gaining sufficient separation from the wingman. The wingman should move toward the center of the runway (still maintaining his or her side) once the takeoff roll begins.

8.12.11. Formation members must use caution during takeoffs in gusty wind conditions for rapidly changing wind direction and velocity, using timely corrections to maintain directional control and ensure aircraft separation.

**8.13. Join-Up After Takeoff.** If aircraft take off separately (an interval takeoff, using 10-second spacing), local procedures will dictate the type of rejoin. Use a turning rejoin, a straight-ahead rejoin, or, in some cases, a combination of both. After lead is airborne with a minimum of 150 KIAS, reduce power to approximately 95 percent and accelerate to tech order climb speed. Initially, the wingman will use military power and be alert for transitions from one type of rejoin to another as lead follows the departure route.

**8.14. Instrument Trail Departure.** During trail departures in IMC, basic instrument flying is the first priority and will not be sacrificed while performing secondary trail tasks. All aircrews will strictly adhere to the briefed climb speeds, power settings, altitudes, headings, and turn points. If task saturation occurs, cease attempts to maintain trail, immediately concentrate on flying the instrument departure, and notify lead.

8.14.1. Takeoff spacing will be no less than 20 seconds.

8.14.2. Each aircraft or element will climb at 180 KIAS with 98 percent power unless briefed otherwise. Thirty degrees of bank will be used for all turns.

8.14.3. Until join-up or leveloff, each aircraft or element will call when passing multiples of every 1,000 feet and when initiating heading changes. Acknowledgments are not required, but monitoring radio transmissions and the progress of the succeeding aircraft or elements is imperative. Immediately correct any deviations from the departure route.

8.14.4. During the climb and through leveloff, each aircraft or element will maintain the briefed spacing using NAVAIDs and all available aircraft systems, including the clock.

8.14.5. Each aircraft or element will maintain at least 1,000 feet of vertical separation from the preceding aircraft or element except where departure instructions specifically prevent compliance. If the wingman cannot comply with the minimum safe altitude, lead may reduce the vertical separation to 500 feet.

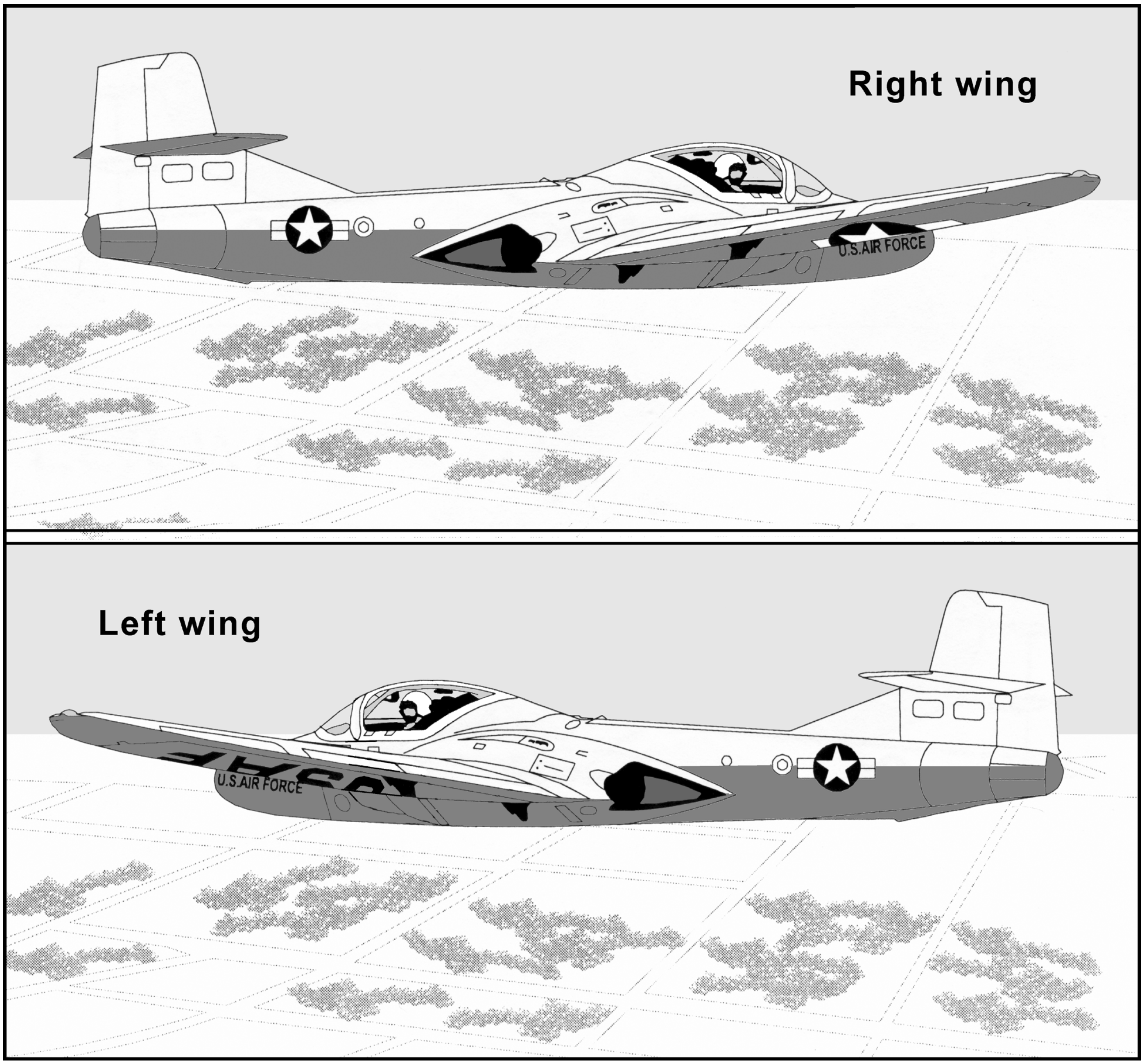
8.14.6. If a visual join-up cannot be accomplished at leveloff, lead will request 1,000 feet of altitude separation for each succeeding aircraft or element, if all aircraft can comply with the minimum safe altitude.

8.14.7. Wingmen will accomplish a rejoin only after visually acquiring lead and receiving permission to rejoin.

**8.15. Fingertip Formation.** This type of formation flying will form a basis for all formation flying.

8.15.1. **Position.** The fingertip position is flown on an angle approximately 30 degrees back from lead with approximately 3 feet of wingtip clearance (**Figure 8.2.**). As the wingman, one reference to maintain longitudinal position is to align the pilot's head in the lead aircraft with the outside flap hinge. As a vertical reference, you should see approximately one-half of the ejection triangle or approximately one-third of the top of the wing and two-thirds of the bottom (**Figure 8.3.**). As the wingman, you will have 3 feet of wingtip spacing when you barely see the trailing edge of lead's opposite elevator. These are only a few of many references. Your IP will point out others. Do not stare at one reference. Look at the whole aircraft and clear through your lead. Scanning from reference to reference will help you detect small changes in position. You must be on the 30-degree line for your vertical and lateral references to be accurate.

**Figure 8.3. Fingertip References.**




8.15.2. **Technique:**

8.15.2.1. Good formation is the result of anticipation, planning, and the application of small corrections. Detect shifts in position promptly and stay in formation. If a deviation from the standard position is noticed, correct one reference at a time in the following order: vertical, longitudinal, spacing. Do not attempt to correct all three parameters at once. Always keep the aircraft trimmed and coordinated. This is one of the most important fundamentals of good formation flying. In turns, the wingman maintains the same relative position as in level flight with respect to lead (**Figure 8.4.** and **Figure 8.5.**).

**Figure 8.4. Turn-Into Position.**

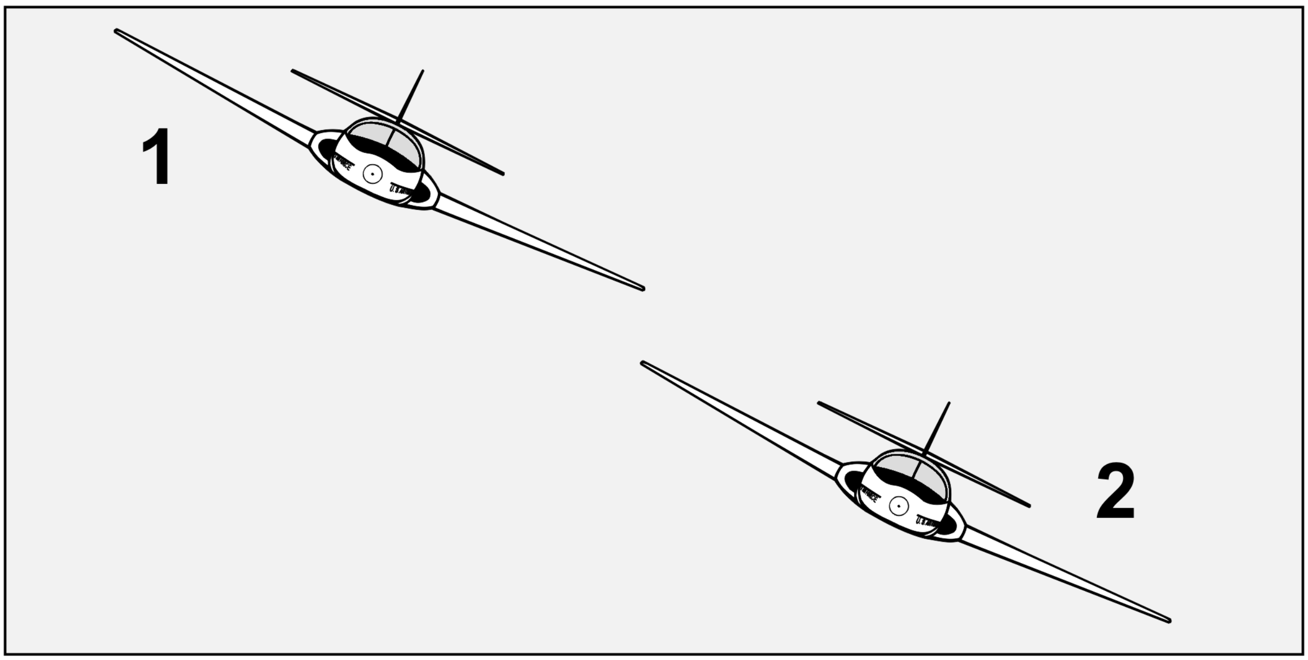
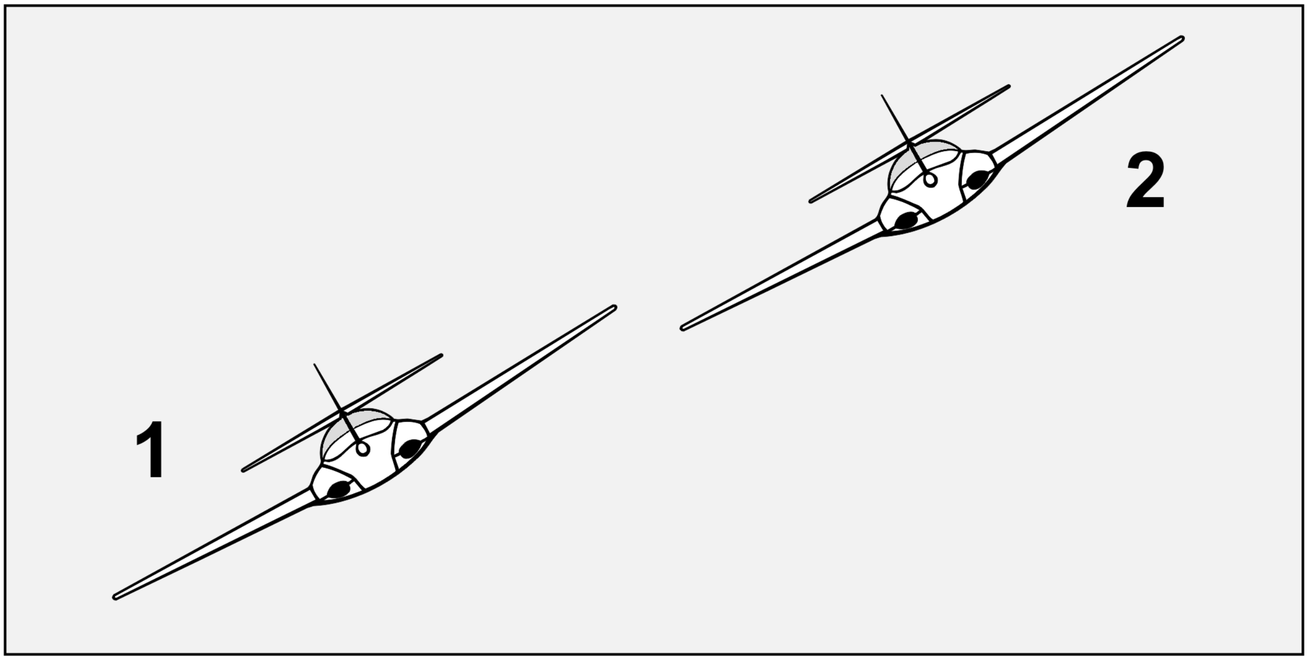


**Figure 8.5. Turn-Away Position.**




8.15.2.2. As the wingman, when lead turns away from you, increase back stick pressure and climb to maintain your vertical position. This requires an increase in power to maintain your airspeed and position on the 30-degree line. When lead stops the roll in, you must reduce power because you are no longer climbing. When lead turns toward you, add slight forward pressure to maintain vertical position and reduce power to stay on the 30-degree line. Be aware of collision potential at all times.

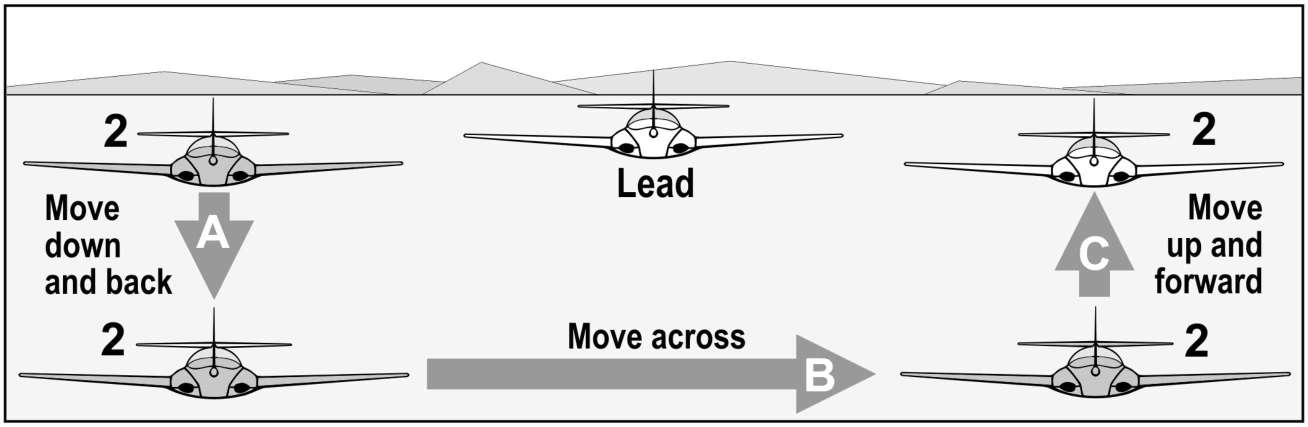
8.15.2.3. In turbulence, while flying maximum performance maneuvers or maneuvers which are not frequently flown (for example, pushovers at less than 1 G), the collision potential increases. During pushover maneuvers, your ability to counteract movement toward lead will be limited with near zero or negative Gs. For example, bank alone in zero G conditions will not produce a heading change. Under these conditions, avoid wingtip vortexes because a rapid roll into lead may develop. Should a breakout become necessary, use rudder, aileron, power, and speed brake as the situation dictates. Break out in the direction that will ensure immediate separation.

**8.16. Crossunder:**

8.16.1. The purpose of performing a crossunder is to efficiently and safely move from one wing position to the opposite wing position. A crossunder may be accomplished from either fingertip or route formation positions. To fly good crossunders as the wingman, you must anticipate each power change and make the smallest possible changes in pitch and bank. Crossunders may be completed during turns when you are proficient. Do not pass under lead.

8.16.2. Lead will signal for a crossunder by dipping a wing in the desired direction of change (**Figure 8.6.**). The wingman will use the following procedures when accomplishing the crossunder from fingertip:

**Figure 8.6. Crossunder.**




8.16.2.1. Reduce power slightly and, as airspeed decreases, move a few feet lower than normal position.

8.16.2.2. Move aft to obtain nose-tail clearance. Then increase power slightly to maintain this spacing. (Anticipate the power increase to prevent falling too far behind.)

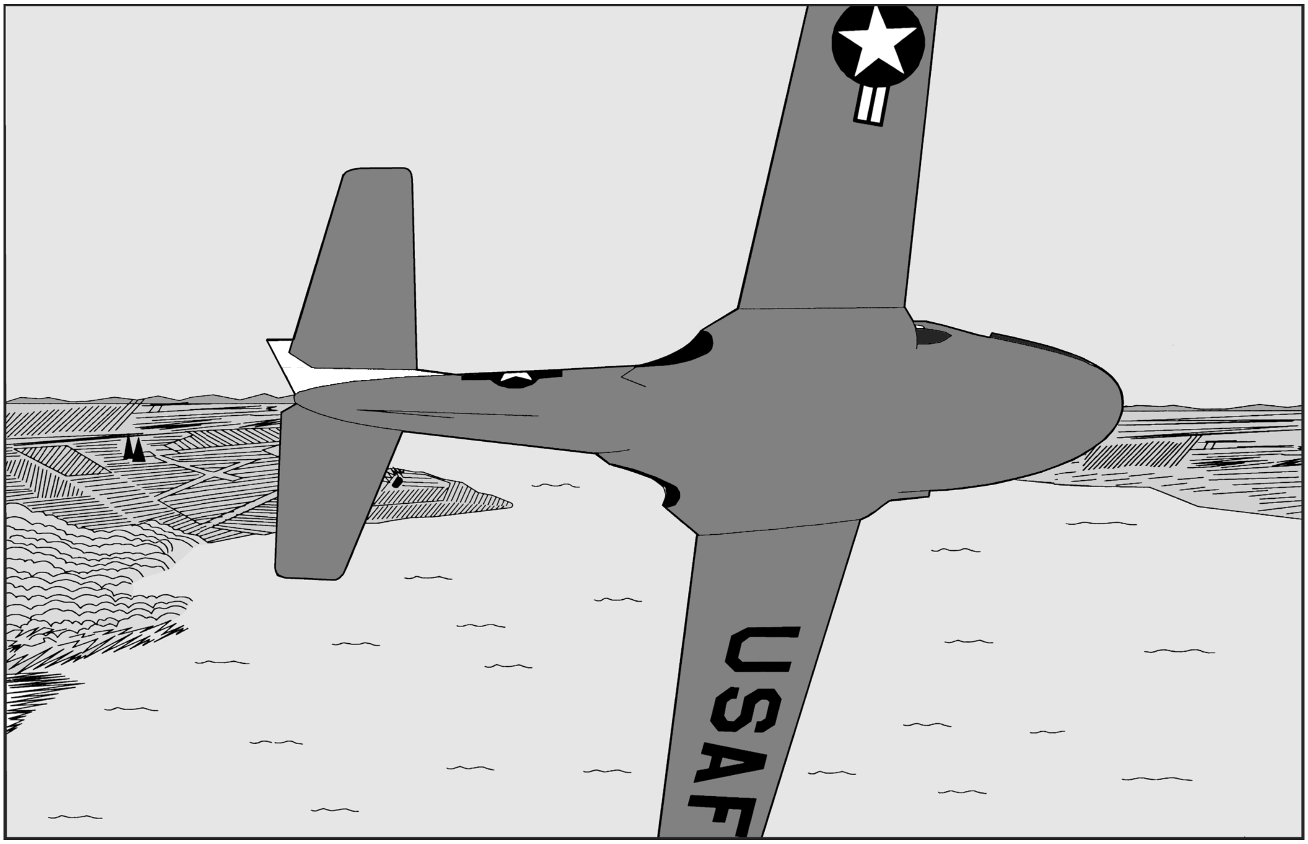
8.16.2.3. Bank slightly toward the new position to change the aircraft heading a few degrees. Roll wings level, and fly to the opposite side. A heading change of only 1 or 2 degrees will cause the aircraft to fly smoothly from one side of lead to the other. Keep proper nose-tail clearance with power. A power increase is necessary to maintain this clearance. <u>Do not cross directly under any part of lead's aircraft!</u> With proper clearance from lead, your canopy bow should appear superimposed on lead's tail light.

8.16.2.4. When you have wingtip clearance, return to lead's heading. Add power and, as you move forward, move up to attain proper pitch references. As you approach the fingertip position, reduce power to stop in position.

**8.17. Echelon:**

8.17.1. Echelon is a variation of fingertip (**Figure 8.7.**). Lead will direct the formation to enter echelon turns by radio call or visual signal. Echelon turns are always made away from the wingman. Lead should roll in smoothly and maintain back stick pressure commensurate with bank angle.

**Figure 8.7. Echelon.**




8.17.2. As the wingman, you should match lead's roll rate. For a level turn, position yourself so the horizon bisects lead's fuselage. Additionally, you should see the forward edge of the ejection decal just in front of the engine intake (fore and aft reference). Distance between aircraft (measured fuselage to fuselage) should be the same as before turn entry. If out of position, use power to make corrections fore and aft, back pressure to maintain horizontal spacing, and bank to make corrections up or down.

8.17.3. During rollout, lead should use a slow, smooth roll rate and gradually reduce backpressure. The wingman should match lead's roll rate and maintain relative position. The maximum angle of bank in echelon is approximately 60 degrees.

**8.18. Route Formation:**

8.18.1. Route formation provides flexibility, allowing the wingman to check aircraft systems and personal equipment, look around, or simply relax. With the formation in route, lead should restrict maneuvering to moderate turns and pitch changes. Maximum bank angle in route is approximately 60 degrees.

8.18.2. Route is an extension of fingertip. As the wingman, fly with the lateral spacing of two ship widths to 500 feet. Fly no farther aft than the normal fingertip line, no farther forward than line abreast, and vertically the same as fingertip. Go to route when lead directs or gives the loosen formation signal.

8.18.3. As the wingman, when on the inside of the turn, descend only as necessary to keep lead in sight and stay below lead's plane of motion. When on the outside of the turn, maintain the same vertical references used in echelon. During turns, you may need to maneuver behind the fingertip line to maintain spacing and keep sight of lead. Do not cross to the opposite side unless directed by lead. Route crossunders may be directed with a radio call or wing dip.

8.18.4. When lead directs a move to route formation from fingertip for radio channel changes, in-flight checks, or lead changes, wingmen will fly two to four ship width spacing unless briefed otherwise. During rejoins, wingmen will stabilize in a route position with two to four ship width spacing before closing to fingertip.

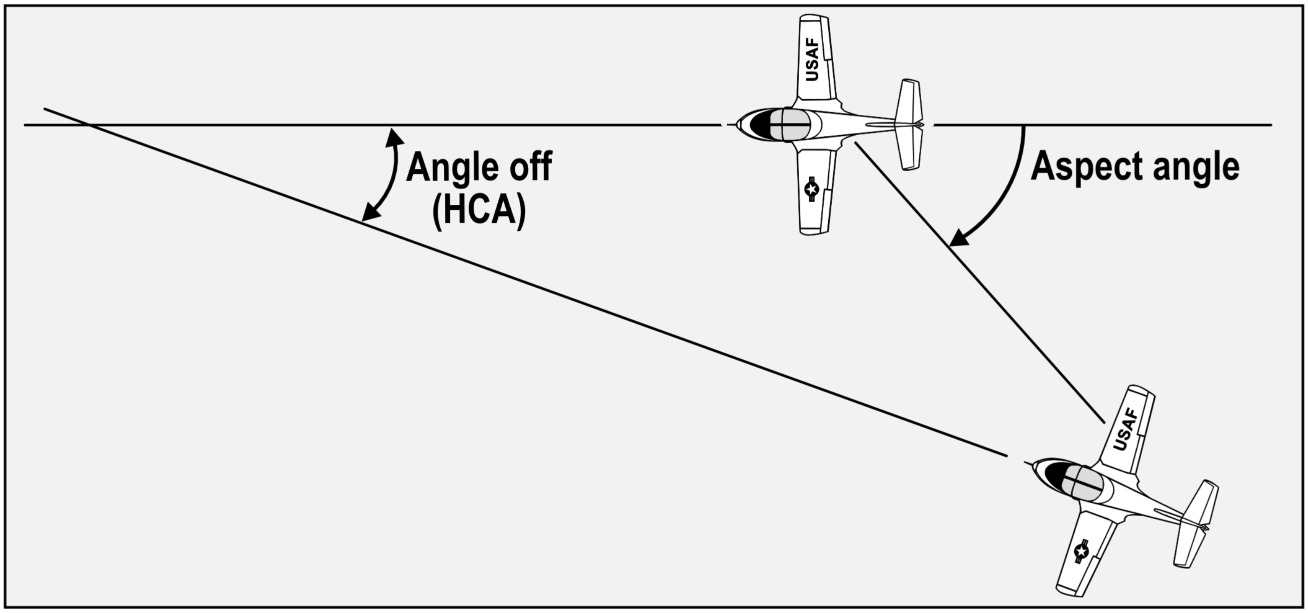
**8.19. Pitchout.** The purpose of the pitchout is to provide spacing for rejoin practice, as follows:

8.19.1. **Lead.** The pitchout signal is the same as the signal for engine runup. Clear in the direction of the desired turn and begin a turn away from the wingman, using approximately 60 degrees of bank. Continue the turn for approximately 180 degrees. Although a level pitchout is desired, you may make modifications to your energy level. Do not sacrifice clearing in order to maintain precise altitude control or an exact 180-degree turn.

8.19.2. **Wingman.** Delay up to 5 seconds. Then begin a turn to duplicate lead's rate of roll, bank, and general flightpath. After turning approximately 90 degrees, play the turn by varying bank and back stick pressure to roll out behind and slightly below lead. An alternate method for obtaining spacing for rejoins may be used when circumstances permit. Lead will direct the flight to take spacing. Acknowledge and drop back to obtain the appropriate spacing.

**8.20. Maneuvering Fundamentals.** The remaining parts of this chapter deal with maneuvering one aircraft in relation to another. Although not always apparent, two basic parameters apply to every situation where two or more aircraft maneuver three-dimensionally in relation to each other. These parameters are aspect angle and angle off (**Figure 8.8.**). Through the use of appropriate pursuit geometry, aircrews can control these parameters. As you read the remaining parts of this chapter and progress in the formation category of training, you will begin to see all the applications of these principles.

**Figure 8.8. Maneuvering Fundamentals (Aspect Angle Versus Angle Off).**

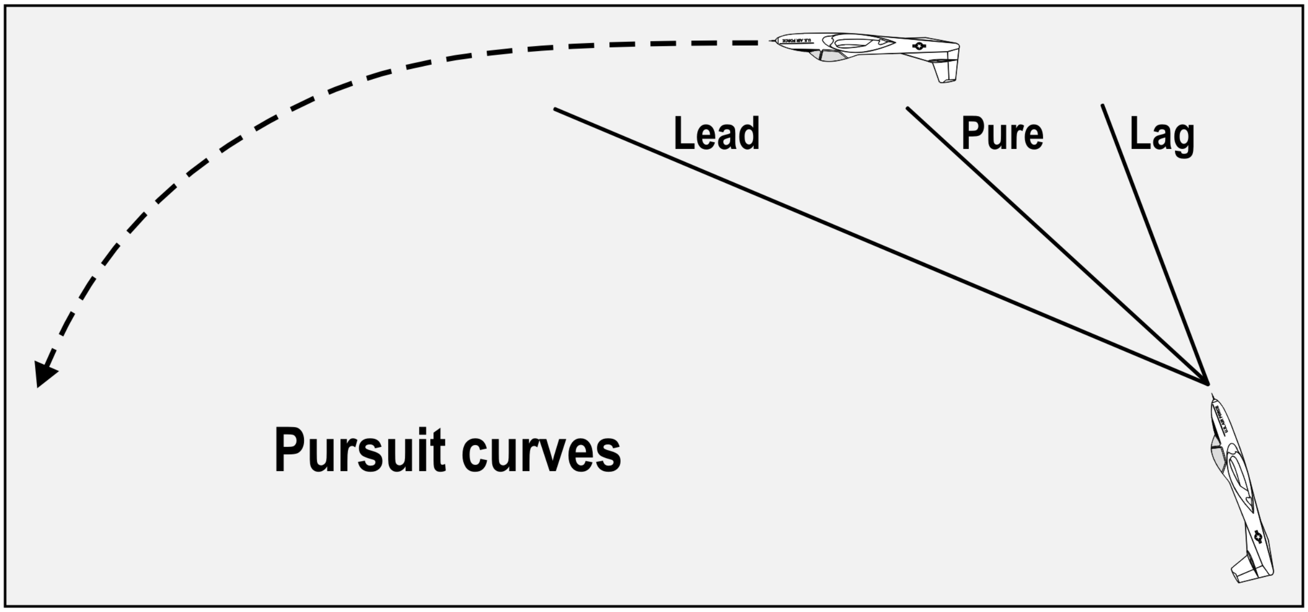



8.20.1. **Angle Off.** Angle off is the relative nose position of two aircraft; that is, the angular difference between the longitudinal axis of the wingman and the longitudinal axis of the leader. Angle off is sometimes referred to as heading crossing angle (HCA).

8.20.2. **Aspect Angle.** Aspect angle is the relative position of the wingman to lead without regard to the wingman's heading; that is, the angle measured from the tail of lead to the position of the wingman. It is not a clock position off of lead.

8.20.3. **Pursuit Geometry.** Lead, lag, and pure pursuit curves control aspect angle and angle off. Although these air-to-air principles are complex in the ever-changing combat arena where very few absolute rules exist, the following basic relationships apply in the controlled training environment: (***NOTE:*** These relationships are shown in **Figure 8.9.**)

**Figure 8.9. Pursuit Curve Relationship Chart.**




8.20.3.1. **Lead Pursuit.** With lead pursuit, the wingman will point in front of lead. Lead's aircraft will create an aft line of sight (LOS) rate across the wingman's canopy (moving from front to back). This decreases angle off, increases aspect angle, and creates closure. If carried to an extreme, lead pursuit will result in the wingman flying past lead.

8.20.3.2. **Lag Pursuit.** With lag pursuit, the wingman will point behind lead. Lead's aircraft will create a forward LOS rate across the wingman's canopy (moving from back to front). This increases angle off, decreases aspect angle, and decreases closure. Ultimately, spacing will increase between the wingman and lead.

8.20.3.3. **Pure Pursuit.** With pure pursuit, the wingman will continually point at lead. Lead's aircraft will remain stationary on the wingman's canopy. This does little to control aspect angle or angle off, but it does create closure. However, the closure rate created by pure pursuit is less than the closure rate created by lead pursuit.

**8.21. Turning Rejoins.** Turning rejoins are used to get the aircraft into fingertip as safely and expeditiously as possible. Rejoin airspeed is 190 KIAS unless otherwise briefed.

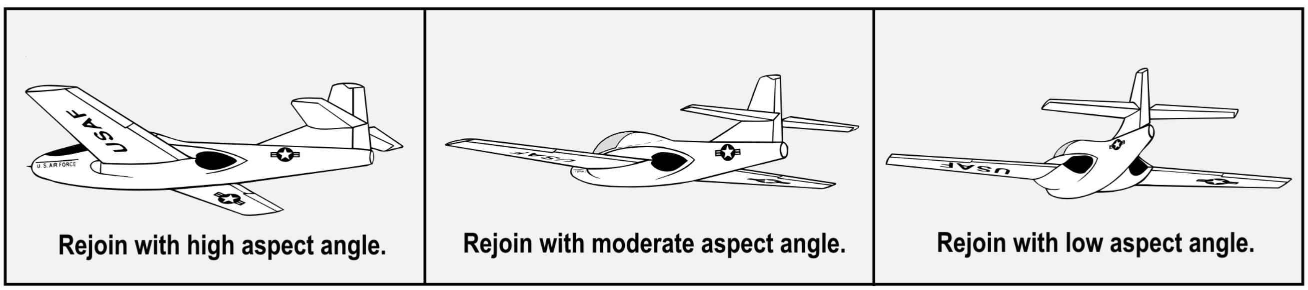
8.21.1. **Lead.** After rolling out of the pitchout, wait long enough for your wingman to roll out in trail. Signal for a rejoin either by a radio call or by rocking your wings. Establish a turn, using approximately 30 degrees of bank, and adjust power and pitch as necessary to maintain rejoin airspeed. If you need to change the prebriefed airspeed, call the new airspeed. Hold the bank and pitch stable to assist the wingman. During the rejoin, monitor the wingman and clear the area.

8.21.2. **Wingman:**

8.21.2.1. When lead gives the rejoin signal and enters a turn, start a turn in the same direction. Use approximately the same angle of bank as lead and pull lead pursuit until you approach the desired aspect angle. Stay slightly beneath lead's altitude at all times so both pilots in the wingman aircraft can keep lead in sight. A power increase will also expedite the rejoin.

8.21.2.2. As you move inside lead's turn, you will notice his or her vertical stabilizer appears to move toward the outside wingtip as the aspect angle increases. When the vertical stabilizer approximately bisects the outside wing, reduce your angle of bank to maintain this reference. If the vertical stabilizer appears to move toward the wingtip, your aspect angle is increasing. To correct this, shallow your bank to decrease lead pursuit. If the vertical stabilizer appears to move toward the wing root, your aspect angle is decreasing. To correct this, increase your bank (lead pursuit). This reference will provide a reasonable cutoff during the initial phase of the rejoin. As you get closer to lead, the tail on the wing reference will change and the vertical stabilizer will appear to move toward the outside wingtip (**Figure 8.10.**).

**Figure 8.10. Appearance of Lead from Various Rejoin Angles.**




8.21.2.3. The critical stage of the rejoin begins when you are approximately 500 feet from join-up and slightly behind the 30-degree line. From this position, you will begin to see normal fingertip references. To move toward lead, drop down slightly and move forward (lead pursuit) slightly onto an extension of the fingertip line. Begin decreasing the overtake airspeed with a power reduction and speed brake as necessary. Monitor bank and overtake closely during the last few hundred feet before join-up to ensure your movement is controllable. Plan to arrive in the route position with airspeed the same as lead. Stabilize in this position, and then move into fingertip at a controlled rate.

8.21.2.4. To rejoin on the outside of the turn (Number 3 position), plan to pass behind (at least two ship lengths) and below lead. Stabilize two to four ship widths out in the route position. Then move into fingertip at a controlled rate.

## 8.22. Straight-Ahead Rejoins:

8.22.1. **Lead.** After the pitchout, call for a straight-ahead rejoin with a radio call or visual signal. The wingman will rejoin to the side you direct. (If not specified, the wingman will rejoin to the left side.) Announce the airspeed if it differs more than 10 knots from that prebriefed.

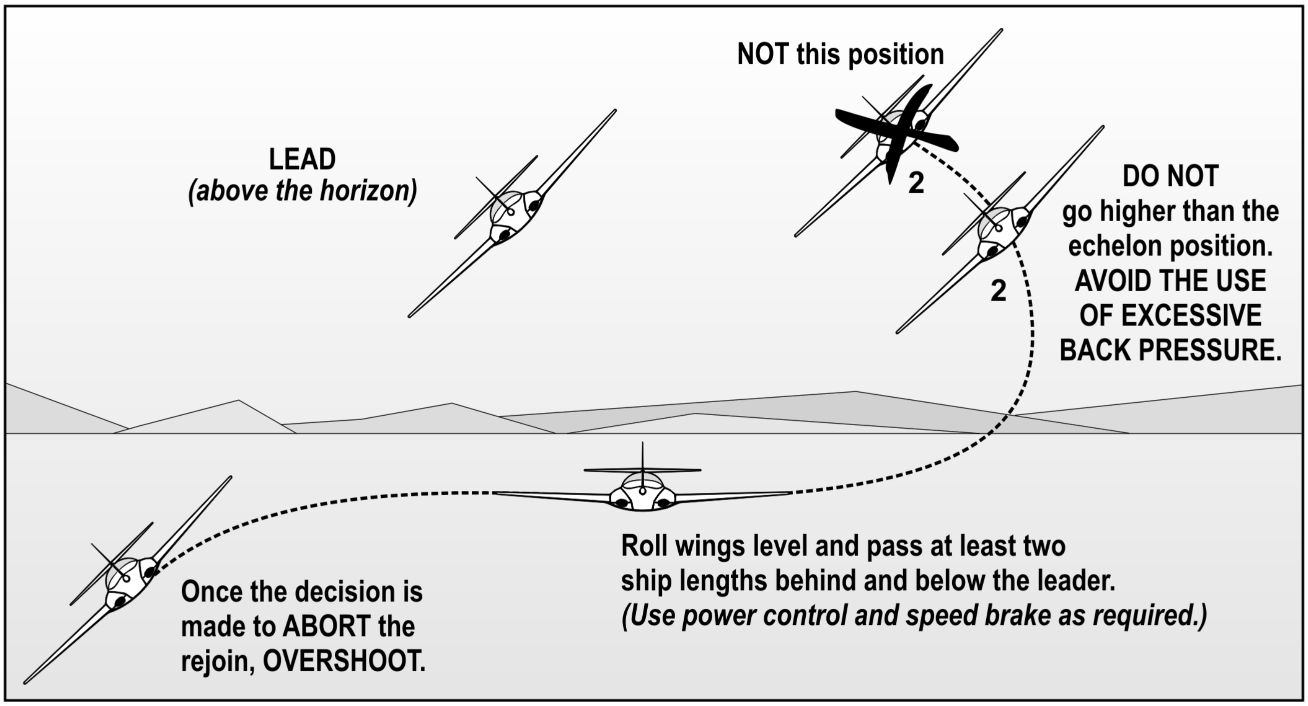
8.22.2. **Wingman.** Initially, use power as necessary and move below and slightly to the left side or as designated by lead. Your flightpath should angle away from lead to the route position. Do not drive up lead's 6 o'clock. Continue to close until you are approximately 1,000 to 500 feet to the rear of lead. From this point, begin decreasing the overtake speed with a power reduction and plan to arrive in the route position with airspeed the same as lead's. After matching speed in the route position, move into the fingertip position. If lead must turn during a straight-ahead rejoin, transition to a turning rejoin and be alert for overshoot situations because you may have both a cutoff and airspeed advantage.

**8.23. Overshoot:**

8.23.1. **Turning Rejoin:**

8.23.1.1. If, despite reduced power and use of the speed brake, an overshoot develops, the wingman will stay low enough to keep lead in sight and use lag pursuit to move outside of the turn with at least two ship lengths of nose-tail clearance (**Figure 8.11.**). The greater the closure rate, the wider the wingman must go to prevent moving forward of lead's position.

**Figure 8.11. Overshoot.**




8.23.1.2. As the wingman, once outside the turn, do not move forward of lead's position. Avoid excessive back stick pressure because this will cause you to close on lead. Go no higher than lead. After momentarily stabilizing, return to the inside of the turn with a minimum of two ship lengths of nose-tail clearance on the lead aircraft and complete a normal join-up.

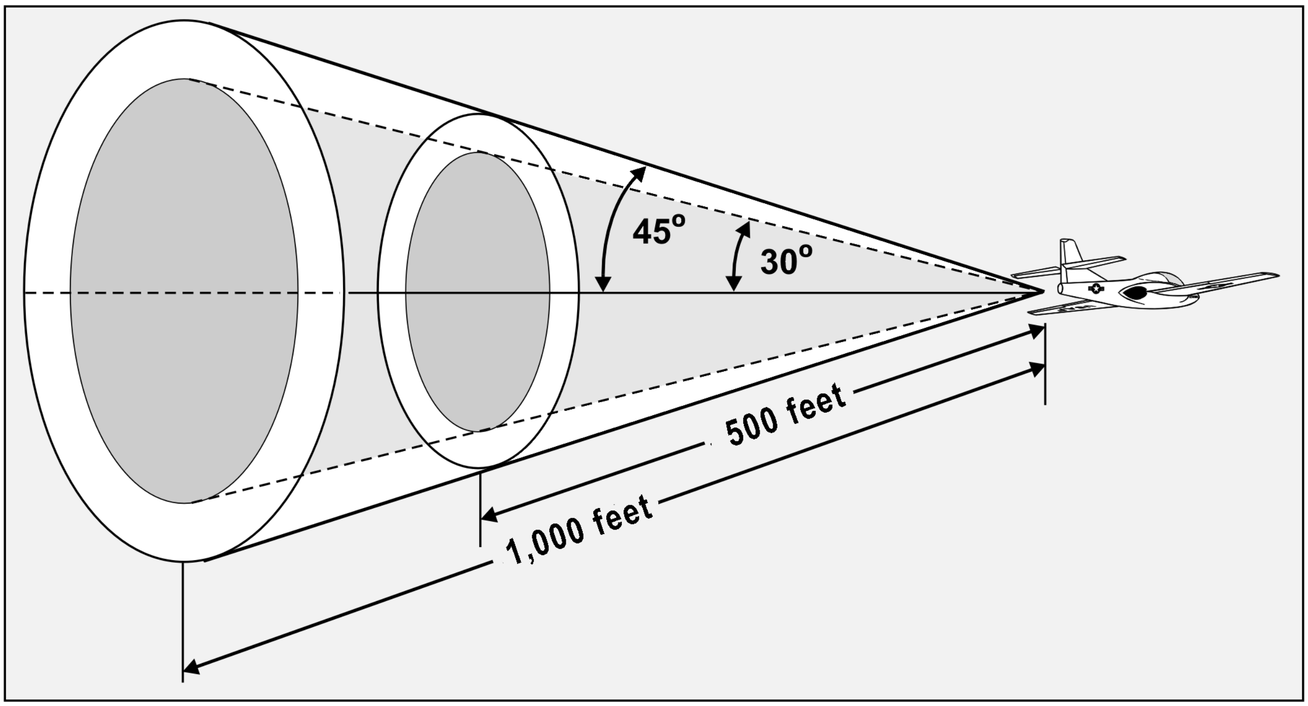
8.23.1.3. During an overshoot, lead should keep the wingman in sight if practical and must provide a stable platform for Number 2. However, if a collision appears imminent, lead must take positive action to prevent a midair collision.

8.23.2. **Straight-Ahead Rejoin.** As the wingman, if your closure rate is excessive during the straight-ahead rejoin, reduce power and use the speed brake as required to establish a safe closure rate. If you are going to overshoot, maintain lateral separation by turning away slightly from the lead. Keep lead in sight. (If you overshoot to the point that it becomes difficult to keep lead in sight, break out of the formation.) Resume the rejoin when lead begins to move ahead. When overshooting straight ahead, there is a tendency to move the control stick in the direction you are looking; that is, toward lead. If uncorrected, this action may cause your aircraft to pass in front of or below lead, resulting in one of the mandatory breakout situations (paragraph **8.6.4.**).

**8.24. Fighting Wing:**

8.24.1. Fighting wing is a fluid position using a 30- to 45-degree cone 500 to 1,000 feet aft of lead. The cone is defined as 30 to 45 degrees out from the extended longitudinal axis of the lead aircraft, with 30 degrees as the inner limit and 45 degrees the outer (**Figure 8.12.**).

**Figure 8.12. Fighting Wing or Extended Trail Cone.**




8.24.2. The wingman may maneuver within the cone to enhance formation flexibility, maximize clearing, or simply to give an alternate departure, cruise, or recovery position. Staying within the cone requires constant analysis of aspect angle and closure in order to apply the proper amounts of lead and lag pursuit.

8.24.3. To send the wingman to the fighting wing position, lead will use a radio call, "Reno, go fighting wing." The wingman will acknowledge the call and maneuver into the cone.

8.24.4. Even though the fighting wing position is defined by the cone described in paragraph **8.24.1.**, the wingman should typically remain on or near the plane described by lead's wings (the plane defined by lead's lateral and longitudinal axis). This "in-plane" position affords good visibility and maneuverability.

8.24.5. During turns, climbs, and descents, the wingman may use different parts of the cone to enhance clearing. To "clear through lead," the wingman can fly on the side opposite lead's direction of flight. For example, if lead is in a descending right turn, the wingman would be on the left side and near "in-plane." This position places the wingman higher than lead on the outside of the turn and allows the wingman to more easily monitor lead and lead's flightpath. The wingman should not stagnate in lead's high or low 6-o'clock position while maneuvering within the cone.

**8.25. Extended Trail Exercise.** The primary emphasis of an extended trail exercise is to develop the ability to use lead, lag, and pure pursuit to explore and practice three-dimensional maneuvering in relation to another aircraft. Lead will serve as a training platform for the wingman. The desired learning objective for the wingman is to maneuver within the fighting wing cone. The process of analyzing and solving angle and closure problems requires an understanding of the consequences of flying each pursuit curve. As with other maneuvers, the success or failure of the extended trail exercise depends heavily on the preflight briefing. Flight leads must ensure all flight members are briefed on SPINS appropriate to the mission. SPINS include, but are not limited to responsibilities, setup parameters, communications plans, deconfliction plans, post maneuver plans, and contingencies.

8.25.1. **Position.** The extended trail exercise is flown in the fighting wing cone. Staying within the cone requires a constant analysis of aspect angle and closure in order to apply the proper amounts of lead and lag pursuit. Both aircraft initially use the same power setting, but the wingman may adjust the power if a power differential becomes apparent.

8.25.1.1. **Lead.** Lead should emphasize clearing, smoothness, and providing a stable training platform for the wingman with consistent, predictable roll rates and no sudden changes in back pressure. Lead is not required to perform maneuvers to the precise parameters used in contact flying. He or she may vary the attitudes and airspeeds as necessary for effective training, area orientation, clearing, and smoothness. Lead will consider the wingman's skill level while maneuvering to prevent exceeding the wingman's capabilities, but will continue to challenge with turns and modified lazy eights. High-G maneuvers are of little value if the wingman is unable to maintain the proper position. Lead must remain constantly aware of G forces because the wingman is often exceeding lead's G level to maintain or regain position. Lead should attempt to keep the wingman in sight, but not sacrifice clearing to do so. However, lead should maintain situational awareness of the wingman's position at all times. Lead should not attempt to maneuver so as to force a wingman to overshoot.

8.25.1.2. **Wingman.** As the wingman:

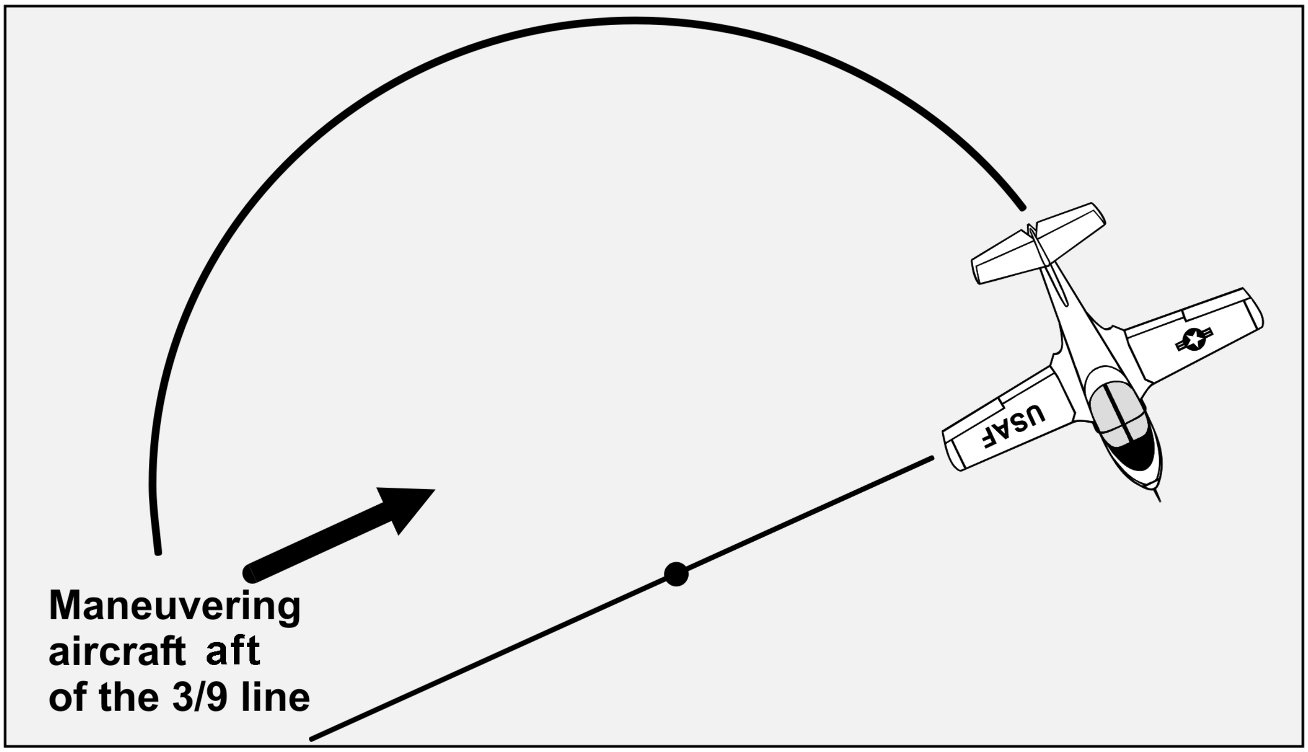
8.25.1.2.1. Strive to maneuver where lead can stay visual. The only time you should be directly aft of lead is when crossing from one side to the other.

8.25.1.2.2. The basic principles of pursuit curves and closure control you learned during rejoins are expanded into a more fluid environment. The extended trail exercise allows your IP to show the relationship between lead, lag, and pure pursuit curves as they relate to aspect, range, and closure. Essentially, you will learn how to properly fly the appropriate pursuit curve to solve problems of range, aspect, and closure that lead will create.

8.25.1.2.3. Learning how and when to transition from one pursuit curve to another to solve these problems requires that you understand basic concepts involving turn circle geometry, aspect awareness, and energy management. You must also remain aware of and be ready to use the correct pursuit curve to maintain position.

8.25.2. **Turn Circle Geometry.** During the extended trail exercise, you (as the wingman) will constantly analyze the geometry of lead's turn; for example, turn rate and turn radius, bank angle, and G-loading. Lead's turn geometry and how you fly the various pursuit curves will determine the aspect, range, and closure problems you must solve. In a level turn—using 2 Gs, 60 degrees of bank, and approximately 230 knots true airspeed (KTAS)—lead's approximate turn rate and turn radius will be 8 degrees per second and 2,700 feet, respectively. As lead turns, his or her 3/9 line will point to the center of the turn circle. The line will continue through the center of the circle, creating the diameter of that circle and defining the airspace in which you (as the wingman) must maneuver. Always remain in the airspace aft of the 3/9 line (**Figure 8.13.**).

**Figure 8.13. Aircraft 3/9 Line.**




8.25.3. **Aspect Awareness.** As the wingman:

8.25.3.1. Aspect recognition and turn circle geometry are equally important in determining how and when to fly the proper pursuit curve. During the extended trail exercise, you will analyze your aspect angle continually during the entry and maneuvering phases. During the entry, because the maneuvering area is limited up to but not forward of the 3/9 line, your aspect angle will range from 0 degrees to 90 degrees.

8.25.3.2. Aspect is referred to from 0 to 9, left or right. (Remember, aspect is not a clock position.) The straight wing of the T-37 makes recognition of the 9-aspect line easy even at large distances. You are already familiar with the 6-aspect line because this is the extended fingertip line. A 4-aspect reference is the vertical tail on or inside the wingtip. A 3-aspect reference is the vertical tail bisecting the wing.

8.25.3.3. When assessing your position in relation to lead, you must determine how aspect will change as you maneuver. Because of the T-37's small turn radius and fast turn rate, you must anticipate where your aircraft is going and maneuver to control aspect. Anticipation will help you avoid exceeding extended trail exercise parameters. This is especially true when lead turns into you or when you use lead pursuit to decrease range. You must also be aware that your aspect angle and angle off are constantly changing due to lead's continuous turning movement.

8.25.4. **Energy Management:**

8.25.4.1. While maneuvering with a fixed, prebriefed power setting, lead will most likely use vertical movement to preserve energy and provide various angle problems for the wingman to solve. As in wing work, vertical movement will allow lead to maintain sufficient energy to maneuver.

8.25.4.2. G-loading is also important while maneuvering because the T-37 is easily susceptible to energy loss under high G-loading. Consequently, both aircraft should avoid the buffet, and the wingman should consider unloading to 1 G or less when applicable to preserve and/or gain energy. This is particularly effective when the wingman is in lag pursuit and both aircraft are in a descent. The wingman has the option to change the power setting to preserve position and prevent training loss or because a difference in aircraft performance dictates.

8.25.5. **Specific TRs for the Extended Trail Exercise:**

8.25.5.1. Aircraft flying inside the 300-foot slant range "bubble" or forward of the 3/9 line will call "knock-it-off" as described in paragraph **8.6.2.**

8.25.5.2. Aircrews will limit the extended trail exercise to turns and modified lazy eights (bank angles not to exceed 120 degrees).

8.25.5.3. Abrupt turn reversals will not be performed; that is, turns in one direction followed by a rapid, unanticipated roll in the opposite direction.

8.25.5.4. The extended trail exercise is limited to two-ship formations.

8.25.5.5. When the wingman is performing the extended trail exercise and loses sight of lead, he or she will break out of the formation as described in paragraph **8.6.4.** and call "blind" as described in paragraph **8.6.5.**

8.25.6. **Flying the Extended Trail Exercise—Entry.** Because of the maneuvers used during the extended trail exercise, lead should select an altitude approximately in the middle of the altitude block and 180 to 220 KIAS. Lead will direct the formation to begin the extended trail exercise over the radio, indicating what level of maneuvering to expect ("Reno, go extended trail exercise level 1/2").

8.25.7. **Flying the Extended Trail Exercise—Maneuver (Level One):**

8.25.7.1. **Lead:**

8.25.7.1.1. After the wingman acknowledges the "level one" call, enter a moderate G turn of approximately 2 Gs. Constantly monitor your G loading and take into account that your wingman is often exceeding your G loading to maintain position. Look for the wingman behind the wing, not at your 6-o'clock position. Monitor the wingman's aspect and closure for inadvertent 3/9 line passage. Be prepared to "knock-it-off" if there is no attempt to correct the deviation.

8.25.7.1.2. Once the desired learning objectives have been met, transition to level two maneuvering or terminate the maneuver by directing a rejoin as follows:

8.25.7.1.2.1. Call "Reno 21 terminate," and then "Reno 1 terminate."

8.25.7.1.2.2. The wingman will answer “Reno 2 terminate.”

8.25.7.1.2.3. Then call “Reno 2 cleared to rejoin left/right side.”

8.25.7.1.2.4. Remain predictable as you transition to a level turn for the rejoin. When directing a rejoin, attempt to be in level flight at approximately 190 KIAS.

8.25.7.2. **Wingman:**

8.25.7.2.1. Once you make the radio call acknowledging the extended trail exercise, lead will fly a stable, approximately 2 G turn to allow you to explore the fighting wing cone using lead, lag, and pure pursuit curves. While maneuvering, your range should never be less than 300 feet from lead or forward of lead’s 3/9 line. The desired range for the exercise is 500 to 1,000 feet.

8.25.7.2.2. During the turn, move forward and aft inside the fighting wing cone, using the appropriate pursuit geometry. Try not to stagnate in any position. Aspect changes can occur rapidly, and you must be prepared to maneuver accordingly. Pause momentarily to see how rapidly lead is moving, predict lead’s flightpath, and then maneuver. When in lag pursuit, do not allow your angle off to build excessively. Normally, you will not spend much time in a lag pursuit curve.

8.25.7.2.3. If you desire to cease maneuvering or are unable to maintain position, use the “terminate” procedures described in paragraph **8.6.2.**

8.25.8. **Flying the Extended Trail Exercise—Maneuver (Level Two):**

8.25.8.1. **Lead:**

8.25.8.1.1. Once the wingman acknowledges the “level two” call, begin maneuvering using moderate G turns and modified lazy eights. Consider the skill level of your wingman when performing all maneuvers. Tight, high-G maneuvers are of little value if the wingman is unable to maintain proper position. Constantly monitor your G-loading and take into account that your wingman is often exceeding your G-loading to maintain position. Monitor the wingman’s aspect and closure for inadvertent 3/9 line passage. Be prepared to “knock-it-off” if there is no attempt to correct the deviation.

8.25.8.1.2. Never maneuver in an unpredictable or abrupt manner that may force the wingman forward of your 3/9 line. Vertical movement to manage energy also presents difficult angle and closure problems for the wingman. Always observe the wingman’s aspect angle and angle off before maneuvering aggressively because he or she may, in turn, be aggressively repositioning to counteract your current flightpath.

8.25.8.1.3. Because you are a training platform for your wingman, it is incumbent upon you to provide reasonable problems to solve. If you maneuver too aggressively, your wingman may not be able to achieve the desired training objectives. Once the desired learning objectives have been met, terminate the maneuver by directing a rejoin as described in paragraph **8.25.7.1.2.**

8.25.8.1.4. Remain predictable as you transition to a level turn for the rejoin. When directing a rejoin, attempt to be in level flight at approximately rejoin airspeed.

8.25.8.1.5. After each extended trail exercise, initiate a fuel and G check, using the radio. For example, you will begin "Reno 1, 800, 4.0 G," and the wingman will respond, "2's, 800, 4.5 G." Report the maximum G reading on all G checks.

8.25.8.2. **Wingman:**

8.25.8.2.1. While maneuvering, your range should never be less than 300 feet from lead or forward of lead's 3/9 line. The desired range for the exercise is 500 to 1,000 feet. Lead will fly turns and vertical maneuvering with modified lazy eight-type maneuvers at various G-loads to familiarize you with the fundamental concepts of maintaining position, using lead, lag, and pure pursuit curves.

8.25.8.2.2. As your proficiency increases, you will explore the performance envelope of the aircraft, thus building the confidence and ability required for high-performance formation maneuvering under varying flight conditions. During these maneuvers, you must predict lead's flightpath and maneuver in relation to lead. This will require you to analyze lead's plane of motion and turn rate before deciding which pursuit curve to fly. Realize that lead and lag pursuit exist in both the vertical and horizontal planes. As you anticipate lead's nose movement, you will move continuously from lag to lead pursuit curves while lead is maneuvering. Aspect changes can occur rapidly, and you must be prepared to maneuver accordingly. For example, if lead turns into you as you are aggressively pulling lead pursuit, you may easily exceed the forward 45-degree limit. Pause momentarily to see how rapidly lead is moving, predict lead's flightpath, and then maneuver. When in lag pursuit, do not allow your angle off to build excessively. Normally, you will not spend much time in a lag pursuit curve.

8.25.8.2.3. Conservation of airspeed is critical during the extended trail exercise; and it requires awareness of the maneuver being performed, amount of back stick pressure applied, and buffet encountered.

8.25.8.2.4. You may have to exaggerate your pursuit curves and adjust your power to remain in position. Normally, you will stay in an exaggerated pursuit curve for only a short period of time and remain below lead's flightpath to enhance your visibility in case lead turns into you. From that position, a move to a lag pursuit curve is the best solution.

8.25.8.2.5. Flying intentional lag rolls is not a desired training objective. Transitory periods in lead's high or low 6-o'clock position while maneuvering is acceptable. However, you should avoid stagnating in the 6-o'clock position, concentrating instead on maintaining the 30- to 45-degree cone and approximately "in-plane" (the plane described by lead's flightpath).

8.25.8.2.6. Even when using the various pursuit curves to maintain position, most of the time you will be in an arc that is ± 45 degrees from "in-plane" when viewing the extended trail exercise cone from the rear. This position will challenge your knowledge of pursuit curves as well as aspect and closure awareness. If you desire to cease maneuvering or are unable to maintain position, use the "terminate" procedures described in paragraph **8.6.2.**

8.25.9. **General.** As with other formation maneuvering, each pilot has the responsibility to take whatever action is necessary to avoid a collision. Because of the dynamic nature of the extended trail exercise, the problems of collision avoidance are compounded and require uncompromising flight discipline. Either aircraft should use the "knock-it-off" radio call as described in paragraph **8.6.2.** to cease maneuvering when a TR has been violated or a safety of flight conflict arises.

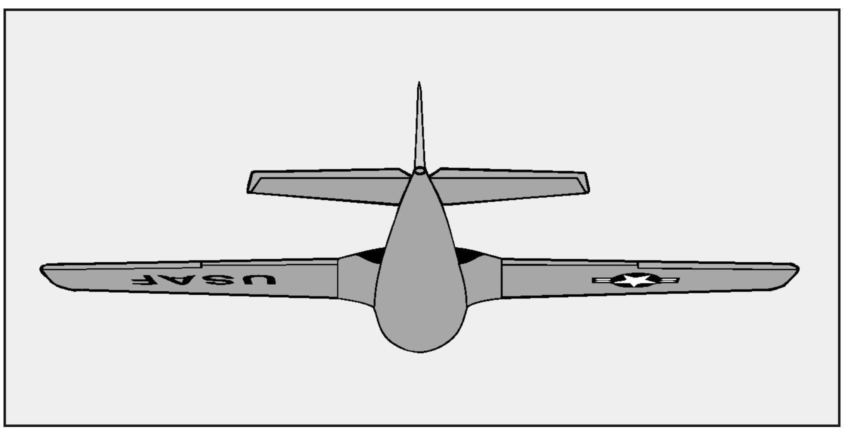
**8.26. Close Trail.** Close trail is flown to demonstrate flying in close proximity directly behind another aircraft. Lead may initiate the maneuver from fingertip, echelon, or route.

8.26.1. **Lead.** Direct the wingman to the close trail position with a prebriefed visual signal or a radio call, “Reno, go close trail.” Wait for the wingman to call in before maneuvering. Maneuver in a smooth, predictable manner and maintain positive G forces at all times. Avoid sudden releases of back stick pressure and rapid turn reversals. Power requirements are identical to fingertip formation.

8.26.2. **Wingman.** Acknowledge the call to go close trail, maneuver to the trail position, and use the radio call, “Reno 2’s in” when you are in position. The proper close trail spacing is one to two aircraft lengths (nose to tail) behind lead and just below lead’s jetwash. Maintain this position primarily through the use of power. However, when lead is turning at higher G-loads, you may need to use a small amount of lead pursuit to maintain position.

8.26.2.1. **Close Trail Position.** Use the relationship between the tips of lead’s horizontal tail and the underside of lead’s wing as an aid in estimating nose and tail separation. At approximately two ship lengths, the tips will line up with the inside of the “U” in “USAF” on the left side and the inside of the chevron on the right side (**Figure 8.14.**). At approximately one ship length, the tips are in the middle of the “U” in “USAF” on the left side and just inside the chevron on the right side. As a vertical reference, place lead’s horizontal tail at the top of the canopy bow. To prevent encountering jetwash, never fly higher than a position where you can begin to look directly into lead’s exhaust nozzles. As lead maneuvers, anticipate power changes to prevent too little or too much spacing.

**Figure 8.14. Close Trail.**




8.26.2.2. **Closure.** Closure rates are difficult to determine when directly behind lead. Therefore, if excessive spacing exists, do not attempt to move forward with power alone. Add power and establish a small amount of lead pursuit while in a turn. If you are in a wings-level attitude, move off to one side to obtain a better perspective of lead. Make a “terminate” call if you fall significantly out of position. The two most important points to remember are to remain below lead’s jetwash and always keep lead in sight.

8.26.3. **Termination.** Close trail maneuvering may be terminated by the lead or wingman when desired learning objectives have been met. Lead will direct the formation to reform to fingertip with a wing rock or radio call. He or she should maneuver in a smooth, predictable manner and avoid any significant power changes until the wingman has reached the fingertip position.

**8.27. In-Flight Lead Changes:**

8.27.1. As the wingman, before each formation flight, you are briefed on the position you will fly. Maintain the position assigned to you for the duration of the flight unless lead directs a lead change.

8.27.2. Lead changes will be made with the formation in wings-level flight. To initiate the lead change, lead will direct the wingman to route and call or signal for the lead change. If lead uses a radio call, the wingman will acknowledge the call and becomes the new lead at that time. If lead uses a visual signal, the wingman will acknowledge with a head nod and becomes the new lead at that time.

8.27.3. The lead change is not complete until the wingman has acknowledged the lead change. (The new wingman will stay in route until rocked back into fingertip by the new lead.)

**8.28. Airborne Formation Aborts.** The primary reason for formation flying is mutual support. (This also applies to noncombat hazards.) If either member of the formation must return to the airfield prematurely, the other aircraft should normally return also and provide any assistance required. (Exceptions to this may be made by the IP if the difficulty is routine and the field is in sight or the weather conditions would complicate a safe formation return, etc.)

**8.29. Descent and Landing:**

8.29.1. During letdowns, the speed brake may be used at lead's discretion. Once established at pattern altitude for entry to the VFR pattern, all turns away from the wingman will be echelon unless briefed otherwise. Before initial approach, lead will position the wingman on the opposite wing from the direction of the break. Initial should be long enough to allow the wingman to settle down in fingertip before the break.

8.29.2. At the break point, lead should smoothly turn to the downwind and delay retarding the throttles until the turn is initiated. After lead's break, the wingman will wait 5 seconds before following, attaining spacing in the break and on downwind. On downwind, the wingman should be slightly outside lead's flightpath.

8.29.3. As the wingman, fly a normal contact pattern. Each aircraft should be able to initiate the final turn at the same point. However, do not follow a poor pattern flown by the aircraft ahead. Go around if you cannot complete a proper pattern. Each crewmember will use his or her individually assigned call sign for the gear check. In crosswinds, lead will normally land on the downwind side of the runway.

**8.30. Instrument Penetration.** Formation penetration procedures are the same as for a single ship with the following exceptions:

8.30.1. At the start of the penetration, as a technique reduce power to 75 percent. As the airspeed approaches 200 KIAS, extend the speed brake.

8.30.2. After leveloff, use the speed brake and power as required to maintain desired airspeed.

8.30.3. Before starting the penetration, position the wingman away from the direction of the penetration turn.

**8.31. Instrument Approach.** Lead will position the wingman on the upwind side of the landing runway if the crosswind exceeds 5 knots. Use a visual signal or a radio call for lowering the gear and flap. A gear-down call will be made either by the lead aircraft for the flight or by each aircraft in turn. Lead will use landing lights on final. Both aircraft will lower flaps as appropriate for the situation. To provide the wingman with a good power response, lead normally will use full flaps and a slightly shallower glidepath when the runway is in sight (approximately 3 degrees). He or she will maintain 110 KIAS on the approach after configuring.

**8.32. Formation Landing:**

8.32.1. Maintain the normal fingertip position during the approach. After definitely breaking out of the weather, but no later than 1/2 mile from the runway, the wingman will maintain the fingertip line but spread laterally to attain a minimum of 10 feet of wingtip clearance and stack level with lead. Lateral spacing will increase the wingman's margin of safety if any problems occur during touchdown and landing roll.

8.32.2. When the formation definitely breaks out of the weather and visual contact with the runway can be maintained, lead will line up with the center of one side of the runway and plans the touchdown approximately 1,000 feet down the runway.

8.32.3. As the flight approaches the overrun, the wingman should begin to cross-check the runway. Continue to fly off lead during the flare and landing, but monitor the runway and flight parameters to ensure a safe landing. (Lead will gradually reduce power for the roundout.) Reduce power gradually with lead to avoid falling out of position during the roundout and touchdown. Once on the runway, maintain your side of the runway and use normal braking technique regardless of lead's deceleration rate. Pass lead rather than overbrake to maintain position.

8.32.4. Lead should initiate a formation go-around, when required, as early as possible. He or she should smoothly add power to approximately 95 percent rpm and follow normal formation takeoff and go-around procedures. If clearing the runway is required, lead should confirm Number 2's position and ensure the wingman has safe altitude and airspeed during maneuvering.

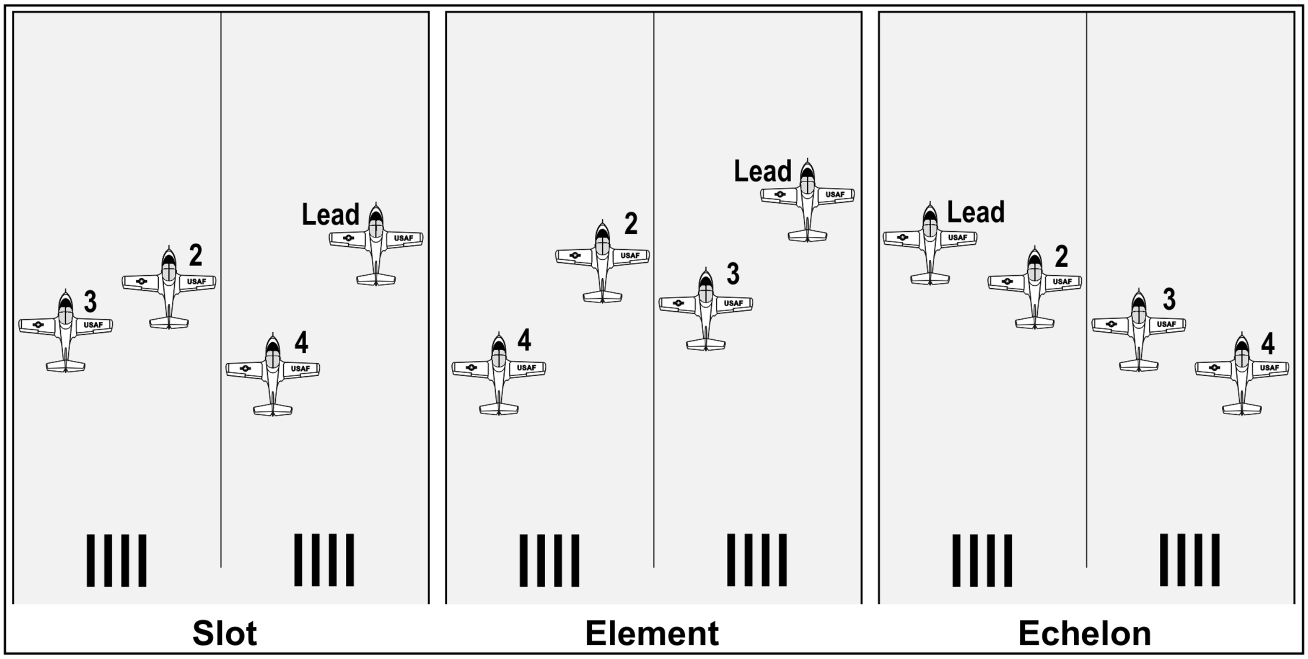
***Section 8C—Three- and Four-Ship Formations***

**8.33. Guidelines.** Three- and four-ship formation flying requires thorough planning and attention to detail from preflight through postflight. All members of the formation will be briefed and be thoroughly familiar with the proposed profile and procedures. Due to T-37 engine response and proximity of aircraft, lead must use smooth throttle inputs and carefully monitor wingmen positions during power changes. The basic formation positions, references, techniques, and procedures described for two-ship formation also apply to three- and four-ship formations. Airspeed for rejoins will normally be 190 KIAS or as briefed.

**8.34. Runway Lineup:**

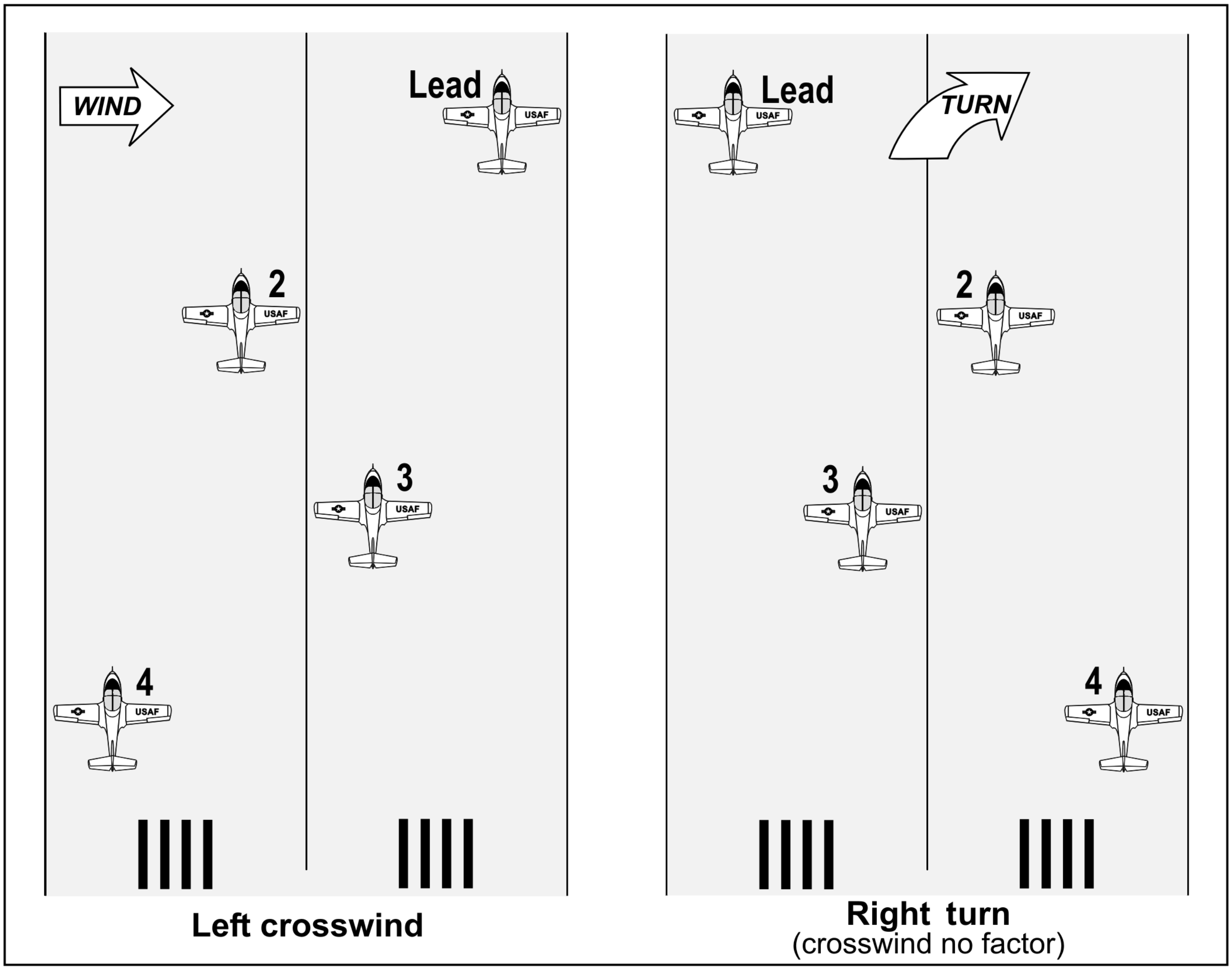
8.34.1. **Figure 8.15.** depicts the runway lineups for a four-ship takeoff. See AFI 11-2T-37, Volume 3, for runway width restrictions for each lineup.

**Figure 8.15. Four-Ship Runway Lineup.**




8.34.2. Normally, a formation will use the element lineup depiction. Wingmen should be placed on the upwind side of the runway just like a two-ship formation. If crosswinds are not a factor, lead will place the wingmen on the inside of the first turn out of traffic (Figure 8.16.). If critical field length is not a factor, 500 feet of space between elements can also be used as an option.

**Figure 8.16. Four-Ship Element Lineup for Crosswinds.**




8.34.3. To establish the slot lineup, lead will be as far to the side of the runway as practical. Number 2 will place the wingtip closest to lead on the centerline. Number 3 will line up with 10 feet of wingtip clearance on Number 2, in echelon position (helmets of Numbers 1 and 2 aligned). Number 4 will pull in between Numbers 1 and 2 with wingtip clearance, aligning to the appropriate formation position on Number 3. Number 4 will pull forward enough to see Number 3'shelmet, but before it is blocked by Number 2's rudder. Number 4 will not run up power until Numbers 1 and 2 roll.

8.34.4. If the departure will necessitate a turning rejoin, Numbers 3 and 4 must join to the outside of the turn. Lead must ensure Number 2 is on the inside of the turn for the element rejoin after safely airborne and cleaned up.

**8.35. Runup and Takeoffs.** When all aircraft are in position, lead will direct the engine runup, using the same runup procedures as in a two-ship formation. During individual takeoffs, Numbers 2, 3, and 4 may delay their runup a few seconds. A three- and four-ship formation takeoff may be accomplished by single-ship takeoffs with individual rejoins out of traffic or by element takeoffs. Use 10-second (minimum) spacing between individual aircraft departures. Use 10-second (minimum) spacing between elements.

However, if element departures are used due to weather, use spacing criteria specified in local directives. Maintain fingertip until reaching VMC.

**8.36. Takeoff Aborts.** Each aircraft must be prepared to react to any situation if a preceding aircraft aborts. Options available are to either hold position, abort, or continue the takeoff as safety dictates.

**8.37. Rejoins.** The type of rejoin will depend on the local departure procedures. It may consist of a turning rejoin, a straight-ahead, or a combination of both; and it must be briefed prior to departure. Normally, for join-ups following element takeoffs, Number 3 will send Number 4 to a route position, with a minimum spacing of 100 feet, prior to rejoining on the lead element. Number 4 will fly a position off Number 3, but will monitor lead throughout the rejoin. During the rejoin, Number 3 must avoid sudden power changes and abrupt flight control inputs. Each aircraft will maintain a minimum of 100 feet of separation until the preceding aircraft has stabilized in route.

**8.38. Turns (From Takeoff).** Lead will start a turn and maintain the briefed airspeed until the formation is rejoined. The wingman will begin the turn no earlier than the departure end of the runway. Each aircraft will individually rejoin in the turn. If the rejoin is delayed, lead may roll out and call for a straight-ahead rejoin. Each formation member will plan the turn to cut off and intercept lead during the turn out of traffic. The rejoin should be readily accomplished unless a formation member delayed the takeoff, did not use enough cutoff angle, or failed to use sufficient power and/or airspeed advantage to complete the rejoin.

**8.39. Straight Ahead (From Takeoff).** Lead will maintain straight flight and briefed airspeed until the formation is rejoined.

**8.40. Formation Positions.** The following positions (fingertip and echelon) are approached primarily from the wingman's point of view:

8.40.1. **Fingertip.** Number 4's position should be determined, using the normal fingertip references relative to the Number 3 aircraft. If Number 3 is rough, Number 4 should fly a stable position on lead and constantly monitor Number 3's position (**Figure 8.17.** and **Figure 8.18.**).

**Figure 8.17. Four-Ship Fingertip Formation.**

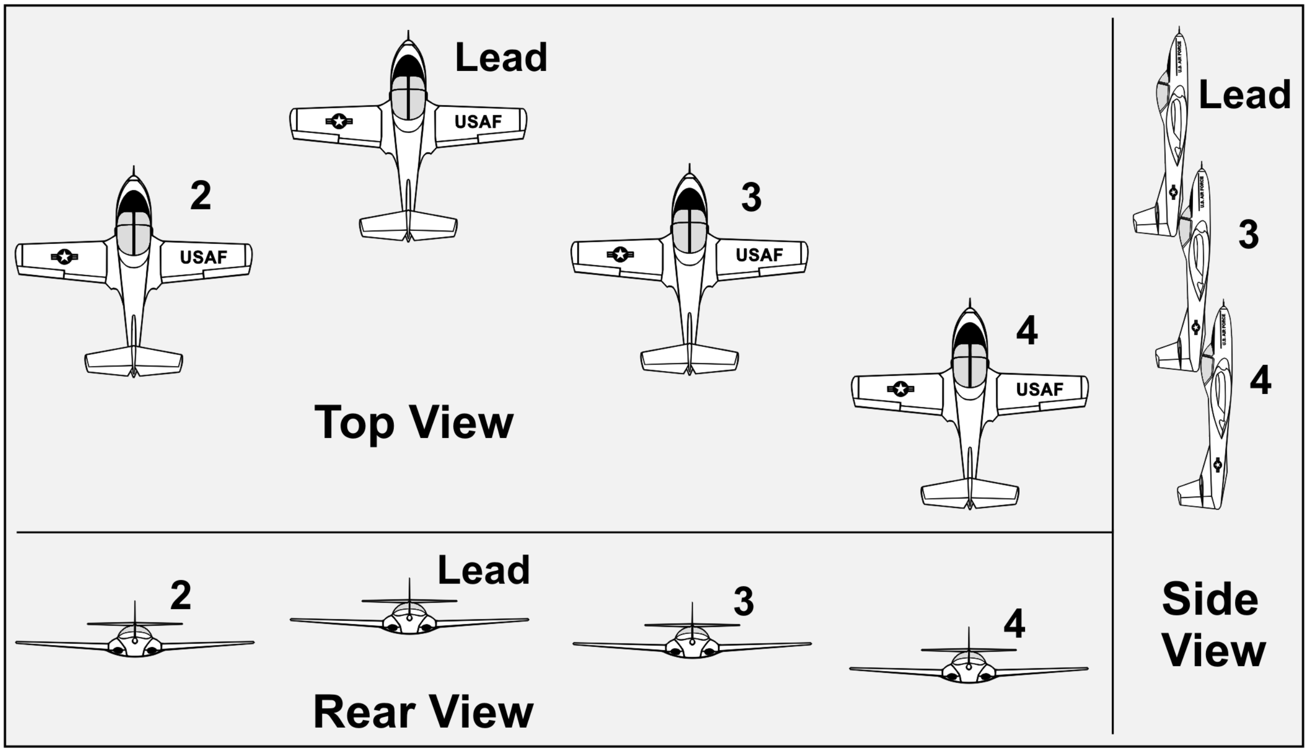
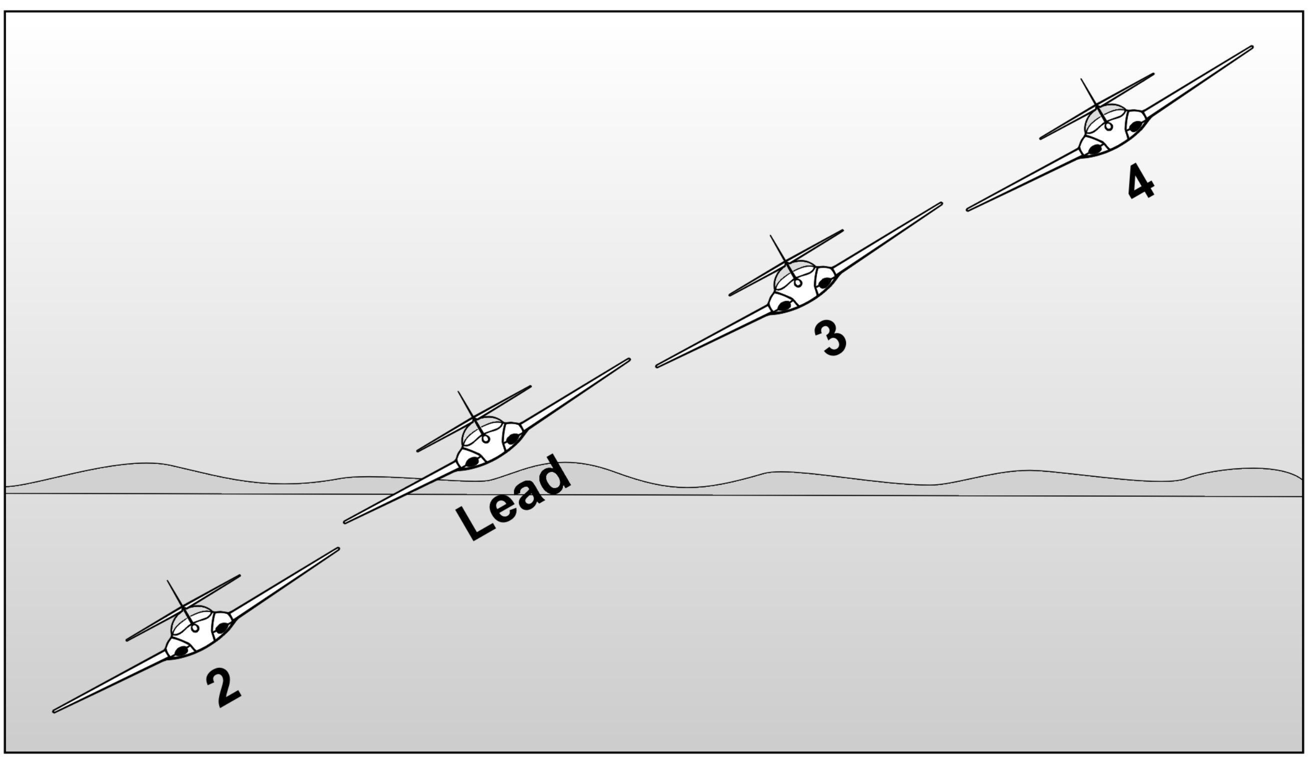



**Figure 8.18. Four-Ship Fingertip Formation in a Turn.**



8.40.2. **Echelon:**

8.40.2.1. Echelon is a variation of a fingertip formation in which the second element aligns itself on the same side as Number 2 or vice versa (**Figure 8.19.** and **Figure 8.20.**).

**Figure 8.19. Four-Ship Echelon.**

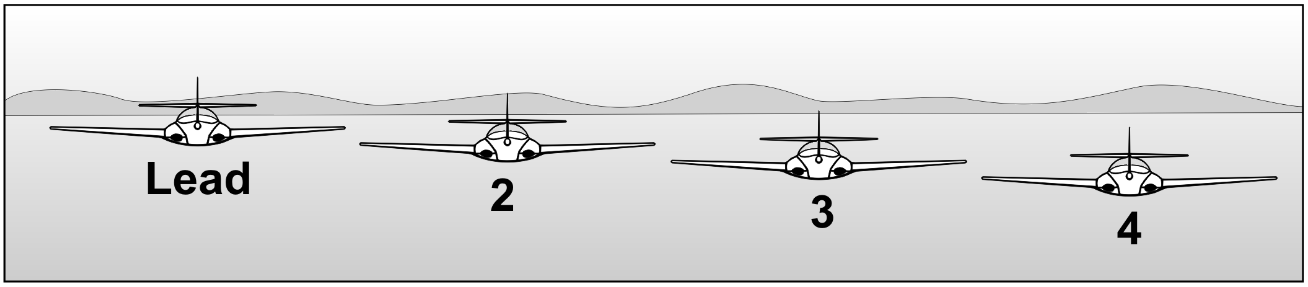
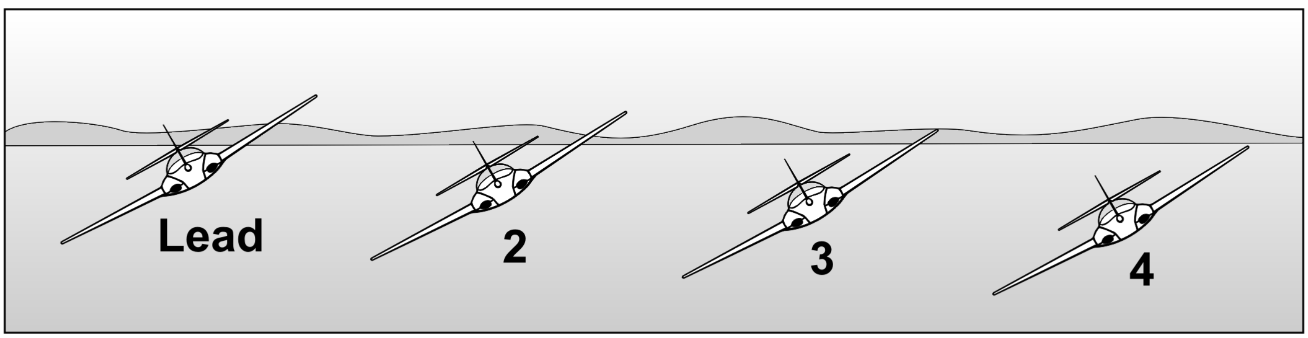
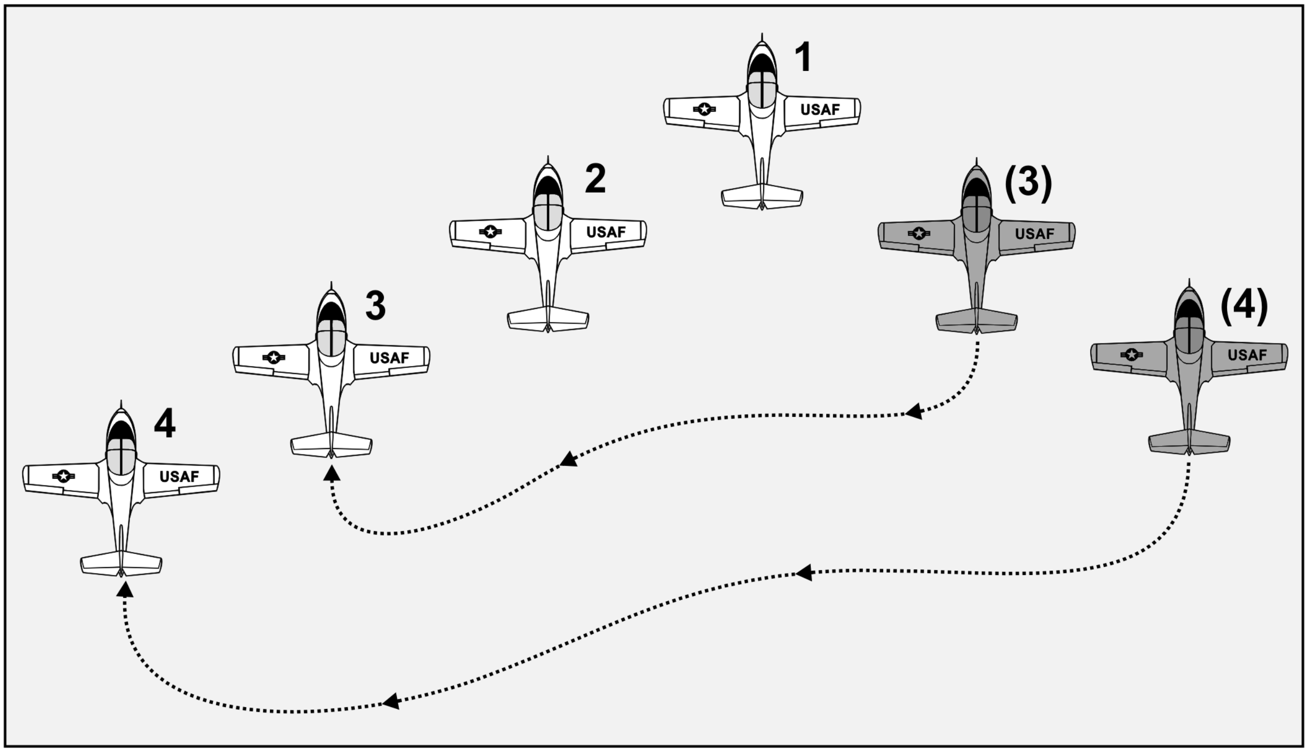



**Figure 8.20. Four-Ship Echelon Turn.**



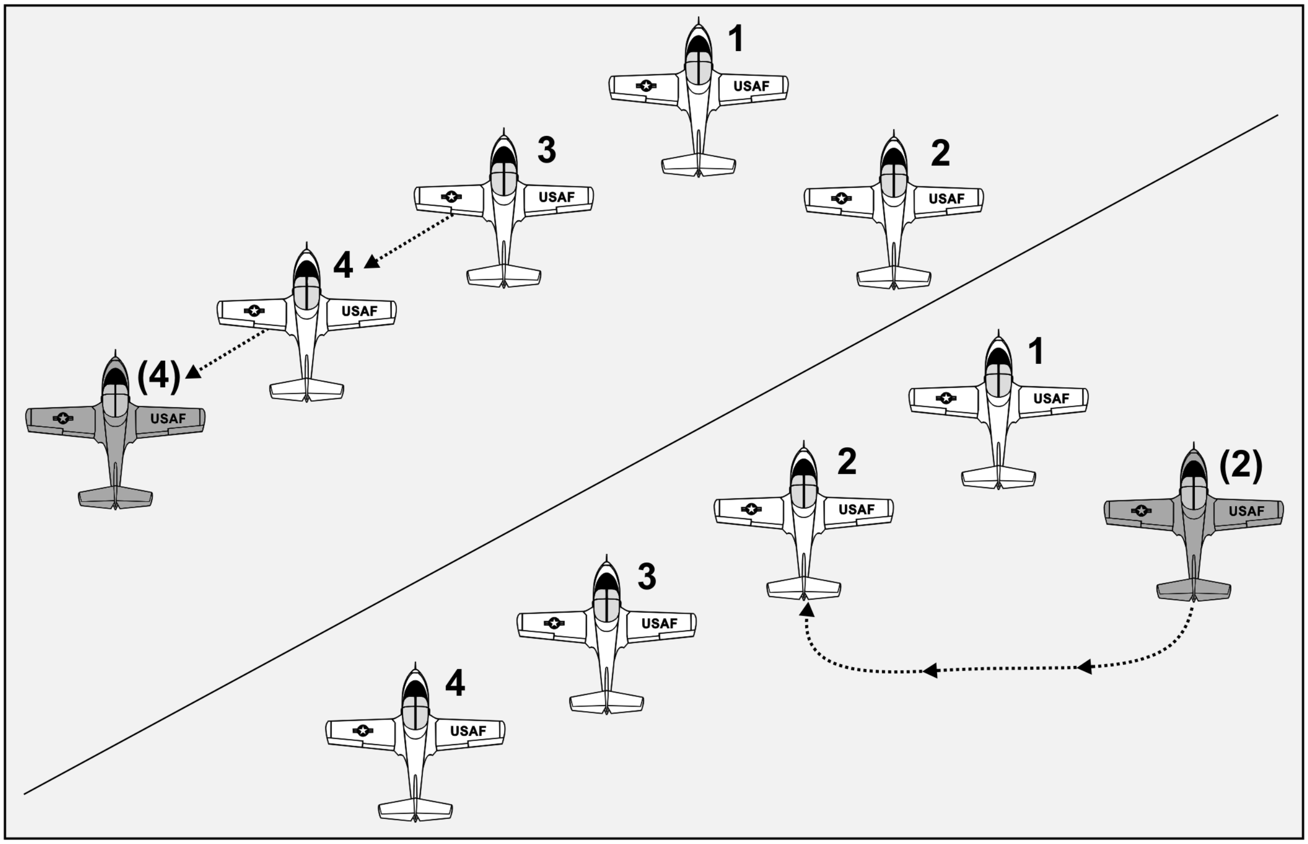

8.40.2.2. Lead will signal for echelon by dipping a wing in the desired direction. If lead's wing dips toward Number 2. Number 2 will hold position. Numbers 3 and 4 will move back and down to provide adequate clearance from the lead element. Number 3 (with Number 4 on the wing) will then begin to cross to an echelon position on the wing of Number 2, keeping safe clearances. As Number 3 crosses behind lead, Number 4 crosses under to the new position on the other wing of Number 3 (**Figure 8.21.**).

**Figure 8.21. Echelon Crossunder (Numbers 3 and 4).**




8.40.2.3. If the echelon signal is given toward the side of the second element, Number 3 (with Number 4 on Number 3's wing) will move out and back and slightly down to make room for Number 2. Number 2 will maintain position until the element has spread out. Once Number 2 has determined the second element has made sufficient room, Number 2 executes a normal crossunder, keeping the element in sight until moving forward on lead. Numbers 3 and 4 will align themselves with Number 2 and lead. Smooth technique by Numbers 2 and 3 will prevent a "crack-the-whip" on Number 4 (**Figure 8.22.**). Except for very gentle turns into the echelon, turns are always made away from the echelon. Number 3 flies off of Number 2; and Number 4 flies off of Number 3, using normal echelon references.

**Figure 8.22. Echelon Crossunder (Number 2).**




8.40.2.4. Lead of a three-ship formation signals for echelon by using the same procedures as in four-ship formation; that is, by dipping a wing in the desired direction of echelon. In a three-ship echelon, turns must be directed by radio call ("Reno, right turn"). If an echelon turn is not directed, Numbers 2 and 3 will maintain fingertip references. Lead will direct the formation back to the fingertip position with a radio call. An aircraft or element that crossed under to form the echelon will return to the original position by executing another crossunder.

**8.41. Route.** The purpose and parameters of a four-ship route are the same as for a two-ship route. Due to the decreased maneuverability of a four-ship route, the wingman should favor the extended fingertip line in level flight and may maneuver behind the line to maintain spacing and sight of lead. Lead may brief more specific parameters for each mission, based on anticipated weather, profile requirements, and/or experience level.

**8.42. Rejoins:**

8.42.1. **Turning Rejoins:**

8.42.1.1. During four-ship turning rejoins, wingmen will relay the wing rocking signal to the aircraft behind them. Number 2 will always rejoin to the inside of lead's turn. Rejoin procedures for Number 2 are identical to the procedures described in the two-ship section. If Number 2 is slow to rejoin, it will complicate the rejoin for Numbers 3 and 4 because they will have to decrease airspeed and/or cutoff to maintain proper spacing on the preceding aircraft.

8.42.1.2. Number 3 will always rejoin to the outside of lead's turn. The basic rejoin techniques used by Number 3 are the same as those used by Number 2. However, Number 3 has the additional responsibility of monitoring Number 2 and remaining aware of Number 4.

8.42.1.3. Number 3 should establish a normal cutoff angle on lead no greater than the angle used by Number 2. Number 3 should accelerate to gain an airspeed advantage on lead and maintain a 100-foot clearance (minimum) on lead until Number 2 is stabilized in route.

8.42.1.4. Number 3 should plan the rejoin to pass at least two ship lengths behind and below the lead element as he or she moves to the outside of the turn. He or she will stabilize in route and slowly move into fingertip position on lead. Avoid abrupt control pressure and rapid throttle movements if Number 4 has closed to minimum distance (approximately 100 feet).

8.42.1.5. Number 4 will also always rejoin to the outside of lead's turn. Basic rejoin techniques still apply, but Number 4 must monitor Number 3 as well as the lead element during rejoin. After receiving the rejoin signal, Number 4 will begin a turn to establish a cutoff angle no greater than Number 3 or Number 2, while accelerating to gain an airspeed advantage. Number 4 will monitor all aircraft in the formation as the rejoin progresses, maintaining this cutoff angle on lead and Number 3. Number 4 will plan his or her rejoin to pass at least two ship lengths behind and below the lead element and Number 3 as he or she moves to the outside of the turn. Number 4 will stabilize in route and slowly move into fingertip position on Number 3.

8.42.1.6. If Number 3 is slow to rejoin, Number 4 should maintain at least a 100-foot clearance on Number 3. This is a fluid position because Number 4 must use a combination of trail and rejoin techniques while monitoring both Number 3 and the lead element. When Number 3 has stabilized in route on lead's outside wing, Number 4 is cleared to join on Number 3's outside wing.

8.42.2. **Straight-Ahead Rejoins.** After completing the pitchout, lead will signal for a rejoin by rocking the wings or making a radio call. The call will identify the side to which Number 2 rejoins. The second element always joins to the side opposite Number 2. If rejoin airspeed is other than prebriefed, lead will announce the airspeed he or she will hold for the rejoin. Wingmen will pass along the wing-rocking signal to the aircraft behind them. Number 3 will turn slightly to rejoin on the side opposite Number 2. Clearances, techniques, and procedures are the same as used by Number 2. After receiving the rejoin signal and/or radio call, Number 4 will rejoin on Number 3 on the side opposite lead and maintain a minimum of 100-foot clearance on Number 3 until Number 3 begins closing to fingertip on lead.

## 8.43. Overshoot:

8.43.1. As a member of a four-ship formation, you must recognize an overshoot situation as soon as possible and make positive corrections. Use power and/or speed brake to control excessive closure rates during rejoins. The element lead will notify wingmen by radio if speed brakes are to be used ("Reno 3, speed brake"). This will alert a wingman who has already moved to a position of a 100-foot clearance that speed brakes are being used.

8.43.2. If an overshoot is appropriate, follow established procedures. Do not go belly up to lead in an effort to prevent an overshoot. Stay low enough to keep the aircraft ahead of you in sight at all times.

Go to the outside of the turn with at least a two ship length, nose-to-tail clearance behind the aircraft ahead. Use speed brakes and power as necessary.

8.43.3. Once outside the turn, position yourself vertically no higher on lead than the echelon turn reference. The greater your overtake speed on the overshoot, the wider you must go to prevent passing lead. As soon as you see you are on or dropping back through the echelon turn references:

8.43.3.1. As Number 2, clear to ensure sufficient spacing on Number 3 before returning to the inside of the turn, reestablish yourself on the rejoin line, and complete the rejoin.

8.43.3.2. As Number 3, if Number 2 overshoots, modify your rejoin by decreasing your airspeed and cutoff to ensure adequate clearance as Number 2 returns to the inside of lead's turn.

8.43.3.3. As Number 4, follow Number 3 whether Number 3 is overshooting or adjusting for a Number 2 overshoot. If Number 3 is overshooting, use good judgment and a combination of trail and rejoin techniques to stay with Number 3. Maintain a 100-foot clearance (minimum) until Number 3 is in route.

8.43.4. When executing an overshoot as Number 3 or 4, use the same procedures as described for a Number 2 overshoot. However, when stabilized on the outside of the turn, determine whether it is more appropriate to remain on the outside of the turn or return to the inside to complete the rejoin.

**8.44. Three-Ship Formation.** A three-ship formation is usually the result of a ground or takeoff abort. Lead will ensure aircraft in the flight are renumbered. In a three-ship formation, rejoins are practiced to the normal positions (Number 2 to the inside and Number 3 to the outside). If practice rejoining both aircraft to the outside of the turn is desired, lead will direct both aircraft to rejoin to the outside. For straight-ahead rejoins, lead may direct both aircraft to join to the same side. When rejoining in this manner, use the procedures described in four-ship rejoins for Numbers 3 and 4 (paragraph **8.42.2.**).

**8.45. Leaving Formation (Breaking Out).** Leaving formation is the same in three- and four-ship formation as in a two-ship formation, with the following exceptions:

8.45.1. If Number 2 or 4 breaks out of fingertip formation, the remaining aircraft will maintain their original positions on lead. If Number 3 leaves the formation, Number 4 will follow Number 3 at a safe distance to maintain element integrity.

8.45.2. When it is confirmed that a member has left the formation, lead will direct the rejoin to the desired formation. An aircraft that has left formation does not rejoin until lead gives permission by radio call and the call has been acknowledged.

**8.46. Lost Wingman (Four-Ship).** Numbers 2 and 3 will follow the procedures described in paragraph **8.6.6.2.** However, because it is impossible for Number 4 to immediately determine that Number 3 still has visual contact with lead, Number 4's initial action must be based on the assumption that Number 3 has also become separated. If Number 4 loses sight of Number 3, Number 4 will proceed as follows:

8.46.1. **Wings-Level Flight.** Simultaneously inform lead and turn away, using 30 degrees of bank for 30 seconds. Then resume course and obtain a separate clearance.

8.46.2. **Turns (Climb, Descent, or Level).** On the outside of the turn, reverse the direction of the turn, using 30 degrees of bank for 30 seconds to ensure separation from lead and Number 3. Obtain a separate clearance. (Using 30 degrees of bank for 30 seconds will develop a significant heading change from lead.) Maintain situational awareness for obstacle clearance when separating from lead. On the inside of the turn, momentarily reduce power to ensure nose-tail separation and increase bank angle by 15 degrees. Tell lead to roll out of the turn. Obtain a separate clearance. Lead will resume the turn only when separation is ensured.

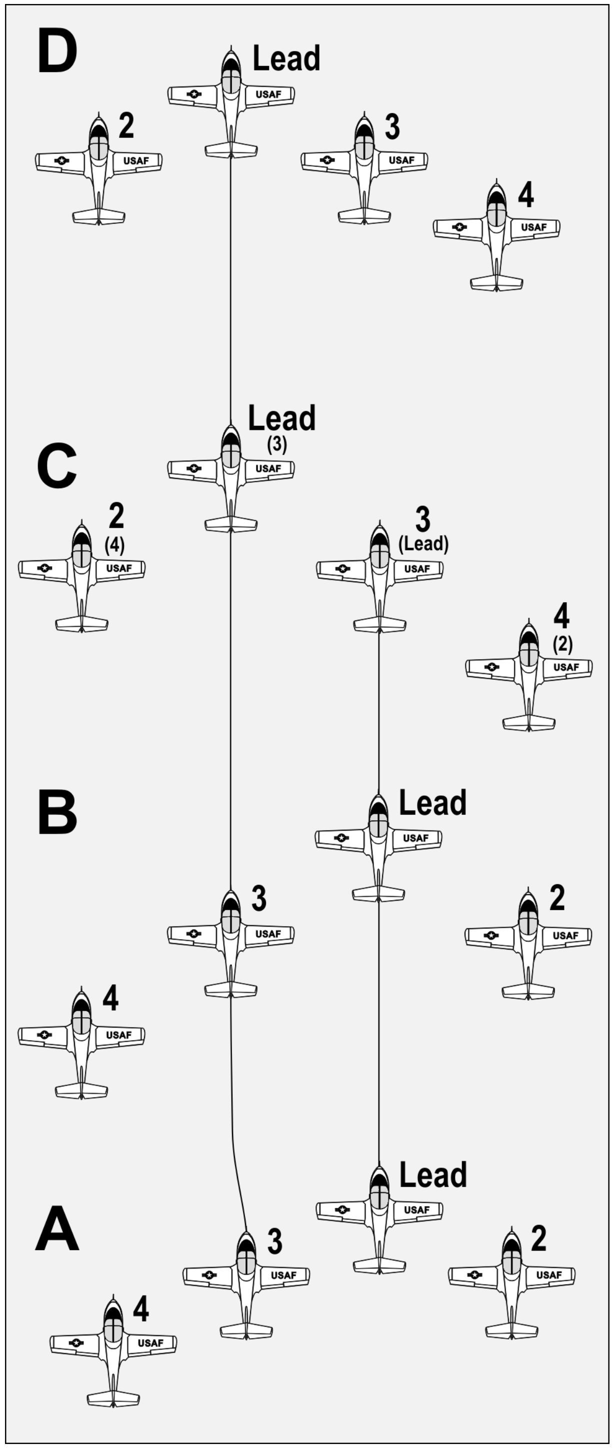
**8.47. Speed Brakes.** If speed brakes are required, they will be lowered or raised on verbal signal by the flight lead or element lead. Visual signals are generally not used in four-ship formations. Do not raise or lower the speed brake when the formation is in an echelon turn.

**8.48. In-Flight Lead Changes.** Three- and four-ship lead changes are made from route fingertip or route echelon. Procedures to be used must be thoroughly reviewed in the formation briefing. The most commonly used method is for lead to direct the formation to go to route with the radio call, “Reno, go route.” The wingmen will acknowledge and move to route. After the formation is stable in the route position, lead will call for the lead change, “Reno, lead change.” The wingmen will acknowledge. The old lead will retain lead responsibility until the lead change is acknowledged by all wingmen. The new lead will confirm the new formation positions with a radio call, “Reno, check,” before reforming the formation to fingertip and beginning other maneuvers.

8.48.1. **Four-Ship Lead Changes:**

8.48.1.1. During lead changes from route fingertip, Number 3 always becomes new lead, Number 4 becomes Number 2, lead becomes Number 3, and Number 2 becomes Number 4 (**Figure 8.23.**).

**Figure 8.23. Route Fingertip Lead Change for a Four-Ship Formation.**




8.48.1.2. During lead changes from route echelon, the original lead becomes either Number 2 or Number 4, as briefed. When the original lead becomes Number 2, the original Number 2 becomes lead and Numbers 3 and 4 keep their previous positions (**Figure 8.24.**). When the original lead becomes Number 4, Number 2 becomes lead, Number 3 becomes Number 2, and Number 4 becomes Number 3 (**Figure 8.25.**).

**Figure 8.24. Route Echelon Lead Change for a Four-Ship Formation (Lead to Number 2).**

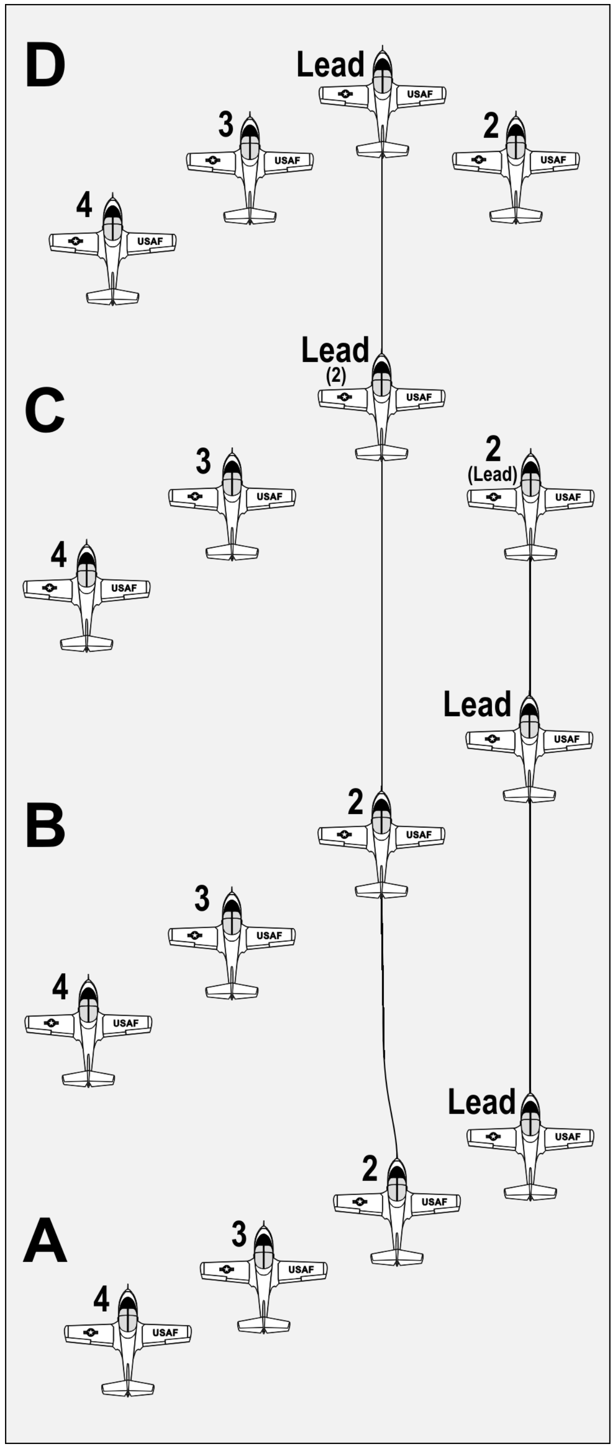
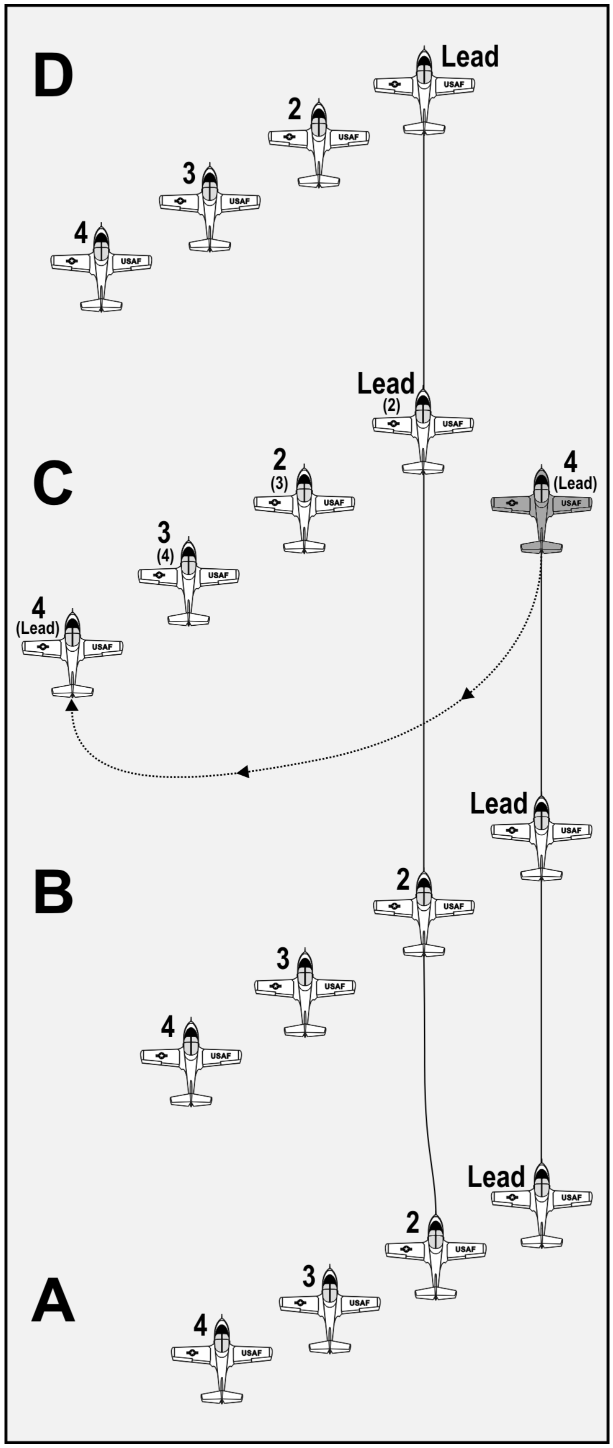


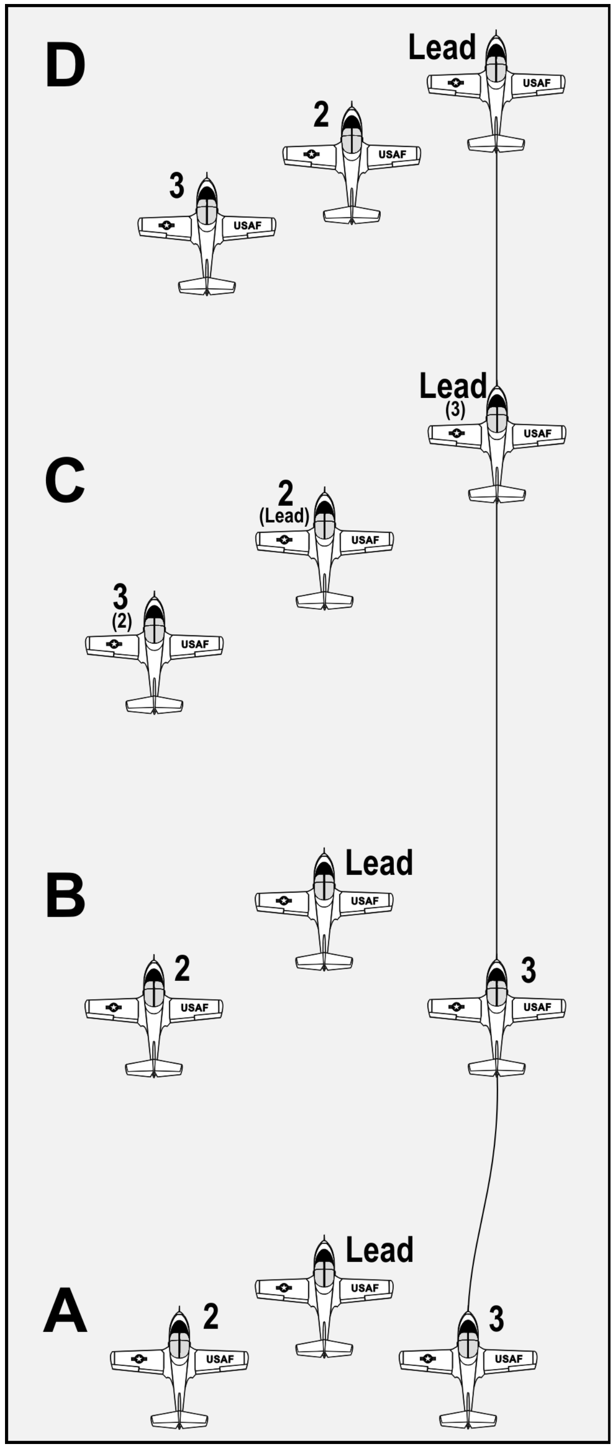
**Figure 8.25. Route Echelon Lead Change for a Four-Ship Formation (Lead to Number 4).**




8.48.2. **Three-Ship Lead Changes:**

8.48.2.1. During lead changes from route fingertip, lead becomes Number 2, Number 2 becomes Number 3, and Number 3 becomes lead. The new Number 2 moves back with the new Number 3 into echelon position (**Figure 8.26.**).

**Figure 8.26. Route Fingertip Lead Change for a Three-Ship Formation.**




8.48.2.2. During lead changes from route echelon, the original lead either drops back to the route fingertip Number 2 position or drops back and crosses behind the flight to the Number 3 position.

# Chapter 9

# INSTRUMENT FLYING

## 9.1. Instrument Takeoff (ITO) and Climb:

9.1.1. The ITO is taught so you learn how to safely transition to instrument conditions when taking off in low visibility conditions. With practice you will smoothly and safely transition from outside references to instruments references. Even during low visibility departures, visual references such as runway lights, a centerline stripe, or actual runway edges are normally visible. During an actual ITO, the visual references are part of the ITO cross-check.

9.1.2. You will perform the ITO in a definite sequence. Learning the procedures before you fly allows you the ability to devote more attention to the cross-check and aircraft control. Once cleared for takeoff, you will normally line up on the centerline of the runway. Perform the lineup check from the checklist.

9.1.3. Once you release the brakes, maintain the runway alignment, using nosewheel steering until computed nosewheel liftoff airspeed. As you rotate at this speed, release the nosewheel steering button and use rudders as necessary to maintain runway alignment. Establish a 5-degree nose-high takeoff attitude. Note that this is also your contact takeoff attitude of 1/4 ground and 3/4 sky. Use the attitude indicator and outside visual references to establish and maintain the takeoff attitude.

9.1.4. The aircraft will normally lift off at approximately 90 KIAS. Control the pitch and bank, using outside references and the attitude indicator. Once the altimeter and the VVI indicate a positive climb (and at a minimum of 100 KIAS), call “gear clear” and raise the gear. When the gear handle is up and you have a minimum of 110 KIAS, retract the flaps.

9.1.5. Maintain wings level and a 5-degree nose-high attitude to establish a definite climb rate. Trim as necessary to relieve the stick forces. Cross-check the altimeter and VVI for continued climb. Maintain the 5-degree attitude until you reach climb airspeed. Normally, you will accelerate to 180 KIAS for most departures. However, you may accelerate to 160 KIAS if you are flying multiple approaches. Many airports have climb gradients published due to obstacles in the departure area. You must meet or exceed all published climb gradients for the runway you are departing.

9.1.6. The rate you transition from outside references to instrument references depends on how quickly the outside references are disappearing. Make the first turn on an instrument departure at a safe airspeed and a minimum of 400 feet above the field elevation unless otherwise directed. AFMAN 11-217, Volume 1, provides an excellent explanation of instrument departures.

**9.2. Leveling Off.** If you must level off at an intermediate altitude on your departure, maintain tech order airspeed for your current altitude.

**9.3. Turns and Turns to Headings.** In jet aircraft, it is possible, but not practical, to maintain a constant rate of turn using the turn needle. This is especially true at higher altitudes and under instrument condition in turbulence. Use the attitude indicator for bank control at all times. Use the turn needle only in an emergency.

9.3.1. **Normal Turns:**

9.3.1.1. Normally, you will use 30 degrees of bank as the maximum bank angle.

9.3.1.2. Enter turns by applying steady coordinated pressure on the aileron and rudder in the desired direction of turn. Refer to the attitude indicator as you roll into the turn. In level turns, maintain a constant pitch altitude and airspeed by cross-checking the attitude indicator and performance instruments.

9.3.1.3. Increase the pitch attitude as necessary to counteract the loss of lift when the aircraft is banked. Apply corrective pressures only when the flight instruments indicate deviations. The cross-check is basically the same as used for straight-and-level flight.

9.3.1.4. When the desired angle of bank is reached, it may be necessary to exert slight aileron pressure in the opposite direction. This prevents the bank from increasing beyond the desired amount. Maintain an exact angle of bank.

9.3.1.5. Adjust the power to hold a constant airspeed. As the bank is established, a small increase in power may be required.

9.3.1.6. Reverse these steps to return to straight-and-level flight.

9.3.2. **Turns to Headings:**

9.3.2.1. Enter a normal turn with smooth and coordinated control pressures. Start the rollout before reaching the desired heading because the aircraft will continue to turn as long as the wings are banked. Pilot technique determines the lead point for the rollout on the heading indicator. As a starting point and guide, use one-third of the bank angle as the number of degrees to lead the rollout. For example, using 30 degrees of bank, you'd start your rollout 10 degrees prior to the desired heading. Develop a *consistent* roll-in and rollout rate. If you miss your heading after rollout, change your lead point until you determine the proper amount needed.

9.3.2.2. If you are turning less than 30 degrees of heading change, use the number of degrees, you need to turn as the bank angle. If the number of degrees of heading change exceeds 30 degrees, use 30 degrees of bank. Precise turns to headings are required in actual instrument flight. The success of an actual instrument approach depends on turning to and maintaining specified headings.

**9.4. Steep Turns:**

9.4.1. A turn using more than 30 degrees of bank is not advisable when flying on instruments. Practice steep turns at 45 or 60 degrees of bank at 160 KIAS or 200 KIAS, respectively.

9.4.2. Enter a steep turn by applying steady, coordinated pressures in the direction of the turn. The attitude indicator is the pitch and bank control instrument. Use tachometers to control airspeed. The performance instruments will indicate the need for corrections.

9.4.3. It is more difficult to control pitch attitude in steep turns because of the greater loss of lift with the increased bank angle. There is a tendency to lose altitude in steep turns so take corrective action as soon as you note deviations. Remember to set the pitch according to **Table 9.1.** The pitch and power settings you find there are approximate and assume the attitude indicator is set correctly and functioning properly. After you make the pitch change, check the altimeter and VVI to determine whether the pitch is set correctly. The VVI typically "leads" deviations in altitude, but will "lag behind" once you input a correction. You will probably notice the VVI showing a climb or descent before it is noted on the altimeter. Once you input a correction, you will note the altimeter change before the VVI responds.

**Table 9.1. T-37A Instrument Flying Airspeeds and Power Settings.**

<table>
<tr><th rowspan="2">ITEM</th><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th></tr>
<tr><th>Procedure</th><th>Airspeed (KIAS)</th><th>Approximate Pitch Attitude</th><th>Approximate Percentage of rpm</th><th>Configuration</th></tr>
<tr><td>1</td><td>Takeoff</td><td>Approximately 90</td><td>5 degrees</td><td rowspan="3">Military</td><td>Gear, 50-percent flaps</td></tr>
<tr><td>2</td><td>Tech order climb <10,000 MSL</td><td>180</td><td>7 to 8 degrees (note 1)</td><td rowspan="6">Clean</td></tr>
<tr><td>3</td><td>Tech order climb >10,000 MSL</td><td>160</td><td>(note 2)</td></tr>
<tr><td>4</td><td>Normal cruise</td><td>200</td><td>level</td><td>(note 3)</td></tr>
<tr><td>5</td><td>Maneuvering/holding (note 4)</td><td rowspan="7">160</td><td rowspan="2">1 degree nose high</td><td rowspan="2">(note 5)</td></tr>
<tr><td>6</td><td>Radar pattern</td></tr>
<tr><td>7</td><td>1,000 fpm climbs (note 6)</td><td>4 degrees</td><td>80 percent plus altitude (note 7)</td></tr>
<tr><td>8</td><td>1,000 fpm descents (note 8)</td><td rowspan="4">1 degree nose low</td><td rowspan="4">57 percent</td><td rowspan="4">Clean (note 9)</td></tr>
<tr><td>9</td><td>Low altitude approach descents</td></tr>
<tr><td>10</td><td>Holding descents</td></tr>
<tr><td>11</td><td>Radar pattern descents</td></tr>
<tr><td>12</td><td>Radar pattern base-leg option</td><td>120</td><td>2 to 3 degrees nose high</td><td>62 percent</td><td>Clean</td></tr>
<tr><td>13</td><td>Final approach (level) (note 10)</td><td rowspan="3">110</td><td>3 to 4 degrees nose high</td><td>82 percent</td><td rowspan="3">Gear, 50- percent flaps, landing lights</td></tr>
<tr><td>14</td><td>Final approach descent (nonprecision) 1,000 fpm</td><td>1 degree nose low</td><td>(note 11)</td></tr>
<tr><td>15</td><td>Final approach descent (precision) 500 fpm</td><td>“line on line”</td><td>(note 12)</td></tr>
</table>

| ITEM | A | B | C | D | E |
|---|---|---|---|---|---|
| | **Procedure** | **Airspeed (KIAS)** | **Approximate Pitch Attitude** | **Approximate Percentage of rpm** | **Configuration** |
| **16** | Missed approach | 160 (note 13) | Approximately 9 degrees nose high | Military (note 14) | Clean |
| **17** | Steep turn 45-degree bank | 160 | 2 degrees nose high | Add 5 percent | |
| **18** | Steep turn 60-degree bank | | 5 degrees nose high | 80 percent plus altitude | |
| **19** | En route descent option 1 | 200 | 5 degrees nose low | 65 percent | |
| **20** | En route descent option 2 | | 10 degrees nose low | | Speed brake |
| **21** | En route descent option 3 | | 7 degrees nose low | Idle | Clean |
| **22** | En route descent option 4 | | 14 degrees nose low | | Speed brake |
| **23** | High VOR non-DME descent | | 10 degrees nose low | 65 percent | |
| **24** | High VOR/DME descents | | (note 15) | (note 15) | (note 15) |

***NOTES:***

1. The initial pitch setting is approximately 7 to 8 degrees, but this may be adjusted as required to maintain 180 KIAS. You may have to initially set the pitch higher in colder weather or lower in hotter weather.
2. The actual pitch attitude will vary depending on aircraft performance. Adjust pitch as necessary to maintain 160 KIAS.
3. One technique for approximate power required is 82 percent and add 1/2 of the flight altitude. For example, you want to maintain 200 KIAS at 10,000 MSL. The approximate power required is 82 percent + 5 percent (1/2 of 10) for a total of 87 percent. This simple formula will get you very close to the right power required to hold you at the desired airspeed. The actual power will vary based on outside air temperature and fuel weight.
4. Use maneuvering speed in holding patterns, in the radar pattern, and when flying low altitude instrument approaches. You may also use maneuvering speed as warranted by mission needs.
5. One technique for approximate power required is 73 percent and add 1/2 of the flight altitude. For example, you want to maintain 160 KIAS at 10,000 MSL. The approximate power required is 73 percent + 5 percent (1/2 of 10) for a total of 78 percent. This simple formula will get you very close to the right power required to hold you at the desired airspeed. Another

option is to use 70 percent plus the altitude. For example, at 14,000 MSL, you would use 85 percent power. The second option works best at higher fuel weights and higher altitudes. Actual power will vary based on outside air temperature and fuel weight.

6. Typically used during vertical-S maneuvers and may be used when established at 160 KIAS on a missed approach. Make sure you have adequate terrain clearance before reducing pitch or power on a missed approach.
7. Approximately 93 percent for vertical-S maneuvers at 14,000 MSL. Actual power will vary based on outside air temperature and fuel weight.
8. Typically used during vertical-S maneuvers and may be used as needed during the mission.
9. The use of the speed brake for 160-knot descents is optional on all descents except vertical-S maneuvers.
10. This pitch and power is used on an approach prior to the final approach fix (FAF) or glide slope intercept point. It is also used once you are level at the nonprecision minimum descent altitude (MDA).
11. Power setting depends on speed brake usage. If you use the speed brake, set 70 percent power. If you do not, set approximately 65 percent power.
12. Power setting depends on speed brake usage. If you use the speed brake, set 74 percent power. If you do not, set approximately 70 percent power.
13. Use 160 KIAS if you are planning to fly another approach or enter a holding pattern or are planning a radar pattern. Accelerate to 180 KIAS if you plan on diverting.
14. Use military power until reaching either 160 or 180 KIAS. Then you may adjust pitch and/or power as required.
15. Use pitch and power as required to meet all descent gradients. Maintain 200 KIAS during the penetration descent.

9.4.4. The effects of precession and G forces on some attitude indicators in a steep turn add to the difficulty of maintaining the desired attitude. The maximum precession usually occurs after 180 degrees of turn. You can minimize G forces if you do not allow the vertical velocity to go below zero. Wait for a deviation to actually occur. Do not arbitrarily put in a correction before the need arises, but do anticipate the changes in pitch. Because any back stick pressure involves an increase in the AOA, the drag will increase and the airspeed decrease. The tendency is noticeable in normal turns, but will increase markedly as the bank angle increases. Therefore, as you enter the steep turn, anticipate the addition of power to maintain a constant airspeed.

9.4.5. Use a constant angle of bank during steep turns. Correct the altitude by adjusting pitch attitude. However, if you are losing or gaining excessive altitude, make a corresponding decrease or increase in bank to help correct the pitch attitude. With practice, you will learn to do steep turns without varying the bank.

9.4.6. Power control is much more critical in a steep turn than a normal turn. Because of the back stick pressure required to counteract the loss of vertical lift, the airspeed will dissipate more rapidly than normal as you enter the steep turn. It will also build more rapidly as you roll out. Return to straight-and-level flight smoothly, using normal rate of rollout. The vertical lift will increase during the rollout, and the aircraft will tend to climb. Make pitch corrections as soon as they are needed. Readjust the power to maintain airspeed. A reduction of power is necessary as soon as you initiate rollout.

**9.5. Airspeed Changes:**

9.5.1. **Establishing and Maintaining Airspeed:**

9.5.1.1. To establish and maintain an airspeed, refer to the airspeed indicator and adjust the power or aircraft attitude. A knowledge of the approximate power required to establish a desired airspeed will help make power adjustments. After you establish the approximate power setting, cross-check the airspeed indicator to see if you need additional power adjustments. Make it a point to learn the approximate power settings for various airspeeds and configurations throughout a normal mission.

9.5.1.2. When you observe an airspeed deviation, correct as necessary with power and pitch. For example, if you are below the desired altitude and fast (or high and slow), a pitch adjustment may correct both the airspeed and altitude deviation. Conversely, a pitch adjustment made while at the desired airspeed will induce a need for a power adjustment. This is more noticeable at slow airspeeds.

9.5.1.3. To increase airspeed, advance the power beyond the setting required to maintain the new airspeed. As airspeed increases, the aircraft will gain lift and have a tendency to climb. Adjust the pitch attitude to maintain altitude. When the airspeed approaches the desired indication, reduce the power to an estimated setting that will maintain the new airspeed.

9.5.1.4. To reduce airspeed, retard the power below the setting for the new airspeed. As airspeed decreases, the aircraft will lose lift and have a tendency to descend. Adjust the pitch attitude to maintain altitude. When the airspeed approaches the desired indication, advance the power to an estimated setting that will maintain the new airspeed. You may use the speed brake for large or rapid airspeed reductions. It is best to reduce the power to the estimated setting and then extend the speed brake. Approaching the new airspeed, retract the speed brake and adjust the power if required. Remember, when you extend the speed brake, the pitch will try to decrease. Be prepared for the pitch change and counteract it as necessary.

9.5.1.5. Airspeed changes require a rapid cross-check and good pitch control. Referring to the attitude indicator, altimeter, and VVI and using trim during these changes will help control the aircraft attitude and altitude.

9.5.2. **Change of Airspeed in Turns.** The process of making a change of airspeed in a turn is the same as making airspeed changes in straight-and-level flight. Airspeed changes in turns are taught to speed up your cross-check and improve your aircraft control. Your IP may vary the amount of turn to give you practice in rolling out before, after, and as you reach your target airspeed. The use of trim is very important during airspeed changes. Along with your cross-check, trim will help maintain altitude while you adjust airspeed.

**9.6. Constant Airspeed Climbs and Descents.** Many instrument flight procedures require constant airspeed climbs or descents. Perform climbs and descents at tech order, maneuvering, or en route airspeeds. If a change of airspeed is necessary, make that change before starting the maneuver.

9.6.1. **Constant Airspeed Climbs:**

9.6.1.1. To enter the climb, simultaneously increase the power and adjust the pitch on the attitude indicator to maintain the desired airspeed. Only a slight amount of back stick pressure is necessary to change from level flight to a climbing attitude.

9.6.1.2. Once you establish the climb, your IP may have you change the pitch attitude so the airspeed is 2 to 5 knots slow. You will note a definite change on the VVI. Use this knowledge as an aid to maintaining a constant airspeed. To regain the 2 knots, adjust the pitch to change the vertical velocity by approximately 100 fpm (or by 200 fpm to regain 5 knots). In climbs, as in level flight, use VVI as an aid in pitch control.

9.6.1.3. To make a leveloff at a predetermined altitude, refer to the altimeter for a lead point. One technique for determining the amount of lead to use on leveloffs (climbs and descents) is to use 10 percent of the vertical velocity. As you start the leveloff, reduce the pitch attitude by referring to the attitude indicator and adjust power to maintain airspeed.

9.6.1.4. To attain level-flight attitude, cross-check the altimeter and VVI to determine if the pitch attitude is approximately correct for level flight. Use power as necessary to maintain airspeed and adjust pitch to maintain altitude. It may be necessary to trim slightly during and after the leveloff.

9.6.2. **Constant Airspeed Descents:**

9.6.2.1. To enter the descent, reduce power and adjust pitch attitude on the attitude indicator. The amount of pitch change will vary with airspeed and power setting. Maintain the desired airspeed during the descent entry. Use the VVI as an aid to maintain airspeed (as previously stated in paragraph **9.6.1.**). Use the speed brake to expedite a constant airspeed descent. This will require a larger pitch change.

9.6.2.2. To level off, retract the speed brake (if extended), adjust pitch attitude for level flight, and simultaneously adjust the power to maintain the desired airspeed. Do this when you reach the lead point for the leveloff. Reset the power and pitch for level flight, using the altimeter and VVI. Then resume a normal cross-check for straight-and level-flight.

**9.7. Constant Rate Climbs and Descents.** Initially, enter constant rate climbs and descents from level flight, maintaining 160 KIAS and a vertical velocity of 1,000 fpm. If a change of airspeed is necessary, make the change before starting the maneuver. As proficiency increases, perform rate climbs and descents at different airspeeds, vertical velocities, and configurations.

9.7.1. **Constant Rate Climbs.** To enter the climb, simultaneously advance power to the approximate climb power setting. Adjust pitch to the proper attitude to maintain airspeed. After the vertical velocity stabilizes, readjust your pitch and rpm as necessary to maintain the desired vertical velocity and airspeed. Maintain heading with the heading indicator. Any deviation from the desired rate of climb on the VVI indicates a need for a pitch adjustment. Coordinate pitch and power correction closely. For example, if the vertical velocity is correct but the airspeed is high, reduce the power. As the power is decreased, increase the pitch slightly to avoid a decrease of vertical velocity. A leveloff from a rate climb is the same as a leveloff from a constant airspeed climb.

9.7.2. **Constant Rate Descents.** The technique and cross-check are exactly the same as those used for climbs. The only differences are the pitch attitude and power setting. A leveloff from a rate descent is the same as from constant airspeed descents. Rate descents have many practical applications in instrument flight procedures. Precision approaches such as the precision approach radar (PAR) and instrument landing system (ILS) require rate descents to maintain the glidepath while descending on the final approach. The precision with which you perform a rate descent could mean the difference between landing safely or performing a missed approach. The rate of descent on a precision final approach is based on the groundspeed of the aircraft and the glidepath angle.

**9.8. Instrument Slow Flight.** Before performing an instrument approach, you should practice instrument slow flight to become familiar with aircraft handling characteristics. Practice instrument slow flight at airspeeds and configurations specified for an instrument approach.

**9.9. Vertical-S (A-B-C-D):**

9.9.1. These maneuvers are designed to improve your instrument cross-check, including pitch, bank, and power control. Procedures for maintaining the descent or climb are the same as those for constant rate climbs and descents.

9.9.2. Establish a climb or descent at a rate of 1,000 fpm. Pitch and power coordination are essential. The lead point for leveloff from a climb or descent is used as a starting point for the reversal in direction after each 1,000-foot change of altitude. The use of trim increases the ease of aircraft control.

9.9.3. A rapid cross-check is necessary during the changes in vertical direction. You must anticipate the need for a power change before reaching the 1,000-foot point because you cannot instantly stop vertical velocity. Use power as necessary to maintain 160 KIAS throughout the maneuver. Accomplish the vertical-S A, B, C, and D as described in AFMAN 11-217, Volume 1.

**9.10. Confidence Maneuvers.** Confidence maneuvers are taught to show that an aircraft can be flown safely through extreme attitudes by using instruments. The attitude indicator is the most useful instrument in extreme pitch and bank attitudes. Before performing confidence maneuvers, ensure loose items of equipment are stowed and ensure the boost pump is operating. If maneuvers are flown a series, you do not have to check these items between individual maneuvers.

9.10.1. **Wingover.** Set the power at 90 percent and lower the pitch to attain the entry airspeed of 220 KIAS. Accomplish the maneuver as described in AFMAN 11-217, Volume 1.

9.10.2. **Aileron Roll.** Set the power at 90 percent and lower the pitch to attain the entry airspeed of 220 KIAS. Accomplish the maneuver as described in AFMAN 11-217, Volume 1.

**9.11. Unusual Attitudes:**

9.11.1. An unusual attitude is an aircraft attitude that occurs inadvertently. Some possible causes of unusual attitudes are a slow cross-check, spatial disorientation, turbulence, transition form VMC to IMC, lost wingman, instrument failure, and extreme attitudes resulting from combat tactics. It is important to immediately transition to instrument references any time you become disoriented or when outside visual references become unreliable.

9.11.2. Use the attitude indicator as the main recovery instrument. Regardless of how the unusual attitude is recognized, verify that an unusual attitude exists by comparing both attitude indicators with control and performance indicators prior to initiating the recovery.

9.11.3. Bank interpretation and control response are most important in recovering from unusual attitudes. In high performance aircraft, an inverted diving attitude is a most critical situation. Proper bank correction to return to right side up is critical. You must be less than 90 degrees of bank before correcting pitch. From an inverted diving attitude (more than 90 degrees of bank), the aircraft must first be rolled to less than 90 degrees of bank to avoid an excessive loss of altitude or exceeding design limits.

9.11.4. From steep climbing attitudes, the aircraft must be rolled toward a 90-degree banked attitude to allow the nose to slice smoothly to a horizon and avoid stalling or negative Gs. By rolling toward the 90-degree bank attitude, the nose will fall naturally to the horizon and enough back stick pressure can be held to keep you comfortably in your seat.

9.11.5. The initial recovery is made by referring to the attitude indicator. As long as the horizon bar is visible on the ARU-42A or ARU-44A, similar indications of attitude can be observed. However, in extreme pitch attitudes, the horizon reference goes out of sight. If the miniature aircraft has a black background, you are diving. If it has a gray background, you are climbing. In other than extreme pitch attitudes, the background coloring and lettering (climb or dive) can be used to determine if you are upright or inverted.

9.11.6. If the aircraft is diving, roll (or continue to roll) toward wings level. Adjust power and extend the speed brake as appropriate and return to level flight. If you are inverted, back stick pressure will only increase the loss of altitude. Therefore, hold only enough back stick pressure as necessary to keep well seated until you are less than 90 degrees of bank.

9.11.7. If the aircraft is climbing, use power as required and roll (or continue to roll) to bring the bank pointer toward the nearest 90-degree bank index mark. Maintain the bank and back stick pressure to remain well seated. As the fuselage dot of the miniature aircraft approaches the horizon bar, adjust the bank to establish a wings-level attitude. Adjust the pitch as necessary, depending on airspeed, to regain straight-and-level flight. Complete the recovery with a minimum loss of altitude. In some cases, recovery can be made before reaching 90 degrees of bank. This recovery is similar to the wingover maneuver.

9.11.8. Recovery from unusual attitudes on a partial panel (without the attitude indicator) is an emergency procedure. Refer to AFMAN 11-217, Volume 1, for this procedure.

**9.12. VOR Orientation.** Previously, most of your instrument flying has been basic instrument maneuvers performed with no specific relation to a fixed ground reference. The VOR provides a fixed reference from which these basic maneuvers can be performed in a planned sequence. The maneuvers and procedures explained in the remainder of this chapter are used to arrive at a definite fix and, if necessary, to hold at a fix until the controlling agency can clear you for an instrument approach and landing. Information for the operation of equipment may be found in Section 1 of TO 1T-37B-1 (flight manual).

**9.13. DME Orientation:**

9.13.1. DME extends the instrument capability of the T-37 by providing continuous slant-range distance information. It also permits position orientation, groundspeed checks, arcing, proceeding directly to a radial/DME fix (fix-to-fix), and improved instrument guidance when flying VOR or DME and VOR and tactical air navigation (VORTAC and TACAN) approaches. Remember, the distance displayed on the DME indicator is the slant-range distance between the aircraft and a TACAN or DME station, not a VOR station. You are receiving course guidance from one station and DME information from another. These two stations may or may not be collocated. Instrument approaches using VORTAC, but designated TACAN, should not be flown because the VOR portion has not been flight checked.

9.13.2. The AN/ARN-154(V) DME indicator displays the distance to the station, station identifier in letter format, bearing to the station, and either groundspeed or time to the station. The bearing information presented may be used for situational awareness and/or cross-tuning purposes. It may not be used to provide course guidance. If the DME signal is lost, the DME continues to calculate the range at the last known speed of the aircraft to the ground station for 10 to 12 seconds. If the signal is lost for more than 12 seconds, the groundspeed indicator portion will show a series of dashes.

**9.14. Course Intercepts:**

9.14.1. **General:**

9.14.1.1. Course interceptions are performed in many phases of instrument navigation. To ensure successful course interception, an intercept heading must be used that results in an angle or rate of intercept sufficient to complete a particular intercept problem. A controller will normally give instructions as intercepting a radial inbound or outbound. For all inbound radial intercepts, you must convert the radial into a course. Adding or subtracting 180 degrees to the inbound radial does this.

9.14.1.2. As a technique, set the radial inbound at the bottom of the J-2 compass card and display the inbound course at the top of the card. Another technique that will help you remember when to add or subtract 180 degrees is the ROCO and RITA method. **ROCO** means the **r**adial **o**utbound = **c**ourse **o**utbound; **RITA** means the **r**adial **i**nbound **t**urns **a**round. This method will help you know when you need to get the reciprocal of the radial and set it in the CSW.

9.14.2. **Intercept Heading.** The intercept heading (aircraft heading) is the heading determined to solve an intercept problem. When selecting an intercept heading, the essential factor is the relationship between the distance from the station and the number of degrees the aircraft is displaced from the course. Adjustments to the intercept heading may be necessary to achieve a more desirable rate of intercept.

9.14.2.1. **Inbound Intercepts:**

9.14.2.1.1. As a technique for determining inbound intercepts, look in the shorter direction from the desired course to the head of the bearing pointer. Then continue beyond the head of the bearing pointer another 30 degrees. This heading will give you a recommended intercept angle of 30 degrees, and this angle should be sufficient for most inbound intercepts.

9.14.2.1.2. You may use any intercept heading between the head of the bearing pointer and the desired course. When determining the recommended intercept heading, do not move more than 90 degrees from the desired course. Otherwise, you will intercept the course going outbound. The following formulas will assist you: course to bearing pointer + 30 degrees not to exceed course + 90 degrees = recommended heading; course to bearing pointer + 1 degree not to exceed course + 90 degrees = acceptable headings.

9.14.2.2. **Outbound Intercepts:**

9.14.2.2.1. As a technique for determining outbound intercepts, locate the tail of the bearing pointer, move in the shorter direction toward the desired course, and then continue beyond the desired course another 45 degrees. This will give you a recommended intercept angle of 45 degrees. This angle should be sufficient for most outbound intercepts.

9.14.2.2.2. You may use any intercept heading between the desired course and the desired course plus 90 degrees, not to exceed the head of the bearing pointer. When determining the recommended intercept heading, do not move more than 90 degrees from the desired course (or the head of the bearing pointer). Otherwise, you will intercept the course going inbound. The following formulas will assist you: tail to course + 45 degrees not to exceed head of bearing pointer = recommended heading; tail to course + 1 degree not to exceed course + 90 degrees or head of bearing pointer = acceptable headings.

9.14.3. **Angle of Intercept.** The angle of intercept is the angular difference between the heading of the aircraft (intercept heading) and the desired course. The minimum acceptable angle of intercept for an inbound course interception must be greater than the number of degrees the aircraft is displaced from the desired course. The angle of intercept should not exceed 90 degrees.

9.14.4. **Rate of Intercept.** The rate of intercept is determined by observing bearing pointer and CDI movement. The rate of intercept is a result of intercept angle, groundspeed, distance from the station, and whether you are proceeding to or from the station.

9.14.5. **Completing the Intercept:**

9.14.5.1. **Lead point.** A lead point to roll out on the course must be determined because of the angle of intercept and the turn radius of the aircraft. The amount of lead required depends on the distance from the station and the aircraft heading in relation to the desired course as well as the time and distance required to turn to course. AFMAN 11-217, Volumes 1 and 2, have formulas to help you determine lead points. As a general rule, use 1 nautical mile (nm) turn radius at 160 KIAS and 1 1/2 nm for 200 KIAS.

9.14.5.2. **Rate of Intercept.** To determine the rate of intercept, monitor the bearing pointer or CDI movement.

9.14.5.3. **Turn.** The time required to make the turn to course is determined by the intercept angle, aircraft turn rate, and distance from the NAVAID.

9.14.5.4. **Complete the Intercept.** Use the CDI, when available, for completing the course intercept.

9.14.5.5. **Undershoot or Overshoot.** If it is obvious that the selected lead point will result in undershooting the desired course, reduce the angle of bank or roll out of the turn and resume the intercept. If the selected lead point results in an overshoot, continue the turn and roll out with a correction back to the course.

9.14.5.6. **Maintain the Course.** The aircraft is maintaining the course centerline when the CDI is centered or the bearing pointer or tail of the bearing pointer indicates the desired course. Apply corrections for known winds when completing the turn to the desired course.

**9.15. Intercept Procedures.** The following are aircraft-specific intercept procedures: (***NOTE:*** Supplemental information and figures on general intercept procedures are found in AFMAN 11-217, Volumes 1 and 2.)

9.15.1. **Tuning, Identifying, and Monitoring the Desired Station:**

9.15.1.1. **Tune.** Tune to the desired frequency or channel.

9.15.1.2. **Identify:**

9.15.1.2.1. Positively identify the station. Through human error or equipment malfunction, it is possible that the station intended to be selected is not the one being received. This may occur as the result of failing to select the correct frequency or failure of the receiver to channelize to the new frequency.

9.15.1.2.2. The VOR station identification may be a repeated three-letter Morse code group or a three-letter Morse code group alternating with a recorded voice identifier. An example would be the three-letter identifier in Morse code followed by "Marianna VOR" and then repeating the three-letter identifier. In the T-37, the AN/ARN 154(V) DME interprets the Morse code identification and displays it in letter form for easy identification. The bearing information displayed on this DME may be used for situational awareness and/or cross-tuning purposes.

9.15.1.2.3. The ILS localizer transmitter puts out a repeated four-letter Morse code group. The first letter of the identifier is always "I" to denote the facility as an ILS.

9.15.1.3. **Monitor.** Monitor station identification while using it for navigation. Removal of identification serves as a warning to pilots that the facility is officially off the air for tuneup or repairs and may be unreliable even though intermittent or constant signals are received. The navigation signal is considered to be unreliable when the station identifier is not being received. (See AFMAN 11-217, Volume 1, for monitoring requirements.) Voice communication is possible on most VOR and ILS frequencies. If the frequency is underlined, it indicates that the NAVAID is *not* voice capable.

9.15.2. **Homing to a Station:**

9.15.2.1. Tune, identify, and monitor the station.

9.15.2.2. Turn the aircraft in the shorter direction to place the head of the bearing pointer under the top index of the RMI.

9.15.2.3. Adjust the aircraft heading, as necessary, to keep the bearing pointer under the top index.

9.15.3. **Proceeding Direct to a Station:**

9.15.3.1. Tune, identify and monitor the station.

9.15.3.2. Turn the aircraft in the shorter direction to place the head of the bearing pointer under the top index of the RMI.

9.15.3.3. Center the CDI with a "TO" indication. (This does not apply when using only the RMI.) The CDI will center on a specific radial inbound and display the reciprocal of that radial in the form of a course. If you are using the CI, you must have a "TO" indication in the TO/FROM window to ensure the aircraft will go to the station. The course that causes the CI to center will be close to the bearing under the top of the RMI bearing pointer. Remember, the CI is a more accurate instrument than the bearing pointer, so keep turning the CSW until the CI centers.

9.15.3.4. Maintain the selected course to the station.

9.15.4. **Inbound (CI and RMI):**

9.15.4.1. Tune, identify, and monitor the station.

9.15.4.2. Set the inbound course in the course selector window and check for a "TO" indication.

9.15.4.3. Turn in the shorter direction to place the heading pointer toward the CDI. Continue the turn to place the heading pointer in the top half of the instrument case. This prevents an intercept angle in excess of 90 degrees. Roll out with the RMI bearing pointer between the desired inbound course and top index. The angle of intercept must be greater than the number of degrees off course, not to exceed 90 degrees. The intercept heading may be adjusted within these limits to achieve the most desirable rate of intercept. Displacing the bearing pointer approximately 30 degrees from the top index will normally ensure a moderate rate of intercept.

9.15.4.4. Maintain the intercept heading until a lead point is reached. Then complete the intercept.

9.15.5. **Inbound (RMI Only):**

9.15.5.1. Tune, identify, and monitor the station.

9.15.5.2. Determine an intercept heading. From the desired course, look in the shorter direction to the head of the bearing pointer. Any heading beyond the bearing pointer, within 90 degrees of the desired inbound course, is a no-wind intercept heading. In many instances, an intercept heading selected 30 degrees beyond the bearing pointer ensures a rate of intercept sufficient to solve the problem. An intercept angle is formed when the head of the bearing pointer is between the desired course and the top index on the RMI.

9.15.5.3. Turn in the shorter direction to the intercept heading.

9.15.5.4. Maintain the intercept heading until a lead point is reached. Then complete the intercept.

9.15.6. **Station Passage:**

9.15.6.1. VOR and VOR/DME. Station passage occurs when the TO/FROM indicator makes the first positive change to FROM.

9.15.7. **Outbound—Immediately After Station Passage (CI and RMI):**

9.15.7.1. Tune, identify, and monitor the station. (This should have already been accomplished.)

9.15.7.2. Turn in the shorter direction to a heading that will parallel or intercept the outbound course. Turning to parallel the desired outbound course is always acceptable. Continuing the turn to an intercept heading may be preferable when the bearing pointer is stabilized or when you know your position in relation to the desired course. Consider the effect airspeed, wind, and magnitude of turn will have on aircraft position during the turn to an intercept heading.

9.15.7.3. Set the desired course in the course selector window and check for "FROM" indication.

9.15.7.4. Turn to an intercept heading (if not previously accomplished). Determine the number of degrees off course as indicated by CDI displacement or angular difference between the tail of the bearing pointer and the desired course. If the initial turn was to parallel the desired course, turn toward the CDI to establish an intercept angle approximately equal to the number of degrees off course. Normally, to avoid overshooting, an intercept angle greater than 45 degrees should not be used.

9.15.7.5. As a technique, if you turn to a parallel heading, look at the tail of the bearing pointer. If the tail of the bearing pointer is *below* the 45-degree index, look across the RMI to the opposite 45-degree index for your recommended intercept heading. If the tail of the bearing pointer is *above* the 45-degree index, count the number of degrees off the desired course outbound from the tail of the bearing pointer and then turn to an intercept heading at least equal to the number of degrees off the desired course.

9.15.7.6. Maintain the intercept heading until a lead point is reached. Then complete the intercept.

9.15.8. **Outbound—Immediately After Station Passage (RMI Only):**

9.15.8.1. Tune, identify, and monitor the station.

9.15.8.2. Turn in the shorter direction to a heading that will parallel or intercept the outbound course. Refer to paragraph **9.15.7.2.**

9.15.8.3. Determine the number of degrees off course. Note the angular difference between the tail of the bearing pointer and the desired course.

9.15.8.4. Determine an intercept heading. If a suitable intercept angle was not established during the initial turn, look from the tail of the bearing pointer to the desired course. Any heading beyond the desired course is a no-wind intercept heading. Turn in this direction an amount approximately equal to the number of degrees off course. Normally, to avoid overshooting the course, do not use an intercept angle greater than 45 degrees.

9.15.8.5. As a technique, if you turn to a parallel heading, look at the tail of the bearing pointer. If the tail of the bearing pointer is *below* the 45-degree index, look across the RMI to the opposite 45-degree index for your recommended intercept heading. If the tail of the bearing pointer is *above* the 45-degree index, count the number of degrees off the desired course outbound and then turn to an intercept heading at least equal to the number of degrees off.

9.15.8.6. Turn to the intercept heading (if not previously accomplished).

9.15.8.7. Maintain the intercept heading until a lead point is reached. Then complete the intercept.

9.15.9. **Outbound—Away from the Station (CI and RMI):**

9.15.9.1. Tune, identify, and monitor the station.

9.15.9.2. Set the desired outbound course in the course selector window.

9.15.9.3. Turn to an intercept heading. Turn in the shorter direction to place the heading pointer toward the CDI. Continue the turn to place the heading pointer in the top half of the instrument case and roll out on an intercept heading. This prevents an intercept angle in excess of 90 degrees. Roll out of the turn on an intercept heading with a suitable intercept angle, normally 45 degrees. Establish a 45-degree intercept angle by rolling out with the desired course under the appropriate 45-degree index or with the heading pointer displaced 45 degrees from the top index and toward the CDI.

9.15.9.4. Maintain the intercept heading until a lead point is reached, then complete the intercept.

9.15.10. **Outbound—Away From the Station (RMI Only):**

9.15.10.1. Tune, identify, and monitor the station.

9.15.10.2. Determine an intercept heading. Look from the tail of the bearing pointer past the desired course and select an intercept heading. Any heading beyond the desired course, within 90 degrees, is a no-wind intercept heading. A heading selected 45 degrees beyond the desired course will normally ensure a moderate rate of intercept. See paragraph **9.14.2.** for techniques on determining intercept headings.

9.15.10.3. Turn in the shorter direction to the intercept heading.

9.15.10.4. Maintain the intercept heading until a lead point is reached, Then complete the intercept.

9.15.11. **Arc Interceptions.** VOR/DME and VORTAC arcs are used during all phases of flight. An arc may be intercepted at any angle, but it is typically intercepted from a radial. An arc may be intercepted when proceeding inbound or outbound on a radial. A radial may be intercepted either inbound or outbound from an arc. The angles of intercept (arc to radial or radial to arc) are approximately 90 degrees. Because of the large intercept angles, the use of accurate lead points during the interception will help prevent excessive undershoots or overshoots.

9.15.12. **Arc Interception From a Radial:**

9.15.12.1. Tune, identify, and monitor the station. Remember that you will need to tune in both VOR and DME frequencies.

9.15.12.2. Determine a lead point based on the speed you are flying. As a general rule, you may use 1 nm when flying 160 KIAS and 1 1/2 nm when flying 200 KIAS.

9.15.12.3. When the lead point is reached, turn to intercept the arc. Monitor the bearing pointer and range indicator during the turn, and roll out with the bearing pointer on or near the 90-degree index (wingtip position). If the aircraft is positioned outside the arc, roll out with the bearing pointer above the 90-degree index. If it is positioned inside the arc, roll out with the bearing pointer below the 90-degree index.

9.15.13. **Maintaining an Arc.** Control the aircraft heading to keep the bearing pointer on or near the 90-degree index (reference point) and the desired range in the range indicator. Some techniques for accomplishing this are as follows:

9.15.13.1. **Bank Angle:**

9.15.13.1.1. Establish a small bank angle that will result in a rate of turn that will keep the bearing pointer on the selected reference point. A reference point other than the 90-degree index must be used when operating in a crosswind. If the aircraft drifts toward the station, select a reference point below the 90-degree index. If the drift is away from the station, select a reference point above the 90-degree index. The selected reference point should be displaced from the 90-degree index an amount equal to the required drift correction.

9.15.13.1.2. Monitor the range indicator to ensure the range remains constant. The angle of bank will depend upon the size of the arc, wind, and true airspeed (TAS). This technique is more suitable when flying a relatively small arc at a high airspeed. A continuous bank angle may contribute to spatial disorientation and attitude indicator precession.

9.15.13.2. **Short Legs.** Fly a series of short, straight legs to maintain the arc. To fly an arc in this manner, adjust the aircraft heading to place the bearing pointer 5 to 10 degrees above the selected reference point. Maintain the heading until the bearing pointer moves 5 to 10 degrees below the reference point. The range should decrease slightly while the bearing pointer is above the reference point; it should increase slightly when it is below the reference point. The arc is more closely maintained by flying shorter legs and controlling the heading to keep the bearing pointer nearer to the reference point. Adjust the heading and reference point as necessary.

9.15.13.3. **Adjust:**

9.15.13.3.1. To correct to the arc, change the aircraft heading to displace the bearing pointer as desired about the reference point. The size of the correction must be adequate to return the aircraft to the arc and is dependent on the magnitude and rate of deviation from the arc. The rate of deviation from or correction to an arc will vary with the size of the arc, whether the aircraft is inside or outside the arc, TAS of the aircraft, wind direction, and velocity.

9.15.13.3.2. A small arc has a relatively sharp curvature, and deviation to or from the arc can occur rapidly. Corrections from inside an arc are assisted by the curvature of the arc. Conversely, corrections from outside the arc for a like amount of deviation must be larger to offset the effect of arc curvature.

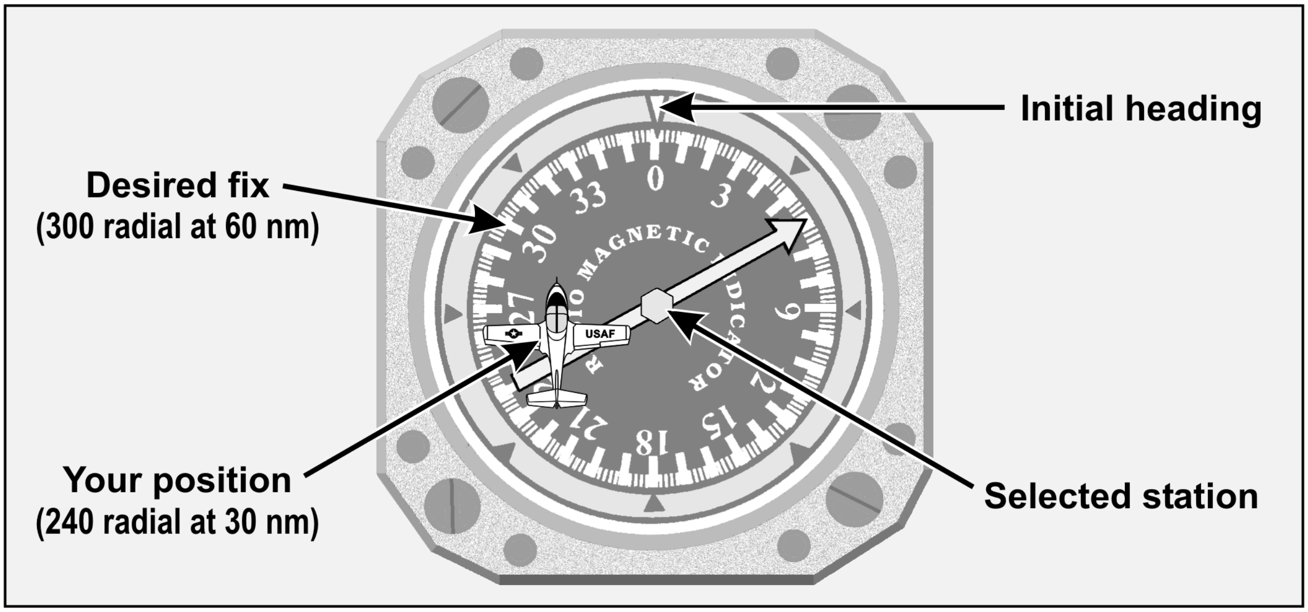
9.15.13.3.3. The effects of aircraft TAS and wind are self-evident. These many variables make it impossible to use a consistent correction for a given deviation. The following technique may be used for determining the size correction to use: displace the bearing pointer 5 degrees below the 90-degree index on the RMI for each 1/2 mile deviation to the inside of the arc and 10 degrees above the 90-degree index for each 1/2 mile outside the arc.

9.15.14. **Proceeding Direct to a VOR/DME fix (Fix-to-Fix).** To proceed directly from one fix to another is often required during departures, approaches, or maneuvering in a terminal area. You may be assigned a direct routing to a holding fix or an initial approach fix (IAF). Bearing and range information from a VOR/DME or TACAN facility is sufficient for navigating directly to any fix within reception range. The following procedures and technique steps will ensure you correctly accomplish a fix-to-fix:

9.15.14.1. Tune, identify, and monitor the station.

9.15.14.2. Turn to a heading between the head of the bearing pointer and the desired radial. The objective is to turn in the general direction of the desired fix rather than flying away from the fix while attempting to determine a precise heading (**Figure 9.1.**). If the DME must be decreased, roll out on a heading closer to the bearing pointer. To increase the DME, roll out on a heading closer to the desired radial.

**Figure 9.1. Fix-to-Fix Initial Heading.**




9.15.14.3. **Visualize.** Visualize the aircraft position and desired fix on the compass card of the RMI. The following factors must be understood when visually establishing the aircraft position and the desired fix on the compass card:

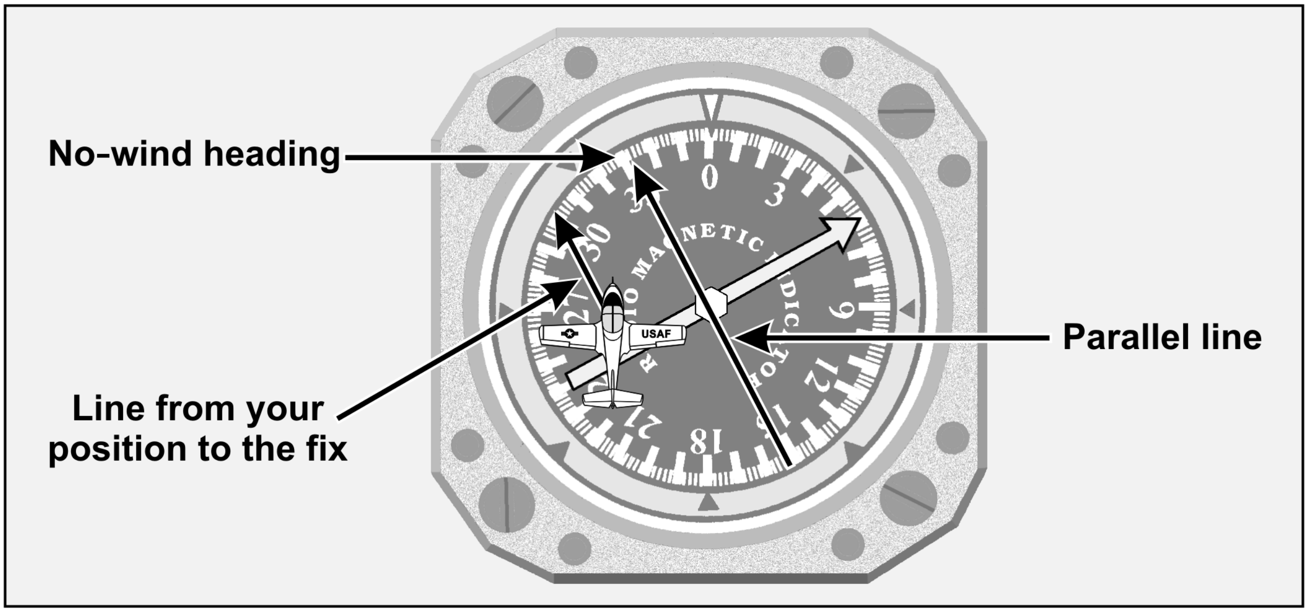
9.15.14.3.1. **Station Location.** The station is located at the center of the compass card, and the compass rose simulates the radials around the station (**Figure 9.1.**).

9.15.14.3.2. **Aircraft Position.** The aircraft position is visualized along the reciprocal (radial) of the bearing pointer (**Figure 9.1.**).

9.15.14.3.3. **Fix.** The fix with the greater range is established at the outer edge of the compass card. The fix with the lesser range is visualized at a point that is proportional to the distance represented by the outer edge of the compass card (**Figure 9.1.**).

9.15.14.4. **Determine a Heading.** Determine a precise heading from the aircraft position to the desired fix. Determine the heading to the fix by connecting the aircraft position to the desired fix with an imaginary line. Establish another line in the same direction and parallel to the original line through the center of the compass card (**Figure 9.2.**). This will establish a no-wind heading to the desired fix.

**Figure 9.2. No-Wind Heading.**




9.15.14.5. **Turn.** Turn to the no-wind heading you determined.

9.15.14.6. **Adjust Heading.** Apply any known wind drift correction. The effect of wind drift and/or inaccurate initial headings may be corrected by repeating steps 9.15.14.3. to 9.15.14.5. while en route.

**9.16. Instrument Departures.** There are several ways to depart an airport on an IFR flight. While you are typically given radar vectors to the en route airway structure, there are other methods to depart. They include departure procedures, standard instrument departures, and diverse departures. Read AFMAN 11-217, Volume 1, carefully for an excellent explanation of departure procedures. Normally, you should use tech order climb speeds during departures, and any intermediate leveloff should be flown at the tech order climb speed for that altitude.

**9.17. Holding.** The various methods for entering a holding pattern are located in AFMAN 11-217, Volume 1. Use 160 KIAS as the holding airspeed at all altitudes. To descend in the holding pattern, use power as required. (Speed brake is optional.) One technique for descents in holding is to use the pitch and power settings used for the vertical-S maneuvers.

**9.18. Arrival.** Arrival at an airport may be accomplished via various methods, including the following:

9.18.1. **Standard Terminal Arrival (STAR).** A STAR is an IFR arrival routing established for the purposes of simplifying clearances and facilitate transition between the en route structure and the instrument approach procedures. More information concerning STARs is located in AFMAN 11-217, Volume 1.

9.18.2. **En Route Descents.** The en route descent is the most common method of arriving at a location. It may take to you to a holding fix, an IAF, or radar vectors. Before starting descent, review the instrument approach procedure (IAP) for the type of final planned, recheck the weather (if appropriate), check heading and attitude systems, and coordinate lost communications procedures as follows:

9.18.2.1. Any time you are flying to a destination for a radar approach, there is no backup approach available, and the weather does not permit a VFR arrival.

9.18.2.2. Any time you arrive at a destination and need radar assistance to fly the approach.

9.18.2.3. On initial contact with the ATC.

9.18.3. **High Altitude Jet Penetrations.** Entry airspeed for a jet penetration will depend whether or not you hold prior to the penetration. Before reaching the IAF, review the IAP, recheck the weather (if appropriate), check the heading and attitude systems, and obtain clearance for the approach. If you do not hold, reduce to 200 KIAS before reaching the IAF. If you hold, your initial speed for entering the penetration will be at 160 KIAS. Slow to holding speed as specified in AFMAN 11-217, Volume 1. Accomplish the descent check prior to reaching the IAF and set the altimeter in accordance with *Flight Information Publications (FLIP)* instructions.

9.18.4. **Hi-VOR Non-DME Teardrop Approaches:**

9.18.4.1. Fly these approaches as outlined in AFMAN 11-217, Volume 1. To initiate the penetration descent, simultaneously reduce the power to 65 percent and lower the pitch to approximately 10 degrees nose low. Once the airspeed reaches 200 KIAS, extend the speed brake. This will ensure you maintain the 800- to 1,000-foot per nm descent gradient required on these approaches. Another option is to use idle power, no speed brake, and maintain approximately 10 degrees nose low.

9.18.4.2. Use the speed brake to prevent exceeding 250 KIAS below 10,000 feet MSL. During the penetration turn, you will normally use 30 degrees of bank. However, you may shallow the bank angle to avoid undershooting of the inbound course. Monitor the altitude carefully during penetration. High rates of descent associated with this type of approach can cause you to easily misjudge the altitude and misread the altimeter. Carefully cross-check all needles and counter drums on the altimeter to prevent misreading errors.

9.18.4.3. You may want to decrease the descent rate as you approach leveloff. Retract the speed brake and reduce the pitch to approximately 5 degrees. Approaching the desired altitude, you may reduce the pitch more and allow the aircraft to begin slowing to 160 KIAS. Begin configuring the aircraft for final approach 3 to 5 miles from the FAF. Slow to 120 minimum prior to configuring. Once you have the aircraft configured, slow to and maintain 110 KIAS. Do not transmit "gear down" until the gear is down and locked and the before-landing checklist is completed.

9.18.5. **Hi-VOR/DME or Hi-VORTAC Approaches.** Fly these approaches as outlined in AFMAN 11-217, Volume 1. To initiate the penetration descent, simultaneously reduce the power (typically 65 percent) and lower the pitch to approximately 10 degrees nose low. Once the airspeed reaches 200 KIAS, extend the speed brake. Modify the pitch and power settings as necessary to comply with the specific altitude restrictions on these approaches. This will normally mean using shallower descents because you are able to calculate distances and descent gradients required between fixes on the approach. Your IP will discuss various techniques for calculating descent gradients and pitch attitude required to meet altitude restrictions on these approaches.

**9.19. Low Altitude Approaches.** There are three types of low altitude approaches available for you to fly in the T-37. (These do not include the radar approaches.) These approaches are classified in two ways—course reversals (including a procedure turn and a holding pattern in lieu of [HILO] a procedure turn) <u>and</u> a procedure track:

9.19.1. **Course Reversals:**

9.19.1.1. **Procedure Turn.** A procedure turn is one method of aligning the aircraft with a runway. You can easily identify the procedure turn in the plan view with a 45/180 degree barb on the inbound course as well as a break in the lines in the profile view. There are several methods of entering and flying the procedure turn. They include the 70-degree method, *Aeronautical Information Manual (AIM)* method, 45/180-degree method, and the 80/260-degree method. Your IP will discuss the various methods and techniques available. When flying the procedure turn, you may want to use descent pitch and power settings used for the vertical-S maneuvers.

9.19.1.2. **HILO.** The HILO is another method of course reversal used to position the aircraft for landing. The HILO is identified by a heavy dark holding pattern in the plan view and a level line in the profile view. The profile view may show a descent while on the inbound course. The profile view also has the heading outbound on top of the line and the course inbound on the bottom of the line. Entry is flown by using the techniques and procedures found in AFMAN 11-217, Volume 1. You will only go *once* around the holding pattern. The timing is normally 1-minute legs unless specifically marked using DME. When flying the HILO, you may want to use the descent pitch and power settings used for the vertical-S maneuvers.

9.19.2. **Procedure Track.** Basically, anything that is <u>not</u> a procedure turn or a HILO is a procedure track. A procedure tracks may incorporate arcs, radials, courses, or turns. Fly these approaches as depicted in AFMAN 11-217, Volume 1. When flying the procedure track, you may want to use descent pitch and power settings used for the vertical-S maneuvers.

**9.20. Radar Approaches.** There are two types of radar approaches available—the airport surveillance radar (ASR) and the precision approach radar (PAR). The ASR is a nonprecision approach while the PAR is a precision approach. Both are known as ground-controlled approaches (GCA). This means the majority of information necessary for you to fly the approach comes from a radar controller. The controller will direct you to descend at a specified point. The point will average from 5 to 7 nm from the runway. For the ASR, the controller will tell you to descend to your MDA. For the PAR, the controller will say "begin descent."

9.20.1. **ASR:**

9.20.1.1. The ASR is a nonprecision approach. It is the radar typically used to control the traffic in the airport area. The radar controller will provide course and distance information during the approach. He or she will normally provide information necessary to ensure a successful approach, including the MDA for your aircraft and the location of the missed approach point for the approach.

9.20.1.2. While being vectored to final, you should repeat all altitudes (assigned and departing) as well as headings and altimeter settings. Acknowledge all other transmissions with your call sign. Once you are established with the final controller, you will be told not to acknowledge any further transmissions. You must still make a "gear down" call prior to crossing the runway threshold.

9.20.1.3. The ASR is a simple approach because all you have to do is fly the headings given by the controller and maintain the airspeed and altitude assigned. Headings are normally given in small increments of 2 to 5 degrees. The controller will give corrections for the wind so fly the headings given and do not correct for wind until transitioning for the landing. Normally, you should use the number of degrees to be turned as the bank angle, up to one-half the standard rate (approximately 10 degrees).

9.20.2. **PAR.** The PAR is very similar to the ASR except it provides glidepath control. The PAR has a specific radar system and is a very precise approach. You must make appropriate corrections to the pitch or VVI settings to correct to the glidepath. Course control is the same as the ASR.

**9.21. Final Approach:**

9.21.1. The airspeed for all final approaches (other than crosswinds or emergencies) is 110 KIAS. Configuration is landing gear down, landing lights extended, and 50 percent flaps. When you initially start flying instruments, plan to configure 3 to 5 miles prior to the FAF. You may modify this distance to 2 to 3 miles prior as your proficiency increases. Be completely configured and stable on the final approach airspeed prior to the FAF for nonprecision approaches and prior to glidepath intercept for precision approaches. When strong crosswinds are present, use the configurations specified for contact conditions.

9.21.2. The transition to landing begins when you make visual contact with the runway environment. While flying nonprecision approaches, you will level off at an MDA. Once you level off, bring outside information into your cross-check so you can start trying to locate and positively identify the runway environment. While flying precision approaches, incorporate outside information into your cross-check as you approach decision height.

9.21.3. It is acceptable to transition to contact aimpoint and configuration once you have the runway environment in sight. This technique may cause you to "duck under." It is highly recommended that you keep your aircraft stable and keep the glidepath you have. Normally, you will have a visual approach slope indicator or some other similar system to help you transition from IMC to VMC. If you elect to transition to contact references, you have the option of setting flaps to 100 percent and slowing to 100 KIAS.

**9.22. Circling Approaches:**

9.22.1. A circling approach is a visual maneuver flown at the completion of an instrument approach to align the aircraft with a landing runway. Perform a circling approach when conditions such as runway closure, winds, etc., rule out a straight-in approach. Many variables exist in executing a circling approach. Consider airfield obstructions, weather, aircraft turning performance, and cockpit visibility in your preflight planning.

9.22.2. While circling at MDA, the visual cues for runway displacement will be considerably different than those you normally see in the overhead pattern. Because a circling approach is generally flown at a lower altitude than an overhead pattern, proper displacement will appear to be much wider than normal. When circling at approximately 500 feet AGL, place the wingtip on the runway to achieve desired spacing.

9.22.3. Remember, if at any time an unfavorable situation develops, go around. Do not attempt to land.

9.22.4. Fly circling approaches at 110 KIAS with gear down, landing lights extended, and flaps at 50 percent. You may extend the speed brake and extend additional flaps on base or final, as desired. If you extend additional flaps, slow to and maintain 100 KIAS.

**9.23. Landing.** The primary purpose for flying any approach is to position the aircraft for a safe landing. Many illusions can occur in the transition from IMC to VMC. AFMAN 11-217, Volume 1, contains many of these illusions and can help you identify and deal with them.

**9.24. Missed Approach:**

9.24.1. Execute a missed approach in accordance with AFMAN 11-217, Volume 1, any time you cannot complete a safe landing from an instrument approach. Advance the throttles to military and retract the speed brake (if extended). Establish a climb attitude on the attitude indicator that is 5 degrees above level-flight attitude for configuration. Cross-check the VVI and altimeter for climbing indications. When a positive climb is established (climbing indications on both VVI and altimeter), raise the gear and flaps and turn the landing lights to "off" or "taxi." If an immediate turn is necessary, ensure you have a safe airspeed.

9.24.2. Ensure a positive climb attitude is maintained. When the airspeed reaches 160 KIAS, adjust the power and pitch as required. Maintain a constant airspeed climb until reaching the missed approach altitude. Cross-check all instruments to ensure the proper heading and climb are maintained. Level off and maintain a minimum of 160 KIAS (if successive approaches are desired) or accelerate to tech order airspeed (if diversion is necessary). Follow the missed approach procedure until you have coordinated for another clearance. Then follow all instructions given by approach control or ATC.

9.24.3. When you are issued verbal missed approach or departure instructions, they take priority over *published* instructions. However, if you are not able to accomplish the verbally issued missed approach or departure instructions on an actual missed approach, follow the *published* missed approach or departure instructions. Immediately advised ATC that you have missed the approach, are unable to accomplish the verbally issued missed approach or departure instructions, and are complying with the *published* missed approach or departure instructions.

9.24.4. To execute a missed approach while circling, simultaneously transition to instruments while establishing a climbing turn toward the runway you planned to land on. Then fly the departure instructions you were issued or the published missed approach instructions for the runway you flew the approach to (<u>not</u> the one you planned to land on).

9.24.5. If you must execute a missed approach prior to the missed approach point (MAP), proceed to the MAP along the final approach course and then via the route and altitudes specified in the published missed approach or departure instructions. You should maintain your final approach speed to properly identify the MAP, but you must climb away from the ground. Add power as necessary to climb at final approach airspeed to a safe altitude and continue to the MAP. Then follow the normal missed approach procedures.

**9.25. Voice Procedures.** Air-to-ground communication is almost wholly dependent on use of the voice. Control of air traffic locally and along the airways is predicated entirely upon voice communication. With the ever-increasing amount of air traffic, there is a corresponding increase in the number of voice transmissions required to control the traffic. Therefore, good voice procedures are not merely desirable, they are mandatory. Refer to *FLIP General Planning, Flight Information Handbook (FIH), and AIM* for voice procedures, position reporting, and phraseology. If you are ever in doubt about issued instructions, ask the controller.

**9.26. Spatial Disorientation Maneuvers.** The spatial disorientation maneuvers listed in paragraphs **9.26.1.** through **9.26.4.** have been selected because of their relation to normal instrument flight or flight associated with turbulent weather. These maneuvers should be simulated and practiced only under direct IP supervision. More violent and prolonged maneuvers may have a disorienting effect, but they are not the type of maneuver or situation likely to be encountered inadvertently. To understand spatial disorientation, carefully study AFMAN 11-217, Volume 1.

9.26.1. **Sensation of Climbing While Turning:**

9.26.1.1. This sensation can be demonstrated by having the pilot's eyes closed while the aircraft is in a straight-and-level attitude. With a relatively slow entry, the IP should execute a well-coordinated 90-degree turn, using about 1 positive G. While the aircraft is turning under the effect of positive G and with the pilot's eyes still closed, the IP should ask the pilot's impression of the aircraft attitude. The usual sensation is a climb.

9.26.1.2. Under actual instrument conditions, if the aircraft enters a slight, coordinated turn in either direction while the pilot's eyes are diverted away from the instruments, the sensation of a nose-up attitude may occur. If the angular acceleration in the turn is too little to stimulate the inner ear, the change in G force caused by the turn is the only sensation perceived. Positive G is usually associated with a climb; negative G with a dive or nose over.

9.26.2. **Sensation of Diving During Recovery From a Turn:**

9.26.2.1. This sensation can be demonstrated by repeating the method described in paragraph **9.26.1.1.** except the pilot keeps his or her eyes closed until the recovery from the turn is approximately one-half completed. While the recovery is being executed and with the pilot's eyes still closed, the IP will observe the pilot's impression of the aircraft attitude. The usual impression is that of an aircraft descending.

9.26.2.2. Under actual instrument conditions, if the pilot's eyes are diverted away from the instruments during a turn under instrument conditions, a slow recovery will cause the body to perceive only the decrease in positive G force. The sensation causes the pilot to believe the aircraft has entered a descent.

9.26.3. **False Sensations of Tilting to the Right or Left:**

9.26.3.1. This sensation may be demonstrated from a straight-and-level attitude with the pilot's eyes closed. The IP should maintain wings level and use rudder to produce a slight skid to the left. The usual sensation is that of being tilted to the right.

9.26.3.2. Under actual instrument conditions, if the pilot's eyes are momentarily diverted from the instruments as a skid to one side occurs, a false sensation of tilting the body to the opposite side may occur.

9.26.4. **False Sensation of Motion Reversal:**

9.26.4.1. This false sensation may be demonstrated from a straight-and-level attitude with the pilot's eyes closed. The IP should roll the aircraft at a constant rate of 1 to 2 degrees per second to a 30- to 45-degree bank angle. The roll should be stopped abruptly and the bank angle held. The usual sensation is a sense of rapid rotation in the opposite direction.

9.26.4.2. Under actual instrument conditions, if the aircraft rolls or yaws with an abrupt stop while the pilot's eyes are diverted away from the instruments, a sensation of rolling or yawing to the opposite direction may occur. Therefore, the natural response to this false sensation would result in a reentry or an increase of the original roll or yaw. This response is a common error in rolls or spins when the visual references are poor. The sense of sight is the only sense that should be relied upon for correct recovery techniques.

9.26.5. **Conclusion.** Actual instrument flying is nothing but a series of basic instrument maneuvers flown in a sequence. You should be able to make an ITO and a tech order climb to altitude and navigate from one fix to another, using VOR and DME equipment. On arriving at your destination, you should be able to hold or penetrate (when cleared), make an approach, and land at the airport. The power settings (referred to in paragraph **9.4.3.** and **Table 9.1.**) are approximate. Use them only as a guide.

# Chapter 10

# NAVIGATION

**10.1. Introduction.** This chapter is a short review of navigation procedures and techniques. It is not intended to replace a through knowledge of AETC TRSS Handout 11-1, *Navigation for Pilot Training,* which is available at **http://trss3.randolph.af.mil/bookstore//general.htm** (Nav4Pilots).

**10.2. Preparation for Flight.** Navigation is an integral part of flying and a culmination of knowledge and skills you have learned in academics and other phases of training. Thorough preflight planning is the key to a successful navigation flight. Preparations for the flight may actually begin days before departure. You can select the base and route early and leave the wind computations, fuel requirements, and weather conditions until just before filing the required flight plan. Remember, the publications normally carried on the aircraft are for the local flying area. Therefore, because your planned route or a possible weather divert may take you to an area not covered by these local publications, you should obtain other publications before departing the home field.

**10.3. Preflight Planning:**

10.3.1. Plan your flight at optimum altitudes and airspeeds consistent with mission requirements, safety, and sound flight planning. Include a review of en route airfields for possible emergency or diversion use. A good technique is to circle these fields on your map for ready reference in flight. These emergency airfields should be compatible with T-37 landing requirements.

10.3.2. Carefully examine the aircraft servicing capabilities of your destination and alternate airfields. Some aircraft transient maintenance personnel, particularly at non-Air Force installations, may not be totally familiar with T-37B servicing procedures. Refer to the strange-field procedures section of your flight crew checklist for fuel, oil, hydraulic fluid, oxygen, and tire-pressure requirements. If you have any doubts about the ability of transient maintenance to properly service your aircraft, check with your supervisor of flying (SOF) before filing your flight plan.

10.3.3. When completing takeoff data, variables such as pressure altitude, temperature, and runway data can cause major deviations from the computations associated with home field operations.

**10.4. Ground Operations.** Ensure transient alert personnel are familiar with starting and post-starting procedures. Before starting engines, confirm the status of your clearance with ground control or clearance delivery. If you anticipate any delay, do not start your engines until clearance is received. After receiving your ATC clearance, check it against your original plan to be sure you can comply with changes.

**10.5. Departure.** Before takeoff, plan for departure by reviewing departure routing and altitude restrictions. ATC may change your clearance by giving you radar vectors, changes in altitude, or changes in route of flight. The better your preflight plan, the easier you can handle these changes. At leveloff, make a comparison of aircraft position and fuel remaining against the preplanned position and fuel. Any significant deviations may require a change in the flight plan.

**10.6. En Route:**

10.6.1. Outside the local training environment, it is very easy to forget the required in-flight checks. The same checks are required; only the location has changed.

10.6.2. Once you have reached cruise altitude and have set the power to maintain your preplanned airspeed, you may want to perform a groundspeed check. Compare your actual groundspeed to the preplanned computations to determine the effects of actual wind. When crossing the checkpoints, compare your fuel and time to the preplanned computations. A significant deviation may require a change in the flight plan.

10.6.3. A good technique is to write down assigned radio frequencies. This will aid you if contact is not made on the next assigned frequency. Return to the previous frequency and confirm the new frequency when necessary.

10.6.4. Maintain a constant awareness of your position through the use of NAVAIDs, map-reading, and dead reckoning (DR). A radio or NAVAID failure can occur at any time.

**10.7. Arrival and Landing.** Refer to **Chapter 9** of this manual and AFMAN 11-217, Volume 1, for the descent and instrument approach. Determine what type of approach to expect at the destination before you commit yourself. Some approaches require extensive cruise at lower altitudes which may not be desirable because of excessive fuel consumption. From this planning, you should be familiar with airfield layout, approach lighting, type of glidepath guidance, field elevation, runway data, tower and ground control frequencies, etc. Wide runways (more than 150 feet) may contribute to high flares and dropped-in landings, and narrow runways may cause late or incomplete flares and hard landings.

**10.8. After Landing:**

10.8.1. After engine shutdown, complete the before-leaving-aircraft checklist and conduct a thorough postflight inspection of the aircraft. Ensure transient maintenance personnel are thoroughly familiar with all servicing requirements outlined in the strange-field procedures section of the flight crew checklist. Make sure the aircraft will be properly secured.

10.8.2. Tell transient maintenance how to contact you should any questions arise or unusual situations be encountered after you leave the aircraft. Remember, the aircrew is ultimately responsible for the aircraft until it is returned to the home station. Even after careful preflight planning, unforeseen circumstances may result in degraded transient servicing capability such as absence of proper servicing fluids and/or equipment. If any doubt exists as to transient maintenance's ability to properly and safely service your aircraft, contact your SOF before any servicing is begun.

**10.9. Low-Level Navigation on Military Training Routes (MTR).** The purpose of low-level navigation is to fly a selected ground track and arrive at a designated target at a designated time over target (TOT). Low-level flying requires extensive preflight planning to ensure flight safety and maximum training from each sortie.

10.9.1. **Preflight Coordination.** The first step in preparing for low-level missions is to become completely familiar with the route requirements and applicable publications, that is, *FLIP AP/1B,* AETC TRSS Handout 11-1, and *Chart Update Manual (CHUM).*

10.9.2. **Mission Planning:**

10.9.2.1. Select a groundspeed that is easily converted to miles per minute but allows for required airspeed corrections (180, 210, or 240 knots). Reference charts in TO 1T-37B-1 (flight manual) for the required fuel flow for the planned TAS. For normal planning purposes, use 210 knots groundspeed.

10.9.2.2. During premission planning, check the forecast weather for the route. Use the forecast temperature, pressure altitude, and winds to compute the indicated airspeeds required for the planned groundspeed.

10.9.2.3. Fly low-level navigation at an altitude of 500 to 1,500 feet AGL. When terrain height varies, maintain a minimum of 500 feet above the highest terrain within 2,000 feet of the aircraft. Because towers and other manmade obstacles are more difficult to see than high terrain, fly a minimum of 500 feet above the highest obstacle within 2 nm of the aircraft. Once the obstacle is acquired visually and positively identified, the 2,000-foot clearance applies.

10.9.2.4. To minimize the possibility of a bird strike and avoid the problems associated with visual illusions, enter the route no earlier than 30 minutes after sunrise (1 hour in mountainous terrain) and exit the route no later than 30 minutes before sunset (1 hour in mountainous terrain).

10.9.3. **Route Development:**

10.9.3.1. Use a 1:500,000 scale map—tactical pilotage chart (TPC)—when flying low levels or VFR legs below 5,000 feet AGL. You may also use a 1:250,000 scale map—joint operations guide (JOG)—on low-level routes.

10.9.3.2. After drawing the route corridor, update the chart with the latest information from the *CHUM.* This step is imperative for flight safety. Next, study the route corridor to identify all significant obstacles and high terrain.

10.9.3.3. Select a target and easily recognizable turn points for navigation. The best features for turn points are usually natural (as opposed to manmade) because natural features seldom change. Choose these turn points for uniqueness, vertical development, funneling features, and surrounding terrain. Avoid using a feature that may be hidden by high terrain or trees.

10.9.3.4. Choose an initial point (IP) about 1 to 3 minutes from the target. An IP is an easily identifiable point used to fine-tune navigation and increase the probability of target acquisition. Minimize the heading change at the IP in order to increase the accuracy of the IP-to-target leg. At the IP, continue running elapsed time to the target. Begin timing at your start route point.

10.9.3.5. The start point must be within the route corridor, but does not necessarily have to be at the published entry point. When picking turn points, consider the turning room required to remain within the route corridor. Remain clear of any *FLIP*-directed, noise-sensitive areas or airfields. Wherever possible, choose easily identifiable points along the route to update and fine-tune course navigation. Where no such points exist, rely solely on DR.

10.9.3.6. A thorough and detailed map study is essential after developing the route. Reading the shape of the land from the map is also important. A JOG may initially help you interpret data if you are using a TPC. Try to visualize all the key points on the route, and the general features around them, so you can minimize reference to the map while airborne. Funneling features such as converging ridgelines, rivers, and roads are especially helpful in locating selected points.

10.9.4. **Map-Marking.** In addition to the information required in AETC TRSS Handout 11-1, make the following marks (or computations) on your map:

10.9.4.1. Draw in the MTR corridor from entry to the planned exit point. Circle turn points to prevent masking critical details.

10.9.4.2. Draw turn circles based on the planned groundspeed and bank angle. Use a tactical plotter, if available, or refer to AFMAN 11-217, Volume 2, for aircraft turn performance.

10.9.4.3. Draw and label timing lines along the planned ground track. A 1- to 2-minute interval is sufficient.

10.9.4.4. Draw information boxes aligned with each leg, to include heading, leg time, and other relevant information.

10.9.4.5. Highlight any obstacles or high terrain features that may be a factor along the route.

10.9.4.6. Compute a continuation fuel for the start point and other selected points along the route. Continuation fuel is the minimum fuel required to complete the route at planned speeds and altitudes and to return to base with AFI 11-202, Volume 3, fuel reserves.

10.9.4.7. Compute a bingo fuel that includes the required minimum AFI 11-202, Volume 3 fuel reserves for return to base by the most practical means from the most distant point on the route. Consider factors such as cloud ceilings, winds, freezing level, and forecast icing when calculating bingo fuel.

10.9.4.8. Compute and clearly annotate a route abort altitude for the low-level route. This altitude will provide 1,000 feet of clearance (2,000 feet in mountainous terrain) from the highest obstacle within 10 nm of the planned course.

10.9.4.9. Annotate the map with emergency and alternate airfield locations and information necessary to expedite an unplanned divert.

10.9.4.10. Plan the routing to and from the low-level route. Look for points that may help identify the start point. Ensure each map has identical turn points, IPs, targets, headings, and times.

10.9.5. **Flying the Route.** If the mission is planned properly, flying accurate headings and airspeeds on each leg will get you close to your turn points, IP, and target. Rely on DR.

10.9.5.1. If the MTR is close to your base and departure procedures allow DR to the entry point, fly your planned headings, airspeeds, and times from takeoff to the entry point. On routes that are a long distance away or at bases that require extensive IFR vectoring prior to route entry, find a point en route at which you can begin DR. In either case, a VOR radial/DME is an excellent way to confirm an entry point.

10.9.5.2. Before arriving at the entry point, compare the RMI and J-2 heading with the magnetic compass to ensure accuracy and recheck that the ball is centered so as not to induce a constant error in your heading control. Identify the point as early as possible and maneuver the aircraft to overfly the entry point on the correct heading. Once inside the route structure, accelerate to the preplanned airspeed. Start your stop watch as you pass the start point.

10.9.5.3. Do not continuously map-read because this will jeopardize safety and may lead to mis-identifying points. Instead, use selective map-reading by only looking for prominent points along the route. Look for points that are 30 seconds to 1 minute ahead of the aircraft; avoid looking at points behind the aircraft. Trimming the aircraft and setting the proper fuel flow or power setting for the planned groundspeed can greatly aid low-level navigation by providing a stable platform. As much as possible, keep your head out of the cockpit. Clearing is essential at low level. When looking at the map, do not look into the cockpit. Raise the map so some forward clearing still exists, but never totally block forward vision with the map. Make corrections as necessary to get back onto track and time, but avoid excessive changes, if possible.

10.9.5.4. As much as possible, assess the height above the ground visually. Occasionally cross-check the altimeter against the known elevation of towers, lakes, airfields, or peak elevations.

10.9.5.5. Develop a work cycle for performing cockpit duties, assessing altitude, and updating aircraft position. Identify a turn point as early as possible and review the next heading and airspeed. If you are unable to acquire the turn point, do not panic. Turn on time and then try to analyze the reason for not seeing the turn point. Attempt to confirm your position with other features. Remember, throughout the route, 500 feet AGL is a minimum altitude. Do not exceed your comfort level in an attempt to fly at 500 feet. An unfamiliar route, poor visibility, a mountainous terrain, or a number of other factors may require a higher altitude for a reasonable level of comfort.

10.9.5.6. Turns at low altitude require extra emphasis in clearing and aircraft control. Clear in the direction of turn. Then roll to the planned bank angle and use back stick pressure and power as required to maintain altitude and airspeed. Cross-check pitch and bank closely, using outside references to prevent a descent and ensure proper clearing.

10.9.5.7. Arrive over the IP as close as possible to your planned time. Make small corrections as early as possible to prevent large airspeed changes later.

10.9.5.8. Avoid becoming complacent during the return to base. Give the return leg the same emphasis as the route entry leg.

10.9.6. **Mountainous Terrain.** Flying low level in an environment with rapidly changing terrain is demanding and requires constant positional and situational awareness. Realize that low-lying check or turn points can easily be hidden when off the planned track. Be alert for areas of turbulence on the downwind side of large features and fly upwind of ridges whenever possible. To fly safely over high-terrain features, begin the climb early enough to arrive at the desired AGL altitude at least 2,000 feet prior to the high terrain. Very large altitude increases may warrant calculation of a start climb point to ensure minimum clearance is maintained. When descending, use an appropriate power reduction to control airspeed.

10.9.7. **Conclusion.** Flying jet aircraft on low-level missions is a deadly serious business. You are flying at high speeds close to the ground in a high-threat environment. The threat is not enemy aircraft or air defense weaponry, but it is just as real and more deadly. (The ground has a 100 percent probability of a kill.) Remember, your margin for error and your time to react are greatly reduced due to the close proximity of the ground. Therefore, thorough preflight planning and preflight briefings are <u>imperative</u> for safe and effective low-level training. As a minimum, use the low-level navigational briefing guide in AFI 11-2T-37, Volume 3.

# Chapter 11

# EMERGENCY PROCEDURES

**11.1. General.** The emergency procedures in this section supplement those in TO 1T-37B-1 (flight manual). The importance of studying all emergency procedures cannot be overemphasized.

**11.2. Bail Out.** If it is necessary to abandon the aircraft, the IP will use the term "bail out" as the final command. If time and conditions permit, crewmembers should discuss ejection procedures before ejecting. However, in critical situations, they should not delay ejection waiting for the command to bail out or delay ejection once the IP has given the command.

**11.3. Complete Electrical Failure, Day or Night:**

11.3.1. If you encounter complete electrical failure, fly over the RSU or tower, as applicable, at an altitude of 500 feet AGL and an airspeed of 200 KIAS. This will alert the controller to your situation.

11.3.2. At the end of the runway, make a 180-degree climbing turn to the downwind leg. Roll out at a normal pattern altitude. Use landing gear emergency extension procedures to ensure the gear is down and locked. (Full flaps are optional.) With complete electrical failure, the speed brake, spoilers, trim, thrust attenuators, flap indicator, and nosewheel steering will be inoperative.

11.3.3. Be alert for a red light or flare from the RSU or tower. This may be a warning of some unseen hazard. If you receive a steady green light or no light from the RSU or tower and it appears a safe landing is possible, continue with the approach and landing.

11.3.4. Without the speed brake and thrust attenuators, the importance of establishing a proper final approach cannot be overemphasized. If a go-around is required, start it as early as possible and do not attempt to raise the gear. With complete electrical failure at night, you can see other aircraft but they cannot see you, so be especially alert.

11.3.5. In certain situations, you may fly the electrical failure pattern when you do not have radio contact with the RSU or tower and want to declare an emergency. Depending on your problem, you may continue with an overhead pattern or perform a straight-in approach.

**11.4. Radio Failure, Day or Night.** When the RSU is in control of the runway, fly a normal overhead pattern, rocking the wings on initial. Watch for a green light from the RSU. If you do not see a green light, flash the taxi light on final and continue the pattern, but do not sacrifice aircraft control to flash the light. When the RSU is not in control of the runway, fly the aircraft alongside the landing runway while rocking the wings. Turn to downwind at the end of the runway and check the tower or RSU for a green light on base leg and final approach.

**11.5. Physiological Problems.** Many physiological factors may affect you as a pilot, but they all have one common result—degraded pilot performance. The cause may be hypoxia, hyperventilation, bends, chokes, or cramps. The symptoms are not the same for everyone. In physiological training, you were allowed to experience and identify some of your symptoms. Learn to recognize your symptoms or the degraded performance. If you notice a problem, gang-load your oxygen controls, declare an emergency, and descend below 10,000 feet MSL. When able, refer to the aircrew checklist for oxygen system emergency operation. If you suspect oxygen contamination, use the parachute emergency oxygen system by pulling the green apple. Land as soon as practical, even if you begin to feel better. The flight surgeon will meet the aircraft and check you and your personal equipment.

**11.6. Visual Flight Rules (VFR) or Low-Level Emergencies.** Almost any VFR or low-level en route emergency will demand that you climb the aircraft to a safe height above the terrain so you can analyze the situation safely and establish radio contact. If you have maintained positional awareness and are able, proceed to the nearest suitable airfield while handling the problem. If unable to contact a controlling agency, follow (1) local lost-communication procedures, (2) specific-route lost-communication procedures listed in *FLIP AP/1B,* or (3) general lost-communication procedures in the *FLIP AIH.* Some emergencies to plan for in the preflight briefing are engine failure at low altitude, bird strike, canopy failure, low-level diverts, and weather.

11.6.1. Compute a route abort altitude for each VFR or low-level navigation route flown and clearly annotate the altitude on the chart for easy reference in flight. Compute this altitude to provide 1,000 feet (2,000 feet in mountainous terrain) clearance from the highest obstacle within 10 nm either side of the course for the entire route.

11.6.2. IMCs encountered while flying VFR or low-level navigation constitute an emergency situation. If you cannot avoid flying into IMC, immediately abort the route and climb to your emergency route abort altitude (or higher, if appropriate). The climb should be immediate, using military power and a safe airspeed. Several factors, such as the terrain or the nature of the emergency, will influence the airspeed used to abort the route. Normally, a minimum of 160 KIAS is sufficient during the climb.

11.6.3. To abort, immediately establish a climb on course and do not, under any circumstances, attempt to reenter the route once an abort has been initiated. Because route aborts are potentially disorienting, immediately transition to instruments and pay close attention to aircraft control and flight parameters. After reaching the route abort altitude, level off, squawk "emergency" (if appropriate), and coordinate with the appropriate controlling agency for an IFR clearance to destination. A climb to an altitude higher than route abort may be necessary to ensure obstruction clearance during the recovery to the destination airfield.

11.6.4. If you miss consecutive checkpoints or turn points and do not recognize any references from your map, climb to the top of the route structure. Maintain planned headings and airspeed while attempting to identify major references. Use any available VOR to fix your position. Check past actions to trace a possible navigation error. If unable to reorient yourself, abort the route and follow the lost procedures discussed in paragraph **11.9.**

**11.7. Airspeed Indicator Malfunction:**

11.7.1. An interruption of static or impact pressure will cause an airspeed indicator malfunction. An obstruction at the static ports or pitot tube will cause erroneous cockpit indications which may result in a slow decrease toward zero or a stable indication. You should suspect a malfunction if you note any improper response. It is important to ensure the pitot heat is turned on when flying in visible moisture to prevent the formation of ice.

11.7.2. The corrective action taken for pitot-static system malfunctions will vary, based on the situation. Because there is not an alternate static system, an emergency source of static pressure can be obtained by breaking the glass of one of the differential pressure instruments. The IP's airspeed indicator or altimeter would be the best choice, but slightly higher than actual airspeed indications should be anticipated. The only cockpit correction for pitot-tube blockage is to use pitot heat.

11.7.3. Recovery and landing with an airspeed indicator inoperative will vary, based upon the availability of a chase aircraft to lead you down for landing. Because this is the preferred method of recovery, coordination with ground agencies may be necessary to facilitate an airborne rendezvous. Use caution during flight without an airspeed indicator. Use approximate power settings and pitch attitudes to maintain desired airspeeds. Avoid rapid pitch and power changes and initiate immediate recovery procedures for any stall indications.

11.7.4. If the situation dictates a single-ship recovery and landing, consider your proficiency level and familiarity with different patterns. This may determine whether you elect to fly an overhead pattern or a straight-in approach. In either case, plan your approach carefully and use appropriate power settings to provide safe airspeed control.

**11.8. After Landing With an Emergency.** If you require assistance from fire protection or maintenance personnel during an emergency or precautionary landing, hold the brakes and raise both hands to signal it is clear to inspect the aircraft. Do not actuate switches without visual coordination with the ground crew.

**11.9. Lost Procedures:**

11.9.1. If you do not pay attention to where you are flying, you may become lost or disoriented. You should have a map of the area to keep yourself oriented in relation to known landmarks at all times. If you become lost, try to regain your position orientation using ground references, NAVAIDs, and/or radio calls. Do not hesitate to call for assistance. It is far better to admit you are lost and get help than to wander aimlessly until you are low on fuel and have to bail out.

11.9.2. Fuel consumption is extremely critical. Take immediate steps to conserve your remaining fuel. While calling for assistance and trying to determine your position, climb to the optimum altitude as indicated in the diversion range summary chart and establish maximum endurance airspeed (125 KIAS).

11.9.3. Attempt to contact an ATC radar facility on ultra high frequency (UHF). If there is no contact, channelize the radio to other frequencies listed in your in-flight guide. Squawk “mode 3 code 7700” or “emergency” on your identification, friend or foe/selective identification feature (IFF/SIF).

11.9.4. If you cannot contact a radar facility on the listed frequencies, attempt contact on guard (frequency 243.0). Preface your calls with, “mayday,” “mayday,” “mayday,” and give your call sign and type of emergency. Several controlling agencies will probably answer your distress call. Select one agency and tell the rest to remain silent. The agency you select will attempt to identify you by requesting that you change your IFF code. Once you are identified, you will be given directional information to the nearest suitable airfield or, if sufficient fuel exists, to your home field.

11.9.5. The UHF radio works on a line-of-sight transmission principle. Therefore, the higher your altitude, the more likely you are to obtain a good steer from a ground facility. The following is an approximate range for transmission over flat terrain:

| Aircraft | Altitude Range |
|---|---|
| 5,000 feet | 55 miles |
| 10,000 feet | 140 miles |
| 20,000 feet | 200 miles |

11.9.6. If you cannot establish radio contact with any controlling agency, try to determine your position by radial and DME from a known navigational facility. If the DME is inoperative, try to orient yourself by using two VOR stations. Tune in a nearby VOR, note the radial you are on, and draw it on your map. Tune in another nearby VOR, note the radial you are on, and draw this one on your map. The point where the two radials cross is your position within 2 or 3 miles. Although factors such as inaccurate plotting and movement of the aircraft affect the accuracy of the fix, this two-bearing fix is very useful in the absence of other landmarks.

11.9.7. If you decide to accept radar vectors or attempt to home to a station, ensure your RMI and J-2 heading indicator are operating properly. Check them with the standby magnetic compass. If the heading indicator and compass do not agree, rely on the compass. In this case, the RMI would be unreliable because it is connected to the J-2 system. However, you may use the CDI to determine the bearing to the station. To do this, set a course in the course window by centering the CDI with a "TO" indication on the "TO/FROM" indicator. Use the CDI to establish a course to the fix while using the magnetic compass for heading information. Once you are oriented, maintain maximum range airspeed as indicated in the diversion range summary chart.

11.9.8. If you are unable to establish your position or navigate using aircraft instruments, pick out an outstanding landmark on the ground. Significant bodies of water, a town, or a railroad crossing are all good landmarks. Try to find your selected landmark on your local area map. You should have some idea of your general location so look for your landmark in that general area on your map. Orient your map with the aircraft heading.

11.9.9. If you cannot locate the landmark on your map, do not just wander around aimlessly; fly a definite heading until you can pick up another good landmark. Set up an orbit around the landmark and identify it.

11.9.10. If you still cannot locate your position, look for a suitable airstrip and land before you run out of fuel. If you cannot locate an airstrip before running out of fuel, **eject.** Do not attempt to make a forced landing.

## 11.10. Trim Malfunctions:

11.10.1. A trouble-free trim system is essential to minimize fatigue from out-of-trim stick forces. Do not attempt to fly an aircraft that fails the preflight trim check. Once airborne, a trim system failure could result in heavy stick forces leading to muscular fatigue or even loss of aircraft control due to disorientation from unusual stick pressures.

11.10.2. The most effective way to reduce or eliminate stick forces caused by trim failure is to reduce the airflow over the control surfaces and trim tabs. Flying at faster airspeeds dramatically increases the force required to maintain a desired pitch. The design of the T-37 is such that nose-down stick forces may increase as airspeed increases at nose-down trim settings. These nose-down forces may become extreme at high airspeeds, and the only way to bring these forces under control is by reducing airspeed or retrimming.

11.10.3. If you experience trim failure or runaway trim at low altitude, consider trading airspeed for altitude and climbing. In addition to trim failure, the trim actuator could "run away" as a result of a malfunction or inadvertent application by a crewmember. This could result in very heavy stick forces. Any time you experience abnormal stick forces, use pitch and power to achieve an airspeed range of 110 to 150 KIAS and refer to the Runaway Trim section of the checklist.

**11.11. Forms (or IMTs) Adopted.** AF IMT 847 and AFTO Form 781.

RONALD E. KEYS, Lt General, USAF
DCS/Air & Space Operations

## Attachment 1

## GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

***References***

AFPD 11-2, *Aircraft Rules and Procedures*

AFI 11-2T-37, Volume 1, *T-37B Aircrew Training*

AFI 11-2T-37, Volume 2, *T-37B Aircrew Evaluation Criteria*

AFI 11-2T-37, Volume 3, *T-37B Operations Procedures*

AFI 11-202, Volume 3, *General Flight Rules*

AFI 11-205, *Aircraft Cockpit and Formation Flight Signals*

AFI 11-214, *Air Operations Rules and Procedures*

AFMAN 11-217, Volume 1, *Instrument Flight Procedures*

AFMAN 11-217, Volume 2, *Instrument Flight Procedures*

AFI 11-218, *Aircraft Operations and Movement on the Ground*

AFPAM 11-419, *G-Awareness for Aircrew*

AETC TRSS Handout 11-1, *Navigation for Pilot Training,* available at **http://trss3.randolph.af.mil/bookstore/general_pubs.htm** (Nav4Pilots)

AETCMAN 3-3, Volume 2, *Mission Employment Primary Flying, T-37*

TO 1T-37B-1, *Flight Manual, USAF Series, T-37B Aircraft*

TO 1T-37B-CL-1, *T-37 Abbreviated Flight Crew Checklist*

*Chart Update Manual (CHUM)*

*Flight Information Publication (FLIP)*

*Aeronautical Information Manual (AIM)*

*General Planning*

*Flight Information Handbook (FIH)*

*AP/1 and AP/1B*

Air Force Records Disposition Schedule (RDS)

***Abbreviations and Acronyms***

**AETC**—Air Education and Training Command

**AGL**—above ground level

**AGSM**—anti-G straining maneuver

**AOA**—angle of attack

**ASR**—airport surveillance radar

**ATC**—air traffic control

**CDI**—course deviation indicator

**CI**—course indicator

**CSW**—course selector window

**DME**—distance measuring equipment

**DR**—dead reckoning

**EGT**—exhaust gas temperature

**EP**—emergency procedure

**FAF**—final approach fix

**FOD**—foreign object damage

**fpm**—feet per minute

**HCA**—heading crossing angle

**HILO**—holding pattern in lieu of

**IAF**—initial approach fix

**IAP**—instrument approach procedure

**IFF**—identification, friend or foe

**IFR**—instrument flight rules

**ILS**—instrument landing system

**IMC**—instrument meteorological conditions

**IP**—instructor pilot; initial point

**ITO**—instrument takeoff

**JOG**—joint operations guide

**KIAS**—knots indicated airspeed

**MAP**—missed approach point

**MDA**—minimum descent altitude

**MOA**—military operating area

**MSL**—mean sea level

**MTR**—military training route

**NAVAID**—navigational aid

**nm**—nautical mile

**NORDO**—no radio

**NOTAM**—notice to airman

**NWLO**—nosewheel liftoff

**PAR**—precession approach radar

**PIO**—pilot-induced oscillation

**psi**—pounds per square inch

**RMI**—radio magnetic indicator

**rpm**—revolutions per minute

**RSU**—runway supervisory unit

**RTB**—return to base

**SOF**—supervisor of flying

**STAR**—standard terminal arrival

**TACAN**—tactical air navigation

**TAS**—true approach

**TOLD**—takeoff and landing data

**TPC**—tactical pilotage chart

**UHF**—ultra high frequency

**VFR**—visual flight rules

**VHF**—very high frequency

**VMC**—visual meteorological condition

**VOR**—very high frequency omnidirectional range

**VORTAC**—VOR and TACAN

**VVI**—vertical velocity indicator

***Terms***

**Closure**—The rate of movement the wingman has in relation to lead. Increasing closure is a result of greater airspeed, a lead pursuit curve, or both. Conversely, decreasing closure is a result of lesser airspeed, a lag pursuit curve, or both.

**High yo-yo**—A reposition of the aircraft, using a combination of pure or lag pursuit and movement above lead's plane of motion to control closure, decrease aspect, and prevent an overshoot. It also allows for turning room in a vertical plane of motion above lead's plane of motion.

**Lag pursuit curve**—The path a wingman's aircraft will follow if it flies to an imaginary point behind lead (**Figure 8.9.**).

**Lead pursuit curve**—The path a wingman's aircraft will follow if it flies to an imaginary point in front of lead (**Figure 8.9.**).

**Line of sight (LOS)** —A line from the pilot's eye to an object being viewed.

**LOS rate**—The rate of movement of the object along the canopy. An aft LOS rate occurs when the aircraft flightpath results in passing in front of the object. A forward LOS rate occurs when the aircraft flightpath results in passing behind the object.

**Plane of motion—**The geometric plane described by the flightpath of an aircraft. At high G-loading (above 4 Gs), the plane of motion is approximated by the lift vector.

**Pure pursuit curve—**The path a wingmans aircraft will follow if it flies directly at the lead aircraft (**Figure 8.9.**).

**Rate of turn—**The rate of change of heading, normally measured in degrees per second.

**Three/Nine (3/9) line—**A hypothetical line extending out of the aircraft's lateral axis. The wingman must remain aft of the lead aircraft's 3/9 line during maneuvering. This line equates to a 90-degree aspect angle (9 aspect) for a trailing aircraft.

**Turning room—**The volume of airspace in the vertical or horizontal (or both) that can be used to execute a maneuver for solving aspect, angle off, and closure when maneuvering in relation to another aircraft.