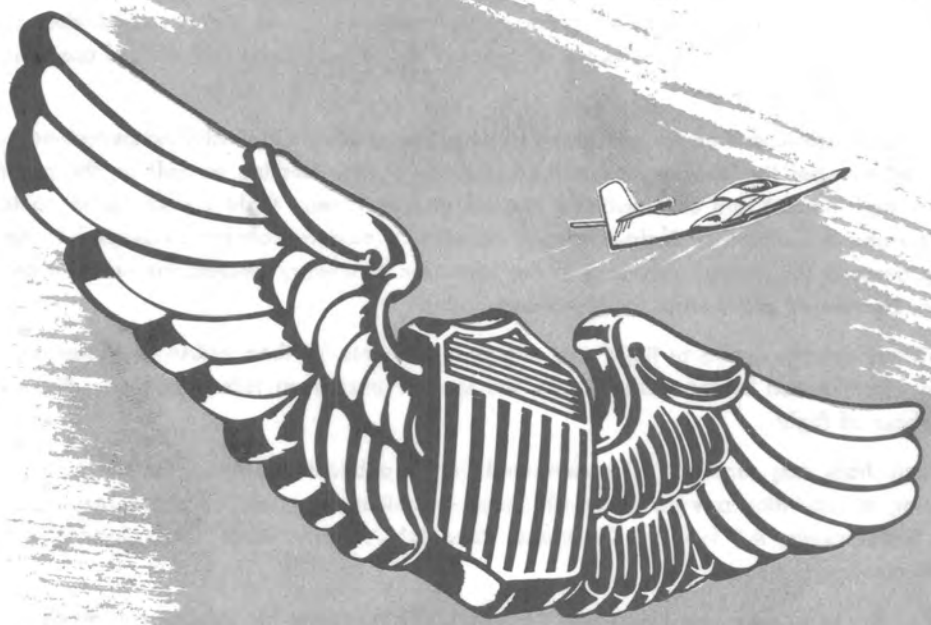
ATC MANUAL 51-4



Primary Flying, Jet

AIR TRAINING COMMAND

ATC MANUAL 51–4
(Service Test Edition)



Primary Flying, Jet

AIR TRAINING COMMAND

ATC MANUAL
NUMBER 51-4 (TEST)*

HEADQUARTERS AIR TRAINING COMMAND
UNITED STATES AIR FORCE
30 March 1961

FOREWORD

This manual is designed as a primary text on the fundamentals of jet flying and is specifically oriented to the T–37 aircraft. Master the basic techniques, procedures, maneuvers, and safety habits described herein and you will establish a sound foundation for all types of flying maneuvers and tactical procedures employed by the United States Air Force.

This manual contains instructions on the use and care of personal equipment including parachute and oxygen equipment. It describes the basic principles and procedures for handling aircraft on the ground and in the air under both normal and extraordinary contact and instrument flight conditions. In contact maneuvers, it incorporates the composite flight-reference concept, a modern concept developed to meet the ever increasing demand for greater precision in the operation of military aircraft. Formation flight is treated to the extent considered practicable for a primary student.

Throughout this manual, the names of flight and engine instruments, or their visible components, are capitalized for easy identification by the student as to the specific instrument reference being discussed for the particular phase of flight.

Air Force organizations may reprint articles contained in this publication without further authorization. Before extracting or reprinting any item, non-Air Force organizations or activities are requested to communicate with Headquarters Air Training Command, Randolph Air Force Base, Texas, indicating the intended use of the material.

Users are invited to send suggestions, comments, and recommendations for subsequent revisions of this manual to this Headquarters, attention DCS/Flying Training.

This manual is organizational, not personal, property. It is meant to be placed in master reference libraries and operational files (AF Regulation 5–31) where it can be kept current and made available to all personnel. Copies issued to individuals will be recalled upon completion of the official duties for which issued.

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GLOSSARY 1

CHAPTER 1

INTRODUCTION TO PILOT TRAINING

Pilot training is your opportunity to learn precision and maximum performance flying. Military pilots, or any other professional pilots, must develop the highest degree of proficiency possible. This manual is designed to help you master the fundamentals.

Operating Air Force aircraft requires initiative, good judgment, trained reflexes, and skillful flying techniques. To become an Air Force pilot, you must acquire all of these qualities. This will take considerable study, practice and determination on your part. Hard work and determination offer the reward of becoming a pilot in the United States Air Force; this should be incentive enough for you to make every effort to complete your training successfully.

Personnel at your base, from the Wing Commander to the newest junior supply clerk, are assigned for one reason—to contribute their skill, experience and industry to the well-being and success of the men who will one day constitute America's air arm. Should the program seem intense or rigid, remember that it is a serious affair with a heavy load of responsibility on all, not the least of which is you. Approach it seriously, learn well, and reap the satisfaction of offering a rare and privileged skill to your country's security.

Pilot training involves close coordination between classroom and flight training. The better you master the classroom theory, the easier it will be for you to perform the maneuvers in the aircraft. Each part of pilot training—classroom and flight—will clarify and enliven the other.

The objective of this manual is to help develop you into a pilot skilled in the basic principles of flight. Your muscular responses must be developed to the point where they become reflex actions. As you gain flying proficiency, the acuteness of your senses (sight, hearing and touch) will develop along with your muscular responses.

THE T–37 AIRCRAFT

The T–37 is a two-place, low-wing, all-metal aircraft, manufactured by the Cessna Aircraft Company. It is powered by two Continental J69–T–25 jet engines which have a rated sea level static thrust of 1025 pounds each. It is equipped with retractable tricycle landing gear, a steerable nose wheel, wing flaps, and speed brake. Its design gross weight is approximately 6575 pounds. The cockpit design features side-by-side seats with individual ejection, a fully transparent "clamshell type" canopy, and dual control sticks and rudder pedals. Duplicate controls for power and for actuation of the landing gear, wing flaps, and speed brake are located to the left of each pilot to simulate a typical "fighter type" cockpit.

The aircraft is unrestricted for all aerobatics necessary for the Pilot Training Program, will fly satisfactorily with one engine inoperative, and requires less than 4000 feet of hard-surfaced runway for takeoff or landing. It is equipped for night and limited all-weather flying. A usable internal fuel capacity of 309 gallons (2008 pounds) of JP–4 will permit approximately 20 full-stop landings and takeoffs, or a climb to 30,000 feet (student

solo flights restricted to 20,000 feet maximum) and subsequent cruise at that altitude for approximately two hours.

The T–37 has excellent stability and control characteristics under all conditions of speed, power, load factor and attitude. The controls are effective throughout the speed range and response is quite rapid. The rate of roll is extremely fast. Trimming of rudder, elevator and aileron allow for "hands off" flying at any speed.

YOUR INSTRUCTOR

Your instructor is a highly qualified professional military pilot. He has a thorough knowledge of the aircraft, maneuvers and teaching techniques. His objective is to graduate expert pilots and reliable, disciplined officers who know of the mutual trust and responsibility on which airpower is founded. To this end, he will expect your earnest endeavors. If he places great importance on exactness, it is because precision is required—first, to insure your own safety and the safety of those around and beneath you; and secondly, to enable you to exploit to the fullest your machine's military potential.

TECHNICAL ORDER LIBRARY SYSTEM

A copy of Technical Order 1T–37B–1, Flight Manual for T–37B aircraft, is supplied to you for your study. Your Flight Manual is a part of a large library system published and maintained by the Air Force to supply you, the crew chief, depot repair personnel, and other interested people with the technical information needed on the job. There are also Technical Orders to assist the motor pool mechanic, the refueling crew, the photo lab worker, and personnel performing any other job involving the maintenance, repair, storage or use of Air Force equipment and supplies. The method of identifying the Flight Manual is as follows:

TO–1T–37B–1

TO	Technical Order
–1	Aircraft Publication
–T–37	Designation of Aircraft
–B	Series
–1	Flight Manual (from which the manual derives the nickname "Dash One")

Following is a brief summary of the information to be found in the Flight Manual (which you will refer to continually during your training):

SECTION I—Describes all the components and equipment of the aircraft in general and covers the oil, fuel, electrical and hydraulic systems.

SECTION II—Discusses the normal operating procedures. It gives the checklists for all preflight and inflight inspections. A checklist extracted from this TO is an essential item in every cockpit. It lists the steps performed in aircraft operation. These steps are the standard procedures which you and every other pilot must follow. Make use of this section frequently to familiarize yourself with all the standard operating procedures.

SECTION III—Covers emergency or alternate operating procedures for single-engine landings, bailouts and systems malfunctions, such as electrical systems, landing gear and brakes.

SECTION IV—Explains operating procedures for auxiliary equipment in the aircraft, such as radio, heating system, and lighting equipment.

SECTION V—Explains the limitations and restrictions imposed by design.

SECTION VI—Covers the flight characteristics of the aircraft.

SECTION VII—Discusses the operations and characteristics of the various aircraft systems.

SECTION VIII—Crew duties (on most aircraft) has been deleted from the T–37 Flight Manual, since the crew of the T–37 aircraft has the sole duty of training. Such duty is too extensive to be treated adequately in Section VIII and is covered in your other training textbooks.

SECTION IX—Covers operation under various weather conditions.

APPENDIX—Contains the performance data charts necessary for efficient preflight and inflight mission planning.

Your manual is revised at necessary intervals. The revision system begins with the "Safety of Flight Supplement." These supplements contain immediate attention items for the information of pilots. They are distributed automatically to each authorized holder of a Flight Manual. They will be inserted at the front of the book, and a notation will be made on the title page of the manual. When a new revision to the Flight Manual is made, information from earlier supplements will be included, and those supplements will then be withdrawn from the manual along with pages that are revised. Notice that each page in your present manual bears the revision date on the lower margin. Paragraphs and passages revised from earlier versions are identified by adjacent vertical black lines on page outer margins in order for those already familiar with the manual to note changes without extensive searching.

It might be expected that the description of maneuvers, procedures and flying techniques in the Flight Manual would be identical to those in this publication; however, instructions in the Flight Manual are not designed to teach elementary flight principles. Instead, the Flight Manual provides a comprehensive description of the airplane, its flight characteristics, and specific normal and emergency operating procedures but no treatment of fundamental or diversified maneuvers. Techniques in this manual are developed to expand these general instructions for specific training requirements. Procedural details of maneuvers in this manual may vary from those in the Flight Manual; however, they are well within the aircraft's limits of performance capabilities and flight characteristics. For this reason, when deviations exist, this publication takes precedence and will not be changed except as directed by Headquarters ATC.

LOCAL FLYING REGULATIONS

As the Flying Manual is designed to assist you in learning the basic elements in flying an aircraft, obviously it cannot include certain types of detailed information which will vary from base to base because of local conditions. This type of information is published by each base in local flying regulations.

Local flying regulations set forth rules to be followed while flying in a specific locality. They cover such subjects as flying areas, traffic rules, traffic patterns, congested areas and local obstructions. They are very important because they outline safe, efficient operations peculiar to the region of your airbase. These local flying regulations are in many cases based on broad regulations from higher levels of command.

Copies of pertinent flying regulations will be available in your flight room. You will be required to read these regulations, know them and to abide by them. Any willful violation of applicable flying regulations will seriously jeopardize your standing as an Air Force officer, your career as a pilot, and will, of course, be answerable by you in Courts-Martial under the Uniform Code of Military Justice.

Local Flying Area

You should be thoroughly familiar with the local area, with those areas designated for the different types of missions and with the areas designated for each type of aircraft.

There is an aeronautical map of the local area in each flight room. You should study it and become familiar with all prominent landmarks.

You will be provided a local-area map to be used on your daily missions. This map will be kept readily available during ALL flights.

When taking off from base on a mission, you will fly in the area designated for that mission. On earlier missions, you will be specifically briefed on designated areas. After you learn them, you will be expected to proceed to the proper area for the mission.

These special areas apply only to the aircraft from your base. Aircraft based elsewhere may fly through the area, so be alert. Clear the area properly before practicing any maneuvers.

No solo aircraft will fly beyond the local area boundaries unless on a supervised navigation flight or in an emergency.

Familiarize yourself with all prominent landmarks in the local area as soon as possible. As you work toward the boundary of an area in your maneuvers, change direction and work back. You should be able to identify your position at any time, even in conditions of reduced visibility. This familiarization will be accomplished during the dual transition flights.

During the dual transition flights, you will be instructed and become proficient in DF homing procedures.

MEMORIZE MINIMUM ALTITUDES

The minimum altitude for entry and/or recovery from the following maneuvers is 6000 feet *above the terrain* (dual or solo), or higher as directed locally: chandelles, lazy 8's, maximum performance climbing turns, all stalls, all aerobatics, recovery from inverted flight, slow flight, simulated single-engine go-arounds, and high-speed dives in excess of 250 knots IAS (indicated airspeed).

Except during the takeoff, climb out, traffic patterns, and landings, the altitude should never be below 6000 feet above the ground while solo, unless otherwise directed by local authority.

Unless directed by local authority, do not fly lower than 5000 feet over any town or city within the local area. In the case of large cities, maintain sufficient altitude to glide clear in any emergency, but not less than 5000 feet.

GROUND SAFETY

Municipal, state, and national officials must enforce rigid traffic regulations to insure the safety of pedestrains and automobile traffic in areas where they intermingle. The Air Force has similar problems and must enforce regulations in areas where ground personnel might interfere with aircraft operation. Your instructor will acquaint you with these regulations before he starts your flight training. Make a mental note to understand them thoroughly and, by all means, follow them to the letter.

The problems of the ground safety officers are your problems. This section will point out some of the general regulations, in order to show that common sense rules apply on the ramp and in the proximity of aircraft during ground operation.

On most bases, there is considerable activity on the ramp. Fuel trucks are driving back and forth; mechanics are running up engines; aircraft are taxiing in and out; pilots and ground crewmen are walking to and from aircraft. At first, you will feel there is no end of movement and noise. Because of this noise, you must use your eyes continuously. Never trust your ears to warn you of an approaching truck or taxiing aircraft.

As you go out to your assigned aircraft, walk to the edge of the ramp and board a line taxi or walk along the inside edge of the ramp to the lane where your aircraft is parked. Then walk down the lane of parked aircraft to the one assigned to you. As you reach the aircraft, approach the cockpit from the lefthand side of the aircraft.

While approaching the aircraft, look around for obstructions and articles such as fire extinguisher or chocks that might obstruct you when you taxi the aircraft. After you have completed your preflight inspection and are ready to start the engines, always be sure that someone is standing by with a fire extinguisher.

When leaving your aircraft after a flight, use the same precautions you used when you first came on the ramp. You may be tired from the flight, but this is not yet the time or place to relax. When you walk away from your aircraft, depart from the front and go

directly to the closest edge of the ramp and then down the edge.

Always exercise caution when walking in front of running jet engines due to the possibility of objects being drawn into the intakes. You have been, or will be, issued ear protective devices. Be sure to use these at all times while in the ramp area. The T-37 engines produce a high-pitched whine which is most noticeable when directly in front of the engines and which may be harmful to the ears. Remain clear of jet blasts behind the aircraft as well.

FLYING SAFETY

Take the proper steps to insure safety in flight. This is a rule you should learn early in your flying training. You will note that frequent reference has been made to flight preparations and planning. Before takeoff, do all the things you are supposed to do. Plan the flight and make all necessary checks by following the procedures in your checklist item by item. A careless pilot may let himself, his crew, and his fellow pilots down because he failed to make a thorough preflight check. Remember that any item neglected on a preflight check can easily become the most important factor in your life. Do not take your responsibility lightly. For your own safety, as well as others, form the habit of making thorough preflight checks.

Throughout your entire flying career you will be concerned with safety. Observe this rule always: *Look Around*! It means flying with safety.

*L*ook above you.
*O*ver your left shoulder.
*O*ver your right shoulder.
*K*eep alert.
*A*lways look before turning.
*R*igid necks are dangerous.
*O*nce is not enough.
*U*nder you is a blind spot.
*N*ever assume that others see you.
*D*ivide your attention.

A most important flying safety requirement during your flying training is a clear and positive understanding at all times as to who has control of the aircraft. The procedure for exchanging control is for the instructor to tell you over the interphone, "I have it" or "You have it." The pilot assuming control will say, "Roger, I have it," and will shake the stick noticeably. The pilot relinquishing control will not do so until he feels the stick shaking and hears the acknowledgment. He will then relinquish and say "Roger, you have it." Stay on the controls and keep flying the aircraft until you are told to do otherwise. Never be in doubt as to who is doing the flying. Always fly as if you were flying solo, unless you know that the instructor has the controls.

COCKPIT TIME

Sometimes, while you are waiting your turn to fly, you may find yourself without a specific assignment. You can use this free time to become better acquainted with the cockpit, instruments and controls of the aircraft.

CAUTION

Do not manipulate control switches or the landing gear handle while becoming familiar with the cockpit.

This period spent in the cockpit of an aircraft on the ground is commonly known as "cockpit time." Your instructor will outline the procedures and policies for utilizing this training.

During your study of the cockpit, examine the checklist and study the prescribed procedures. As you go through the checklist, visualize the movements of the controls and the readings on the instruments. This practice will help you to develop the systematic approach you will need to perform the procedures in the checklist. Keep in mind that a thorough system is important in performing all proce-

dures. The sooner you become familiar with the checklist, the cockpit arrangement and the aircraft in general, the sooner the proper checks will become second nature to you. Your attention may then be devoted to flying the aircraft.

BE READY TO FLY

To utilize a flying period fully, you must be completely prepared for the lesson. Be sure that you read and understand all available material concerning the lesson. Be sure that your flying equipment is in good order and ready for use. Show your initiative, resourcefulness, and intelligence by being alert and planning ahead. Be eager and enthusiastic, and you will find that your instructor will reflect your enthusiasm.

Many things may occur that will seem strange to you and contrary to your former ideas about flying. Make certain that you seek a solution to each problem. Ask questions, for you can never learn too much about flying. Pilots with years of experience and thousands of hours of flying are still asking questions, still learning, and making refinements.

Your instructor will brief you before each flight. In the preflight briefing, he will tell you what you will do, why you will do it, and how you will do it. Question any point that is not clear.

After each daily flight, your instructor will review the day's lesson. This is your chance to clear up any mistakes and to learn the correct procedure. Your instructor's review will clarify these points, but ask questions if you have failed to grasp all the steps in any maneuver being discussed. Becoming an Air Force pilot demands that you grasp each lesson fully. Be sure to get a complete understanding of your mistakes and the action you take to correct them. The time to ask questions is immediately after the flight, when your problems are still fresh in your mind.

Physical Condition

Absorbing flying lessons quickly and completely requires physical stamina. Even if you are in top physical condition, learning all the information you will receive in the first few days will be fatiguing. Your first flights will not be long; adjust your mental attitude so that your mind is free to consider the techniques of flying. A good physical condition helps improve your mental condition.

Outside Study

Learning to fly is learning to develop the proper reaction to an experience in an aircraft. You cannot understand each step unless you are prepared for it. Study each lesson and visualize how pressures on the flight controls will change the attitude of the aircraft. Review the lessons of each day, visualizing the "why" behind each operation. Use this text, the Flight Manual, and the checklist to prepare, review, and answer your questions about flying. In addition to these sources of information, you will have other reference books, most of which are listed in the bibliographies of your various flight and academic textbooks. Consult them. Request assistance on points you don't understand. All of your military academic instructors are jet pilots with but few exceptions. They were selected for Academic and Officer Training positions only after exceptional performance as pilot instructors on the flight line. Their dual experience in teaching can be an invaluable aid to students encountering difficulty.

CHAPTER 2

PERSONAL EQUIPMENT

The personal equipment that is issued to you is yours on a permanent issue basis. With the exception of the parachute, this equipment will be taken with you even on overseas assignments. The Air Force still owns it, but it is yours to keep as long as you remain on flying status. Therefore, it behooves you to be especially careful with it.

YOUR PARACHUTE

Your parachute should be treated as though you expect to jump each day—although the probability of bailing out is slight. If you ever need to use your parachute, it must work perfectly. Experts rigidly inspect it every ten days and repack it every sixty days. Your responsibility is to see that it remains in good condition under your care. It will open when needed, provided you handle and use it properly.

There are three main parts to a parachute—the canopy, the pack assembly, and the harness. The canopy is constructed of high-grade nylon fabric which constitutes the supporting surface. It employs a framework of suspension lines by which the load (the man who has to use it) will be suspended. Each line is attached to the harness by a connector link, snap, or D-ring. It feeds to one side of the canopy skirt, through a canopy channel entirely across the surface of the canopy, to a diametrically opposite skirt and then back to a harness connector. This arrangement provides maximum strength because each line is a continuous length of cord connected at the harness with the lines crossing each other at the apex of the canopy. The canopy is strengthened by bands of reinforcing tape.

To speed the opening of the canopy, a small spring-loaded pilot parachute is attached to the canopy. When the ripcord is pulled, this pilot chute is projected into the airstream and immediately blossoms, drawing the canopy out of the pack and into opening position. Although the canopy will open without the assistance of the pilot parachute, the action is slower and not as positive.

The pack is the part of the parachute assembly in which the canopy is packed and carried. The bottom of the pack is usually semirigid in construction. An inner covering equipped with fabric loops and rubber bands, holds the folded suspension lines. The sides and ends of the pack are constructed to enclose the folded canopy completely and to release the pilot chute and canopy instantly when the ripcord is pulled. The ripcord is a flexible steel cable with a handle attached to one end. Attached to the other end are the pins which serve to lock the packed parachute. The cable is enclosed in a flexible housing for protection and the prevention of premature release of the canopy.

To insure positive opening of the pack after the ripcord is pulled, elastic cords, known as pack-opening elastics, are used. These cords are attached under tension so that when the ripcord is pulled, the sides and ends of the pack are jerked away from the folded parachute permitting the pilot chute to be projected into the air. New parachutes, now being produced, have springs in place of the elastic cords. The harness is a flexible webbing framework that secures the pack to the wearer. Provision is made for adjustment of the harness to fit the wearer and for quick snap-on and release.

Your harness should be individually fitted to you at the Personal Equipment Section or the Parachute Pool. While you are being fitted, make certain you understand the meth-

od of quick snap-on and release. You will be shown the approved way of folding your harness for chute stowage.

In the T–37 you will wear a back-type parachute. But in other assignments, your parachute may also be either a chest- or seat-type chute. This checklist is valid for all types. Follow it each time you fly:

1. If you are at a base that assigns individual parachutes, see that the one taken from your stowage bin or locker is yours. If yours is out for repacking or inspection, check the replacement for fit.

2. Examine the harness and the pack assembly to see that they are in good order—without frays, weak spots, or other defects.

3. Make sure that it is dry and without grease or oil stains.

4. Check the parachute log to see that the chute has been repacked or inspected recently. As stated above, regulations require a parachute to be inspected every ten days and repacked every sixty days.

5. If flaps or pack assembly are slightly loose, tuck them in with a parachute paddle. If flaps are very loose, with considerable fabric showing, do not use the chute.

6. Open the ripcord flap and make certain the locking pins are properly inserted in the cones. Check to see that the pins are not corroded or bent and that there is a slight amount of play in the movement of the pins in the cones. Too much play may let the seal be broken prematurely or the pins may work out of the cones and, of course, the chute would "pop" open.

7. Check to see that ripcord-grip pocket holds the grip or handle securely and still permits it to protrude sufficiently so that it is easily accessible.

8. Check the quick-release mechanisms to see that they work properly and freely.

Be careful, at all times, when you handle a parachute. Do not throw it on the floor or ramp where it may become dirty or damaged. Fuel, oil, grease, and battery acids are very harmful to the fabric. Exercise extreme care, therefore, to see they do not contaminate your pack. If fuel does get on the chute, turn it in to the Personal Equipment Section immediately and report what happened. Care must also be taken while walking, and getting in and out of planes, so that the chute is not caught on sharp projections. Many parachutes have been "popped" because the ripcord handle caught on something and the pins were extracted.

Your automatic parachute, combined with the automatic belt in the aircraft, will provide safe and reliable deployment of the parachute in the event of ejection. In the case of high-altitude ejection, the aneroid action of the automatic parachute will automatically delay deployment until a preselected safe altitude is reached by free falling. The parachute may be opened at any time by manually pulling the ripcord grip. In order to permit improved low-altitude escape capability, a system incorporating a one-second safety belt delay after ejection and a zero-second parachute delay ("one-and-zero" system) is provided for low altitude ejection-seat escape. Refer to T. O. 1T–37B–1 for further information.

Before The Flight

Put your parachute on and be sure the harness fits properly. The shoulder and chest straps should be snug, without play; the chest buckle should be 12 inches below the chin. The leg straps should be snug. The harness should be comfortably snug when you are seated and disagreeably tight when you stand.

TAKE CARE OF YOUR PARACHUTE

The longer you fly, the more you will pamper your parachute. Inspect the pack whenever you go up. If it becomes dirty, greasy, or wet, return it to supply. Always check it for breaks or signs of abuse.

Don't dump your parachute on the floor. Never kneel on it, or carry it jammed against your hip. Don't leave it in the aircraft or any other place where moisture may reach the

pack. Your parachute is your life insurance. Don't let your policy lapse.

YOUR HELMET

The helmet that you receive with your initial personal equipment issue is a very important item. In order for it to fit properly and be comfortable, it must be adjusted to you by trained personnel. If it does not fit properly, it will be uncomfortable and lose some of its protective capability. After the first few times you use it, take it back to the base personal equipment section and have it readjusted again. This will insure a lasting adjustment that will be comfortable and afford maximum protection.

YOUR OXYGEN MASK

The oxygen mask is one of the most important items of equipment you will use. Its proper fit and good condition cannot be overemphasized. It will be fitted to you at the time your helmet is adjusted and will be checked at least once each month thereafter. If at any time you discover a crack in the hose, a leaking valve, or any other discrepancy, it should be corrected immediately or the mask turned in for a new one.

FLYING CLOTHING

This equipment will be issued to you by the Personal Equipment Section. It includes flying suits, jackets, gloves, boots, knife, clipboard and flashlight. Be sure that you get a comfortable fit, and then take care of your clothing.

For stowage of your equipment, you will have a locker and bin or rack assigned to you. Place your clothing in the locker to insure safekeeping and proper airing.

Flying clothing properly fitted and in good condition add to your comfort and safety when you fly. Flying clothing should be cleaned frequently.

CHAPTER 3

AVIATION PHYSIOLOGY

EFFECTS OF G–FORCES

As the pilot of a high-speed jet-propelled fighter, you will become increasingly aware of the effect of excessive positive and negative gravitational forces in the performance of routine maneuvers. Because of high speed of the T–37, the pilot will encounter "black-out" sensations from routine pullouts. It is, therefore, important to you, as a T–37 pilot, to understand what occurs in the human body when it is exposed to excessive gravitational forces and how the pilot can counteract these forces.

Most fighter pilots have experienced "black-out" and are more familiar with it than with the "red-out." The black-out sensation results when the downward pull on the body forces the blood from the blood vessels in the head, and causes it to collect or pool in the veins in the lower portions of the body. Thus, the eyes, having no adequate supply of blood and, therefore, receiving a very reduced supply of oxygen, fail to function properly. If this condition is prolonged, the brain is similarly affected, and unconsciousness occurs. It must be remembered that continued exposure to successive G-forces over a short period is accumulative in effect, thereby reducing the pilot's tolerance to a given quantity of G's following successive exposure to G-forces.

When exposed to positive G's, the blood is forced toward the feet and may result in the following:

- Sensation of heaviness – being pressed into seat.
- Hands and feet awkward and hard to move.
- Vision becomes dim.
- Black-out.
- Hearing fails.
- Unconsciousness.

The average pilot in a relaxed state will normally black-out when subjected to a positive 5.2 G for five to six seconds. However, the human body can withstand very high positive G's for a short period of time without blacking-out. For short periods of time (3 seconds or less) depending on the amount of positive G, there is sufficient blood remaining in the head to prevent black-out. If the exposure to high positive G's is allowed to continue, the pilot will black-out, and if continued further, he will become unconscious. Ability to withstand G-force varies with the individual and the individual's physical condition. The pilot can increase his G tolerance without an anti-G suit by performing the M–1 maneuver.

The M–1 maneuver consists of forcibly tensing all of the body muscles, particularly those of the legs and abdomen. It is important that normal breathing be carried out and breath holding be avoided during this maneuver. The tensing of the body muscles tends to prevent the pooling of blood in the lower extremities, thus making available a greater volume of blood to the heart for pumping to the head and rest of the body. In addition, the tensing of muscles also aids by reducing the flow of blood from the head when exposed to positive G-forces.

Very little is known about the phenomenon "red-out" caused by negative G's. However, this phenomenon has been reported on several occasions. Experiments have shown that the human body can stand a negative 3 G's for 15 seconds and a negative 4 G's for 5 seconds without detrimental effects. There is no authenticated report of brain damage as a result of high negative G's. When exposed to negative G-forces, the blood of the body is forced

toward the head and may result in the following:

- Breathing becomes more difficult.
- Pain occurs behind the eyes and in the back of the throat.
- The face becomes flushed and swelling may occur.
- The eyes become bloodshot.
- Small blood vessels may rupture around the eyes, resulting in "black eyes."
- Unconsciousness will result if exposure to high negative G's continues for a long period of time.

It is recommended that pilots, when exposed to negative G's, relax and breathe normally through the mouth, so as to minimize the increase of blood pressure in the head. It is believed that the main danger in encountering negative G's is that damage will occur to the aircraft before it will occur to the human body. The average pilot can remain conscious when exposed to 3 to 4 negative G's for a short period of time, but the T-37 aircraft is restricted to not more than 2.67 negative G's. It is therefore apparent that great care must be taken to avoid excessive negative G's.

The pilot with or without the anti-G suit can withstand up to 20 G's for approximately one second without blacking-out or becoming unconscious. It is important to remember the maximum G loading for the T-37. It is sudden, violent maneuvers, placing many G's on your aircraft structure for a short period of time rather than a prolonged G force that will cause your aircraft to fail.

WARNING

You are cautioned not to exceed the the allowable G limits at any time.[A] Constant stall in which the aircraft keeps buffeting may tear the counterweights from the elevators. When the aircraft is stalling in this manner, the stall must be broken at once. For rolling pullouts, do not exceed approximately 2/3 of maximum G limits. (4.8)

ALTITUDE AND USE OF OXYGEN

Proper fit and use of personal equipment are of the utmost importance for successful altitude flying. Initial fit of the helmet and oxygen mask is extremely critical and particular care should be taken to insure proper fit of both. The following procedure will be followed in performing the preflight oxygen check:

Oxygen Check

Pressure—The gage should read 425 psi and should agree approximately with other gages in the aircraft if there are other oxygen stations.

Mask—Be sure you have your own mask and helmet and that they are properly and securely attached. Look for cuts, tears, and cracks in the rubber and for faulty fasteners and loose tubing clamps. Make sure the inlet check valves and exhalation valve are properly installed. See that the inlet check valves are covered with plastic shields, with the arrows pointing downward.

Connection at Mask—Check to see that the metal end (male part of the quick-disconnect) is rounded and not warped and that the rubber gasket is in place. Make the connection and test the pull required to separate the two parts (10 to 20 pounds). Refer to Section IV of the Flight Manual for correct method of attachment.

Connection at Regulator—Check to be sure that the clamp connections at the seat are secure. Run the tubing through your hands to detect kinks, cuts, cover fraying, or flat spots which could cause malfunction or breakage of the regulator hose.

Regulator—With the hose dust-cap back, observe switch in the "ON" position and depress emergency button. A steady flow of oxygen should result. Place button in the normal position. The flow of oxygen should cease. You can detect a leak in the regulator diaphragm by placing the open end of the regulator hose against your mouth and blowing gently for 5 seconds. Conduct this test with the diluter lever of the regulator at the normal position and then at

the 100% oxygen position. There should be resistance to blowing. Little or no resistance to blowing indicates a leaking regulator diaphragm, faulty check valve in diluter air inlet, or a leak between regulator and quick disconnect.

Indicator—With the automix lever in the "100% oxygen" position, breathe two or three times into the end of the regulator hose to see that the blinker works.

Pressure Test—For inlet check valves and exhalation valve. Hook up your mask and do a "suck" test to be sure your mask is leak proof. This not only tells you that you have a good mask seal but also that the exhalation valve is properly seated. Push the emergency button to test mask. If mask leakage occurs, readjust mask. Now take a deep breath and hold it. The oxygen should stop flowing. If the mask appears to be properly fitted but the oxygen continues flowing, the exhalation valve is not holding pressure and should be replaced. Release the push to test button. If you cannot exhale, one or both of the inlet check valves are obstructed, are defective, or are improperly seated. If obstructed, or improperly seated, it should be adjusted; if defective, it should be replaced.

NOTE: A proper mask fit is of particular importance in the T–37 aircraft as the aircraft is not pressurized and breathing ambient cockpit air above 10,000 feet can be extremely hazardous. Loose mask fits have accounted for the overwhelming majority of hypoxia incidents.

Emergency Cylinder—Check your bailout bottle. Make sure the red tag with safety cotter pin is removed. Check the pressure gage for a minimum of 1800 psi. The bailout bottle will be connected to the mask adapter.

General Rules

Follow to the letter the briefing on your first altitude flight. Be thoroughly familiar with emergency procedures to be followed in case of physiological disturbances caused by high altitude and improper use of oxygen eqiupment (hypoxia, bends, hyperventilation, etc.).

Solo student training missions will not be conducted above 20,000 feet indicated altitude unless unforseen circumstances dictate otherwise.

At 5,000 feet check oxygen diluter control lever on "Normal." Check for fumes and/or smoke. If either are detected, turn diluter control lever to 100%. Attempt to locate source, and prepare to land. All pilots will make an oxygen check at each 5,000 feet and at level-off altitude, checking mask fit, hose connections, blinker gage, and oxygen pressure.

If for any reason you suspect that you are not getting an adequate supply of oxygen, turn the diluter lever to the 100% position, and check your connections. If this procedure does not remedy the situation, depress the emergency button. You should receive a positive pressure of oxygen in the mask.

NOTE: Be very careful of hyperventilation, (see sub-section below). If positive pressure in the mask is not present, re-check the connections. If everything is intact, descend to an altitude below 10,000 feet immediately. During descent trim the aircraft for a moderate hands-off descent to a safe altitude; then apply and hold forward elevator pressure to descend at a more rapid rate and land as soon as physical condition returns to normal. (The necessity for trimming the aircraft is to assure a controlled moderate descent even if the pilot becomes unconscious from hypoxia during the descent to a safe altitude.) When using the emergency position, keep a close check on the oxygen supply.

When the oxygen supply is down to 100 psi, a descent to altitude not requiring oxygen (10,000 feet or lower) must be made. With "Normal" or "100%" oxygen settings, the 100-psi supply is adequate for both cockpits in a comfortable descent from 24,000 to 10,000 feet.

If a rapid loss of oxygen pressure is noted, a descent to below 10,000 feet will be established immediately by entering a rapid descent straight ahead using the same technique and procedures used in the instrument penetration

(throttles 65% speed brake out). The aircraft should be trimmed for hands-off descending flight as described above to insure the probability of a recoverable aircraft attitude in the event you loose consciousness during the descent. If the oxygen supply falls to 50 psi, depress the emergency button to obtain the last 50 psi from the system. Normally, the last 50 psi of the system will not be used, and its use must be noted in the Form 781 as the system must be flushed for condensation prior to refilling.

Hypoxia

Know all the symptoms of hypoxia. Hypoxia can be detected but only if you are familiar with the symptoms (hot and cold flashes, feeling of suffocation, cold sweat, upset mental calculations, fuzziness of vision, inability to coordinate muscular movements, the extreme feeling of well-being, "I don't care" attitude, etc.). It is extremely important that the individual become familiar with his own symptoms during the low-pressure chamber flights. If altitude symptoms other than hypoxia are encountered (bends, chokes, gas distention, etc.), start an immediate descent to lower altitude.

If pains in body joints are felt, limit the use of these joints until pain disappears. Massage of painful joints serves no useful purpose and is *not* recommended. If such action does not relieve symptoms, land as soon as practicable. When hypoxia and/or other altitude symptoms have been encountered in flight, report them to the Flight Surgeon or Physiological Training Officer immediately after landing. Even if you feel "normal" after landing, you may need treatment. Failure to report *may cost you your life*. Neurocirculatory collapse may occur as much as 12 hours after hypoxic conditions. Your hypoxia incident report may also save someone else's life.

Hyperventilation

Another problem you may encounter in flying is hyperventilation. Hyperventilation, or overbreathing, is a disturbance of respiration that may occur in individuals as a result of emotional tension or anxiety. At ground level, the symptoms of hyperventilation are normally associated with emotionally unstable persons. At high altitude, however, anyone who is uneasy or nervous may experience hyperventilation. The symptoms have been known to occur in experienced rated pilots as well as student pilots and passengers. In most cases the person who is overbreathing is unaware of the abnormal respiration, and as a result, the symptoms of hyperventilation are later attributed to other causes. Sometimes it is induced by emergencies in flight.

The mechanism of hyperventilation in pilots may be explained as follows: Because of anxiety or nervousness, the individual unconsciously begins to breathe more deeply and rapidly than usual. In the process of this overbreathing, large amounts of carbon dioxide are eliminated from the lungs and, as the process continues, from the bloodstream. The resulting symptoms culminate in muscular spasms and finally collapse.

The early symptoms of hyperventilation are tingling in fingers and toes and sensations of "lightheadedness." The mental symptoms of hypoxia and hyperventilation *are the same.* (They both come about as a result of oxygen deficiency at the level of the brain cell). Therefore, it is useless to try to distinguish between the two on the basis of mental symptoms. Continued hyperventilation may result in: (1) Muscular spasms of the hands, feet and face; (2) sensation of tightness in chest and abdomen; (3) difficulty in speaking; (4) increased dizziness; and (5) partial or total loss of consciousness.

If hyperventilation is suspected, it is recommended that you position the diluter lever to 100% setting and direct close attention to the rate and depth of your breathing. If the symptoms disappear after slowing the breathing rate down, return the diluter lever to the normal position and continue breathing control. If the symptoms persist, descend to an altitude below 10,000 feet, recheck the oxygen equipment and land as soon as practicable.

HIGH–ALTITUDE BREATHING TECHNIQUES

It is important to note that many of the symptoms of hypoxia and hyperventilation are similar, and, since the person who is hyperventilating usually does not realize it, it may be difficult to decide which condition, hypoxia or hyperventilation, exists. For this reason the following breathing techniques are suggested:

During periods of stress or excitement, make a conscious effort to relax as much as possible and to breathe at a normal rate. Should symptoms occur which you can not definitely identify as either hypoxia or hyperventilation, the following steps should be taken:

1. Check your oxygen equipment and put the regulator on 100% oxygen.

2. After three or four normal breaths of oxygen, the symptoms should improve markedly if the condition experienced was hypoxia. (Recovery from hypoxia is extremely rapid.)

3. If the symptoms persist, you should consciously slow your breathing rate to an abnormally slow rate for 30 to 45 seconds, and then maintain your breathing at a normal rate.

You must remain alert at all times, and remember that you can become unconscious from either a lack of oxygen or a lack of carbon dioxide. Even the way you breathe is important, and must be done properly.

CHAPTER 4

PARACHUTE DESCENTS

Anyone who flies in an Air Force aircraft other than MATS passenger flights must be equipped with a standard-type parachute and know how to use it. This is a standing order to all personnel.

BAILING OUT

The T–37 Egress System is virtually automatic. The only thing the pilot needs to do is position himself, raise the arm rests, and squeeze the trigger. The remainder will take care of itself. However, detailed instructions contained in T. O. 1T–37B–1 should be committed to memory along with a thorough knowledge of the equipment. This will insure successful ejection in almost any circumstance.

In the event the automatic-opening aneroid device fails to function properly, it is easy to open your parachute safely. Just do three things.

1. Straighten your legs and put your feet together. This reduces the opening shock and prevents tangling your harness.

2. Grasp the ripcord housing with your left hand.

3. Grab the ripcord grip with the right hand and yank! Keep your eyes open and look at the ripcord cable as you pull it.

The Descent

About two seconds after you have pulled the ripcord, you will feel a sharp, strong tug as the canopy opens and bites the air.

Look up to see if the parachute is full open. If a suspension line traverses the top, or if the lines are twisted, manipulate the lines to remedy the fault.

You probably will swing somewhat on the way down. Don't try to check the swinging or to "slip" the parachute. Such maneuvers are useful only to experts and are dangerous below 200 feet.

Estimate your altitude quickly by looking first at the ground below, then at the horizon. You will descend about 1,000 to 1,500 feet per minute.

Keep your feet parallel and use them as a drift indicator. Observe your drift by sighting at the ground between your feet.

Face downwind in the direction of your drift.

BODY TURNS

You cannot steer your parachute, but you can turn your body to face the landing direction. In other words, you can turn yourself so that you will be facing your direction of drift (downwind) before your feet hit the ground. This is the easiest and safest way to land.

To turn your body to the right:

1. Reach up behind your head with your right hand and grasp the left risers.

2. Reach across in front of your head with your left hand and grasp the other risers. Your hands are now crossed, the right hand behind, and you have two risers in each hand.

3. Pull simultaneously with both hands; this crosses the risers above your head and turns your body to the right. You can readily turn 45°, 90°, or 180° by varying the pull.

Remember, to turn right, put your right hand behind and grab the opposite risers. To turn left, reverse this procedure.

Practice the body turn in a suspended harness if you get the chance, and pay close

attention to the required technique. All you have to do is to remind yourself:

"To turn right, right hand behind my head."

"To turn left, left hand behind my head."

In the descent, start your body turn high enough to give you time to master it. Once you make the turn, you will have perfect control. Hold the turn or ease it slowly, if necessary, to face downwind until you reach the ground. Continue to hold the risers, whether they are twisted or not, and ride to the ground.

LANDINGS

Whether you have made a body turn or not, keep your hands above your head grasping the risers. Look at the ground at a 45° angle—not straight down.

Normal Landings

Be relaxed and get set for the landing by placing your feet together and bending your knees slightly with light tension so that you will land on the balls of your feet. Don't be rigid or limp.

Keep your feet firmly together with your knees bent slightly and your hands grasping the risers above your head. Now you are ready to ride to the ground, drifting face forward.

As soon as you touch the ground, you should fall forward or sideways in a tumbling roll. This will reduce the jar of landing.

High-Wind Landings

If you suspect that a strong wind may be blowing across the ground when you land, be prepared to do these things to prevent a "ground ride."

1. Carry out the normal landing procedures as described above, including the body turn.

2. After landing actuate the quick disconnect located on your left shoulder harness. This will spill the air from your parachute.

Tree Landings

Tree landings are usually the easiest of all. If you see that you are going to come down into a tree, drop the risers and cross your arms in front of your head. This protects your face and gives you a chance to glance downwind between your arms. Keep your feet and knees together.

If you get hung high in a tree don't release your harness and fall to the ground. It may be a long fall. First consider your chances of being rescued. If rescue prospects are dim, make your way to limbs which offer substantial support, then get out of the harness carefully and cut the suspension lines to make a rope for climbing down.

Water Landings

If you see that you are going to come down in water, start getting ready at least 500 feet up.

1. Pull yourself back into the sling as far as possible, then release the leg straps.

2. Unbuckle your chest strap.

3. Inflate one-half of your life preserver.

After you unhook the leg straps and have unbuckled the chest strap, keep your arms folded across your chest so that you will not fall out of the harness. Then as you strike the water *(not before)*, raise your arms over your head and slide out of the harness. After you have entered the water inflate the other half of your life preserver. Then swim clear of your parachute.

4. Hang onto your parachute if it is equipped with a life raft. You can use the canopy for a sail or for protection against the sun.

5. Use a knife if necessary to cut yourself free from the harness and suspension lines if you become entangled.

Quick Release on Some Types of Parachutes

If your parachute is of the quick-release type, merely operate the release mechanism on the risers to free yourself of the parachute instantly. These releases are located just forward of your shoulders.

This technique should be employed whenever it is necessary to get away from the canopy and risers hurriedly. Before operating

the release mechanism, you should be sure that you are on the ground, in the water, or do not have a great distance to fall, since the mechanism releases the entire riser and canopy sections from the harness.

You may then get out of the harness in the normal manner.

High-Tension Wire Landings

There is a possibility that you might come down into high-tension wires, strung high above the ground about six feet apart. To keep your hands from touching the wires, hold them above your head with the palms flat against the inside of the risers. Hold your feet and knees together and turn your head into one shoulder to protect your face.

Streamline your body as much as possible so that you will fall straight through the wires. The parachute may collapse but will open again enough to break the fall. Do not worry if your parachute becomes entangled in the wires; dry nylon is a nonconductor.

Night Landings

As soon as your parachute is open, prepare for a normal landing. Since you cannot see the ground on a dark night, you should be ready to make your landing at any moment. Get your feet and knees together, your legs slightly bent. Hang onto the risers above your head and wait for contact with the ground.

CHAPTER 5

GROUND OPERATIONS AND RADIO PROCEDURES

INSPECTIONS, CHECKS, AND PROCEDURES

Instructions for inspections, checks, and procedures are outlined in the T–37 Flight Manual, and will require no further explanation. During flying operations, it is impractical to carry a Flight Manual while making an inspection or while flying. Therefore, an abbreviated checklist is used.

This checklist should be in your possession at all times while you are on the flight line. In order to utilize it effectively, you must be thoroughly familiar with the contents of Section II of the Flight Manual, and that portion of Section I that explains the operation of the flight instruments. The abbreviated checklist is a pilot's reminder of the items and the procedures to use in performing his checks.

VISUAL INSPECTION

The preflight check starts before the pilot reaches the aircraft. Survey the proposed taxiing routes for any possible obstructions such as ground repair work on or near the ramp, and for stray equipment or personnel that might be harmed by the jet blast. A complete visual inspection of the aircraft is a very important part of each mission. Visual reference to the T–37 Aircrew Checklist during this inspection is required by AFR 62–2.

NOTE: If any doubt arises as to the condition, setting or operation of any single item, be sure to ask the opinion of your instructor or other personnel whom you are certain are qualified to answer.

Particular care should be exercised while checking the jettison and ejection systems. All safety pins should be well-seated.

The importance of checking the Form 781 cannot be overemphasized. Discrepancies noted, such as improper status, failure to sign off preflight, etc., should be reported to the Line Chief, and the aircraft should not be accepted until you are satisfied that the aircraft status is properly shown and that this is a flyable status.

Special emphasis should be placed on checking for fuel and hydraulic leaks when inspecting the wheel well and speed brake areas. These leaks will usually be apparent from fluid along fairing doors, seams and line couplings. Remember that hydraulic fluid is highly flammable.

When inspecting the general condition of the wings, keep in mind the high speeds at which this aircraft is flown and how easily dents and popped rivets could affect your flight.

Security of Dzus and Airlock fasteners requires a close check. One loose fastener may lead to the failure of others and subsequent loss of an access door, causing damage to the aircraft. In addition to noting whether Dzus fasteners are flush, check the alignment of their slots, and tap the access plate with your hand to detect any looseness.

Check general condition of trim tabs, hinges and control surfaces. Binding of the controls and cracked hinges or control surfaces are reasons for rejecting the aircraft.

It takes time for your eyes to adjust to the darkness of the tailpipe, but the importance of taking time to inspect turbine buckets

should be apparent. Check the turbine buckets (blades) to insure that none are missing, chipped or cracked. Wrinkles in the tailpipe up to ¼ inch in depth are allowable.

AFTO FORM 781—AIRCRAFT FLIGHT REPORT AND MAINTENANCE RECORD

The Form 781 is the official log of aircraft operation, refueling and maintenance. It stays with the aircraft at all times. A pilot's full cooperation is mandatory for the proper completion of the Form 781. Most errors in recording a pilot's flying time can be traced to an erroneous or an incomplete entry in the Form 781. These errors affect not only the individual pilot's flight records, but also the time clerks and maintenance personnel, in that they must devote extra time unnecessarily to the corrections of the records. Timely performance of maintenance and inspections depends on accurate records. Use only black lead pencil to make entries.

Part I – Pilot's Log—Care and common sense are the pilot's guide in completing the form. The date, aircraft serial number, home station, organization, and crew chief's name will be filled in by the maintenance personnel. Check this section for completeness.

Your name, rank, and serial number are printed in column 1 of Part 1; duty, flight condition, and time flown are entered in columns 2 thru 7, and will be logged in accordance with current directives. The word "Local" will be printed diagonally across column 8 for all flights in the local area. For any other symbols which you may be concerned with, see the inside of the front cover of the form. The symbol to be entered when more than one phase of flight training is performed on a single flight will be determined by the predominating time devoted to any phase. Example: Contact and Instrument scheduled: Total time flown 1:30 – Contact 1:00, Instrument 0:30. The symbol to be used will be as directed for Contact. A detailed breakdown of time will be reported to the flight dispatcher in the flight ready room.

In logging time flown, takeoff time begins when the aircraft begins to move forward on the takeoff roll. Landing time will be not more than 5 minutes after the wheels touch down and includes taxi time not to exceed 5 minutes. Time is logged to the nearest 5 minutes. The Form 781 is good for only one calendar day—0001 to 2400 hours; however, should a flight begin at 2300 and end at say, 0300, the time would be logged on the previous day's form. The next flight would require a new page.

Part 2 – Maintenance Log—After each flight, the pilot must complete so much of Part 2 as is necessary to record the condition of the aircraft, and affix his signature. Remarks should be appropriate and to the point regarding the aircraft's condition. Be specific regarding instrument readings, airspeeds, altitudes, power settings, or other variables that appear to have a relation with any discrepancies being reported.

POSITION IN THE AIRCRAFT

Each time you fly, your position in the aircraft should be the same. Ask your instructor to help you determine the correct position of the seat. Vertical seat adjustment is controlled by a lever located on the right side of the seat. Adjust the seat so that your helmet will have adequate clearance from the top of the canopy and yet provide you proper vision over the nose of the aircraft. Whether you are short or tall, the eye level of all students should be approximately the same so the instructor can be sure that visual references are uniform for teaching purposes.

During ground operation, if seat adjustment is necessary, the seat pin will be installed before moving the seat adjustment lever. This is to prevent the possibility of inadvertently jettisoning the canopy. In flight, exercise extreme care to insure that feet are clear of the ejection handles and that the proper handle is moved to raise and lower the seat.

Fore and aft adjustment of the rudder pedals is accomplished by a rudder adjust-

ment hand crank provided for each set of pedals. The rudder pedals should be adjusted to a comfortable distance, and with your feet on the pedals you should have full travel of the rudders.

SAFETY BELT AND SHOULDER HARNESS ADJUSTMENT

After positioning correctly, fasten your body in the aircraft by locking and adjusting the shoulder harness and safety belt. To do this, first actuate the lock for the shoulder harness (the locking lever is located on the left side of the seat) and adjust both shoulder straps to reach your lap. Check your flying suit collar, placing it above the shoulder harness straps to protect your neck and take care that the straps lay flat and are not twisted. The buckle adjuster on each strap should be outward, away from your body. Next, place each half of the seat belt across your legs without fastening the belt.

The end of each shoulder harness strap should now be centralized in your lap with the buckle from each half of the seat belt. First thread the eyelet of the buckle on the right half of the seat belt through the loops of the right and left shoulder harness straps, then through the parachute lanyard anchor (which is attached to the lanyard spring), and then into the locking buckle on the left half of the seat belt. Close the latching arm of the buckle so that the latch holds securely. Now you are ready for the final adjustment and check. After latching the seat belt, tighten it; then tighten the shoulder harness straps. This can be done only after the assembly is latched.

As a final check for the harness adjustment, look around to the left and right. You should have enough freedom of movement to permit seeing behind you toward the tail of the aircraft. The shoulder harness inertia real lock may be left unlocked if desired for freedom of movement.

STARTING AND OPERATING PROCEDURES

The items in your checklist are listed in such an order as to begin from the left of the cockpit and move to the right. This system makes it easy to learn and reduces the margin for error.

As in the Visual Inspection, each item must be considered as important as the next. If an item is overlooked, it is possible for certain systems to become inoperative or damaged. This procedure will be executed with direct reference to the checklist so that the possibility for error is minimized.

The importance of a thorough and proper oxygen system check cannot be overemphasized. It might be said that your oxygen is the most important single item necessary for your safety in flight. A complete and unhurried check of the system is as necessary as any of your preparatory or in-flight procedures. How long can you live without air? In truth, death from lack of oxygen while flying is about as quick as drowning under water. Unfortunately, you don't get the same unmistakable warning.

Prior to the actual starting of the engine, be sure the brakes are set. Your attention will be in the cockpit after starting, and more than one pilot has inadvertently begun rolling forward while completing the after start check. Note closely your RPM and exhaust gas temperature (EGT) gages during engine starting. These will give the first indication of anything unusual in your start. If they are within limits, the start is likely to be a good one.

RADIO PROCEDURES

The T–37 in use for student training is equipped with an ARC–34 UHF command radio. Frequencies and their uses are listed in the current issue of the USAF/USN Flight Information Publication (FLIP), Enroute Supplement. All frequencies and channel assignments are subject to change; therefore, you should continually refer to the current pub-

lication to insure current radio data. Radio channels, frequencies, call signs and procedures used at your training base are listed in local flying training directives and will be given to you at each pre-flight briefing for all local flights.

Radio Discipline

Radio voice communications will be kept to a minimum at all times. The call to the tower will serve as the radio check. A typical call will normally be, "Randolph Tower, 694 taxi."

Remember that when the mike button is depressed, the entire channel is blocked for other aircraft. Don't depress the mike button during another local transmission. You may freely interrupt distant transmissions of other activities, since you will not block them out in their own local areas (i.e., their transmissions will be stronger than yours in their own area and vice versa). Make certain that the RADIO IS ON and THE PROPER CHANNEL IS SELECTED. It is imperative that your message be CLEAR and CONCISE. Therefore, decide first what you are to say. Then, depress the mike button, say what you intend to say, and get off the air.

Always monitor the air before transmitting.

While taxiing, use the interphone sparingly in order to concentrate on handling the aircraft and receiving any instructions which may be given.

Line-of-Sight Transmission

Due to its high frequency, UHF is almost entirely free from static disturbances. A characteristic of UHF or VHF is that the radio waves travel in a straight line-of-sight transmission. It is, therefore, important for you to be aware of the characteristics of line-of-sight transmission. One of the prime factors to consider is the elevation of the tower transmitter; another is obstructions such as a hangar, mountain, or other objects between the transmitter and the intended receiver.

Radio Set Operation

Follow the radio operation procedure listed in Section IV of the Flight Manual.

After landing, few transmissions will be necessary except to cross active runways.

TAXIING

After completion of the "After Start" and "Before Taxi" checks, visually clear the area to the front and rear. Increase power to 60–75% while holding the brakes, depress the steering button and release brakes. As soon as the aircraft is rolling, check brakes to be sure they are working. Pick up momentum straight ahead, apply rudder in the desired direction of turn, and simultaneously reduce power (normally to IDLE). When brakes are being used to sharpen turns in the taxi area, increase the power slightly to give the aircraft momentum in the new direction and overcome the resistance of the braking. When leaving a parking area, be especially alert for aircraft taxiing past your position; watch also for personnel, ground equipment, etc.

When you are clear of the parking area, use power as needed to keep the aircraft rolling at a moderate rate of speed. Use the brakes as sparingly as possible to prevent excessive wear and overheating. Taxi time should be kept to a minimum because of the high rate of fuel consumption. Fuel consumption during taxiing is approximately one gallon per minute with engines at 40% RPM.

Do not taxi closer than two aircraft lengths to the preceding aircraft, nor directly behind it except as necessary in a congested area. Extreme caution should be exercised to prevent debris from entering the air intakes. If it becomes necessary to taxi directly behind another jet aircraft, close and lock the canopy to prevent jet exhaust gases entering your cockpit. Check the oxygen regulator control to 100% oxygen and hold the aircraft controls in the neutral position to prevent control surface damage from the jet wash. Exhaust gases of other aircraft contain harmful quantities of carbon monoxide (CO), an odorless

but deadly gas. Use of 100% oxygen precludes your breathing these gases. However, you must reset your oxygen to Normal when the aircraft ahead of you have cleared; otherwise your oxygen supply will be depleted prematurely if left on 100% for the entire flight.

Nose Wheel Steering and Brakes

The T–37 is equipped with nose wheel steering to facilitate better ground control. It provides a steering range of approximately 40° either side of center and is actuated by a button-type switch located on the lower front portion of the control-stick hand grip and operated by steering with the rudder pedals. Depress the right rudder for a right turn and vice versa.

You will probably encounter some difficulty in adjusting yourself to the steering of the aircraft. You will have a tendency to neutralize the rudders just as the aircraft starts turning. This will merely straighten the nose wheel, necessitating the application of rudder to again put the aircraft in the turn. Unlike flying turns the angle of turn during nose-wheel steering is determined by the amount of rudder applied. The rudder pedals should be neutralized prior to engaging the nose-wheel steering. They will engage only in a neutral position, never when off center. After applying enough rudder to start the aircraft turning, hold the rudder in this position. When the angle of the turn becomes greater than desired, merely ease off the rudder but keep the stick-grip button depressed. Do not overwork the steering mechanism by constantly changing the rudder position.

If a sharper turn is desired than can be made with the steering mechanism, release the steering button and use the brakes to establish the angle of turn desired. While making a turn in this manner, keep the inside wheel rolling. Any attempt to pivot the aircraft on a locked inside wheel damages the wheel, tire and strut. Much worse, the damage may not be apparent, but the gear may be damaged to the extent that it will collapse under the strain of subsequent normal landings. To insure that the inside wheel rolls, release the inside brake intermittently.

You should taxi with your heels on the cockpit floor and with the balls of your feet on the rudder pedals. Slide your feet high on the rudder pedals only when it is necessary to depress the brakes. The brakes should be used to stop the aircraft at a desired point, to slow down the aircraft or to make a sharp turn. Apply the brakes smoothly, evenly and cautiously at all times.

In taxiing, you will have to learn to anticipate the movements of the aircraft and apply nosewheel steering (rudder) accordingly. Since the aircraft will continue to turn slightly as the rudder pressure is released, you must anticipate the recovery and neutralize the rudders before reaching your new heading.

Flight Instrument Checks While Taxiing

Some ot the flight instruments can be checked for proper operation only when the aircraft is taxiing. Your instructor will show you which instruments these are and how to check them. Among these are your Turn Indicator and compasses.

Aileron and Elevator Usage for Taxiing

When taxiing at normal taxi speeds in a no-wind condition, the aileron and elevator control surfaces have practically no effect on the maneuverability of your aircraft and cannot be considered steering devices. Their effect on the aircraft is only at high speeds as the result of pressure being exerted against them by high-speed airflow around them. Very little pressure is created by the resultant airflow from the forward movement of the aircraft at a slow taxi speed.

The presence of moderate to strong wind and/or jet blasts from other aircraft makes the use of these surfaces necessary to control the aircraft while taxiing. This becomes apparent when you consider the lifting action that may be created by either of these two factors. The elevator control should normally

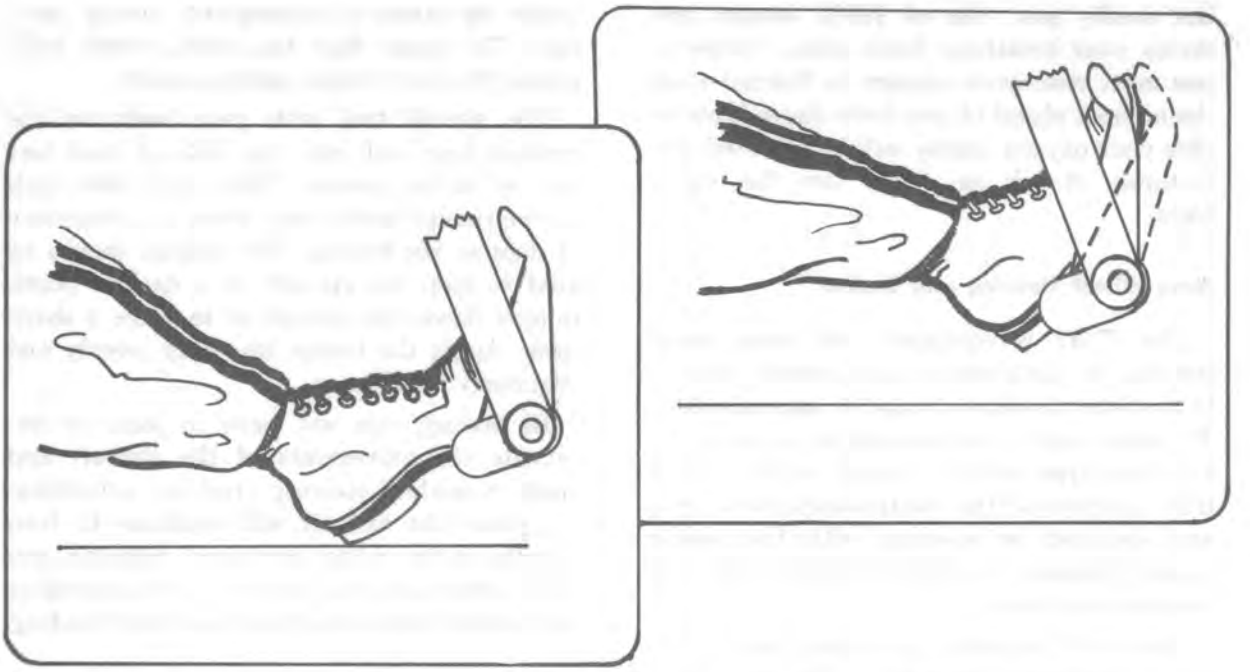


FIGURE 5-1 *Position of the Foot on the Rudder Pedal and Brake*

be held in the neutral position at all times while taxiing.

When taxiing into a strong crosswind from the right, the right wing would tend to be raised by the wind unless the stick were held in that direction (right aileron). Since right aileron moves the right aileron control surface into the UP position, this reduces the lift and the impact of wind striking underneath that wing. The reverse of this technique should be used for a crosswind from the left.

In taxiing with a quartering tailwind, keep the elevator in neutral and the upwind aileron down (control stick downwind). Since the wind is striking from behind, this reduces the tendency of the wind to get under the aileron and wing.

The application of these crosswind taxi corrections help to minimize any weathervaning tendency and consequently result in making the aircraft easier to steer.

Taxi Techniques

While taxiing, be alert at all times and look around to be sure your aircraft's wings will clear all obstructions. If at any time you have any doubt about the clearance of the wing tips, stop the aircraft and get someone to guide you past the obstruction. If no help is available, stop the engines and let the ground crew move the aircraft. When you are taxiing on the ramp or near other aircraft, your safe taxiing speed is never faster than a brisk walk, and you should maintain at least two aircraft lengths between other taxiing aircraft.

You need a mental, up-to-the-second picture of the entire area. Visually check the location and movements of everything in your taxi path. You must be aware of other aircraft taking off, landing and taxiing. Show consideration for the right-of-way of others. To really clear the area visually, your eyes must cover almost a complete horizontal circle. Your neck is a swivel, and your head must move side to side with your eyes, sweep-

ing to the limit of your vision. Never allow your eyes to freeze on one object. You are operating the aircraft until you have cut the switches and finished the last entry in the Form 781. No matter how exciting your flight has been, while you are taxiing in is not the time to exult in it. As in every other phase of flying, plan your task in advance and be constantly alert as you follow your plan.

CHAPTER 6

EFFECT AND USE OF CONTROLS

Each phase of flying is based upon one or more fundamental maneuvers of flight. In learning to fly, as in any learning process, you must master the fundamentals before you can undertake the more advanced problems of flight. A thorough knowledge of these fundamentals will greatly speed up your progress in mastering the more advanced maneuvers in flight training.

In your *Principles of Flight* manual and in ground school, you learn why an aircraft flies. You also learn that, under normal conditions for which the aircraft was designed, it tends to maintain a set path of straight-and-level flight through the air. At this time, let us consider the controls with which we can vary this path of flight at will or maintain it.

EFFECTS OF CONTROLS ON AIRCRAFT AXES

Each flight control has its effect on the attitude of the aircraft and controls the movement about one of its axes. You should learn these effects in order to control the aircraft and to 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 of progressively increasing complexity. These same predictable responses to control movements will result, regardless of the attitude of the aircraft. You should think of yourself as the pivot point about which all changes of attitude occur.

AXES OF AN AIRCRAFT

There are three axes about which an aircraft will rotate and three flight controls which may be used to control this rotation. The axes are the lateral, vertical, and longitudinal. The external flight controls are the elevator, ailerons and rudder. The first two are actuated by the stick and the latter by the rudder pedals. The axes and their corresponding flight controls are:

Lateral Axis: An imaginary line which runs from wing tip to wing tip through the center of gravity perpendicular to the fuselage centerline. Rotation about this axis (pitch) is controlled by the elevator surfaces.

The elevator is composed of two movable horizontal surfaces on the horizontal stabilizer of the aircraft and is actuated by forward or backward movement of the stick. In straight-and-level flight, when forward pressure is applied to the stick, the nose moves down; when back pressure is applied to the stick, the nose moves up. In other words, the aircraft will rotate about its lateral axis in the same angular direction as the stick about its pivot point when the stick is actuated fore and aft. This rotation of the aircraft nose about the lateral axis determines pitch attitude which is the angular displacement of the nose measured positively beginning from the horizontal upward.

Vertical Axis: An imaginary line which runs through the center of gravity perpendicular to the lateral axis and the fuselage centerline. Rotation about this axis is called yaw and is controlled by the rudder.

The rudder is the movable vertical surface on the tail of the aircraft and is actuated by movement of the rudder pedals. When pressure is applied to the right rudder pedal in flight, the nose will move to the right; when

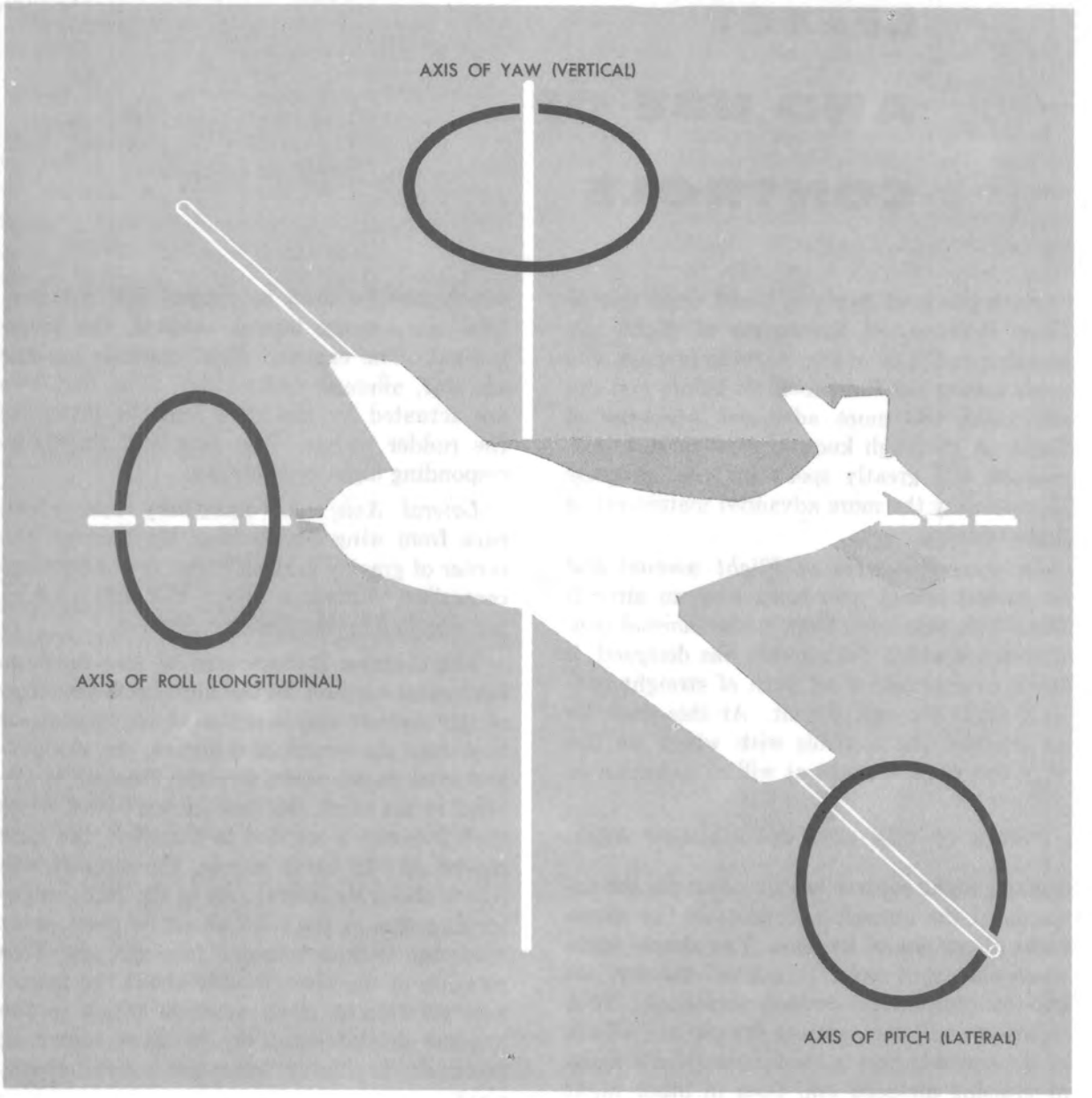


FIGURE 6–1 *Axes of the Aircraft*

pressure is applied to the left rudder pedal, the nose will move to the left.

Longitudinal Axis: An imaginary line which runs through the center of gravity from nose to tail along the fuselage centerline. It is perpendicular to the lateral and vertical axes. Rotation about this axis (roll) is controlled by the ailerons.

The ailerons are the movable panels on the outer trailing edges of the wings and are actuated by side pressure on the stick. Rotation about the longitudinal axis is caused by the lift differential created as aileron surfaces are moved out of the streamlined position in the airfoil or wing. The wing with the raised aileron goes down because of decreased lift,

and the wing with the lowered aileron goes up because of its 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 that wing to go up. Rotation about the longitudinal axis is in the same angular direction of stick movement. The forces causing the roll are equal and opposite.

USE OF CONTROLS

The amount of pressure exerted on a control surface by a control movement is governed by the airspeed and the degree that the surface is moved out of its streamlined position. Since the airspeed will not be the same in all maneuvers, a knowledge of measured amounts of a control surface's movement is of little importance to the pilot, but it is important that he be able to maneuver the aircraft by applying control pressures to obtain a desired result, regardless of how far the control surfaces are actually moved.

Coordination

Always remember that to get the desired results from the controls, you should think of using pressures rather than significant movements.

The effect of each control has been taken up individually, but you should realize that no one of these control movements provides exclusive 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 and erratic usage of all or any one of the controls will cause the aircraft to react accordingly, so it is important that you be able to apply the pressures smoothly and evenly for graceful, efficient flight.

How to Use the Rudder

The position of the feet should be comfortable with all the weight on the heels. Let your heels rest on the cockpit floor with the balls of your feet on the rudder pedals. Don't let your legs and feet become tense, but keep relaxed just as you do when driving an automobile.

When you use the rudder pedals, apply pressure smoothly and evenly by pressing with the ball of one foot just as if you were using the brakes of an automobile. Of course, when one rudder pedal is pushed forward, the other will come back an equal distance. When necessary to make large pressure changes, do so by applying the pressure with the balls of your feet and letting your heels slide along the cockpit floor. Remember, let the balls of your feet rest comfortably on the rudder pedals so that you can feel the pressures.

How to Use the Stick

It is the coordinated pressure exerted on the stick and rudder pedals that determines the aircraft's movement about its axes. When a control surface is moved out of its streamlined position, the air flowing past it will exert pressure against it and will try to return it to its streamlined position. It is this pressure that you feel on the stick and rudders.

Generally, you should hold the stick lightly, the same way you would hold the steering wheel of an automobile—relaxed and comfortable. Some maneuvers, however, such as aerobatics, require more positive pressures. It is important that your arm and hand be relaxed so you can feel the counter-pressure that may be exerted on the stick. Nevertheless, you must always control the aircraft and *never* let it control you.

How to Use the Throttles

Throttle movement should always be smooth, though positive, to insure adequate

and correct engine response. Rough or abrupt throttle usage in jet aircraft may result in delay or complete loss of power in addition to the possibility of exceeding engine design limitations. Initial throttle movement should be slow with an increase in throttle movement as engine response is obtained. Monitor the EGT during throttle advance. By adjusting the rate of throttle application to the rise in EGT, the EGT should not be allowed to exceed the redline limit. There is no situation that will be improved by rough or abrupt throttle usage. By monitoring the EGT, you will find that throttle can be advanced more rapidly at the higher RPM's.

CONDITIONS AFFECTING FLIGHT

The control surfaces are equipped with small movable tabs located on the outer edges. These trim tabs (with the exception of the one on the right aileron) are controlled from the cockpit. Before we explain the use of these trim tabs, let us see why we have them.

Balance

We have said that the aircraft was designed to hold a tendency toward straight-and-level flight under normal cruise conditions. However, these conditions vary quite frequently. One of these variables is balance. Due to the close side-by-side seating arrangement in the T–37, you will notice very little change in balance whether your instructor is in the aircraft or you are flying solo. Fuel imbalance in the wing tanks, however, can be readily detected by the amount of trim tab deflection during hands-off level flight. In larger aircraft, balance is greatly affected by such things as fuel quantity, passengers, cargo, and weapons and must be considered for the various conditions of flight.

Airspeed

Another variable is airspeed. We do not always wish to operate at the normal cruise airspeed. At higher airspeeds, the aircraft will tend to nose up; at lower airspeeds, it will tend to nose down. Your instructor will demonstrate this to you.

TRIM

When you sum up all the factors that affect the aircraft in various conditions of flight, the need for compensating the condition or trimming the aircraft becomes apparent. Considerable stamina is required, for example, to hold the correct elevator control pressure for level flight with low airspeed if the pressure is held in continuously by the pilot. Flying would become exceedingly fatiguing if some means were not available to relieve the pilot of these pressures. By trimming the aircraft, you relieve yourself of extra physical exertion.

Now we can easily see the importance of the trim tab and the necessity for its proper use. Because of its location it has leverage and can be used to equalize the pressures exerted on either side of the parent control surface; that is, to dynamically balance it for any condition of flight. Since the trim tab equalizes the pressure exerted on the parent control surface, it is always moved in the opposite direction from which the parent control surface is moved.

For example: Suppose you are holding considerable back pressure in order to maintain a constant pitch attitude. In this case, the elevator would be in the raised position and the air pressure exerted on its top side would tend to push against it or try to return it to its streamlined position. To equalize this pressure or hold the elevator in the slipstream for you, the elevator trim button, located on top of the stick grip, must be triggered back or toward you. When it is triggered back, the trim tabs will extend downward and into the air flow across the bottom of the elevator, causing pressure to be exerted against it which in turn deflects the entire elevator surface upward. When the pressure exerted against it is equal to the pressure you are exerting on the elevator control, you will immediately feel this assistance and the aircraft will maintain its pitch attitude without any

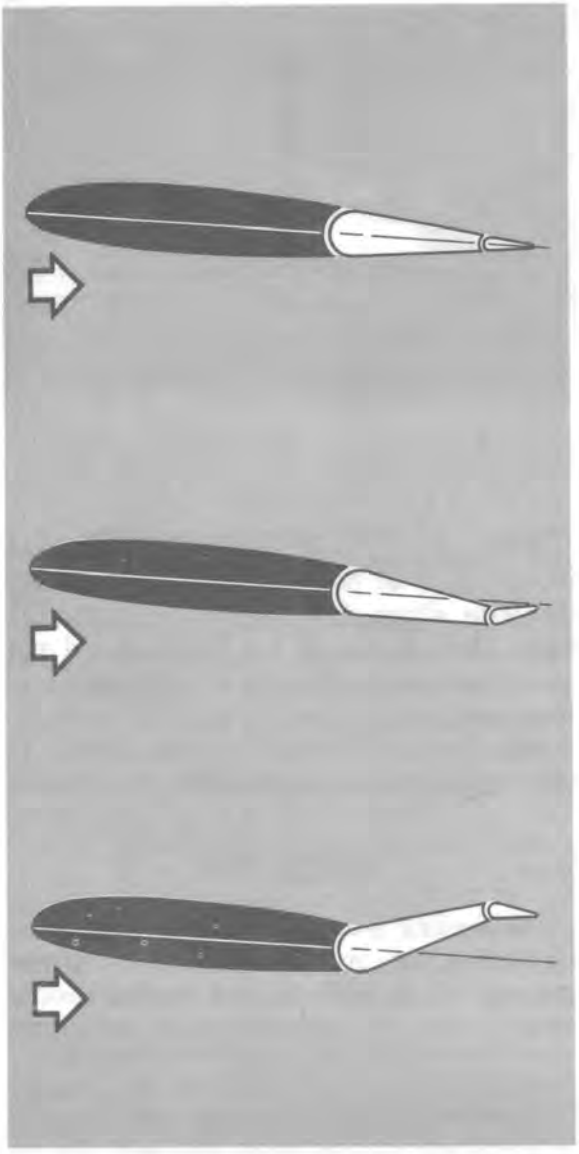


FIGURE 6-2 *Trim Tabs are Aids to Smooth Flying*

stick pressure from you. When this has been accomplished, the elevator is said to be properly "trimmed."

There are three trim controls: The rudder trim, the elevator trim, and the aileron trim. To overcome unbalanced rudder forces, adjust the rudder trim; to overcome pitch forces, adjust the elevator trim; and to correct wing heaviness, or rolling tendencies, adjust the aileron trim. When the pressures on the controls have been neutralized, the aircraft is correctly trimmed.

The trim controls, correctly used, are aids to smooth flying; misuse of the trim controls will result in flying that is physically tiring and decreases the efficiency of aircraft performance.

In the T-37, power changes normally do not require large immediate changes in control pressures. Because of the gradual nature of acceleration and the time lag in thrust, which is regulated for design reasons by the fuel control, jet aircraft accelerate and decelerate rather slowly. The need for trim, therefore, will become gradually evident as the airspeed changes. Always think of trim as a recurring process.

There are other devices on the aircraft controlled from the cockpit by the pilot which have some effect on the flight of the aircraft. These are the flaps, the landing gear, the speed brake and thrust attenuators, but these all have other primary purposes and have an incidental effect on aircraft control. Trim, however, is available to compensate for these incidental effects.

FLAPS

Flaps are movable panels on the trailing edges of the wings. They are hinged so that they may be lowered, which causes the wings to increase lift and drag. The purpose of this is to let the aircraft land at a lower airspeed and descend at a steeper angle. A steep angle is desirable in order to avoid the hazards of dragging in over the tree tops. Duplicate sets of wing flap levers on the T-37 are located to the left of each set of throttles on the pilot's and instructor's throttle quadrants. The quadrants are labeled FLAPS and have three marked positions—UP, HALF and DOWN—with a detent at the HALF position which can be felt as the levers are moved to the HALF position or beyond. To position the flaps to any position, the flap lever is moved to the corresponding position and left there. Position of the wing flaps is indicated by a

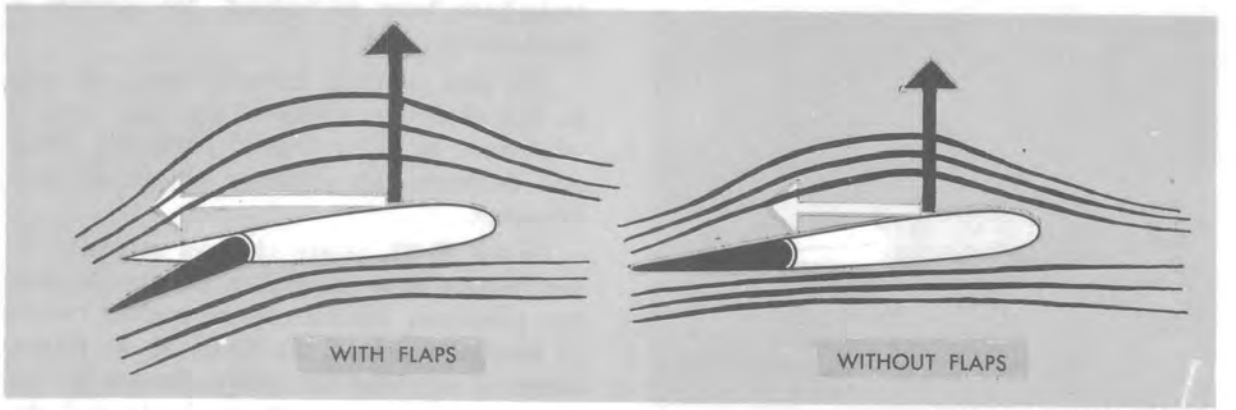


FIGURE 6–3 *Effect of Flaps on Lift and Drag*

wing-flap position-indicator instrument located on the instrument panel. The indicator is marked in 10% increments from zero to 100% with 40 degrees of extension being 100% deflection.

Lowering and raising the flaps has a very noticeable effect on the flight of the aircraft. With a constant power setting while maintaining level flight, airspeed will be lower when the flaps are extended. If power is increased to maintain a constant airspeed in level flight when flaps are extended, the pitch attitude of the aircraft must be lowered as the flaps are extended.

When lowering flaps on the T–37, airspeed should be at or below 135 knots. Lowering the flaps above this airspeed may damage them. An airspeed of 135 knots should not be exceeded with flaps in a down position. If airspeed limitations are exceeded unintentionally with flaps extended, they should be retracted immediately regardless of airspeed.

LANDING GEAR

The landing gear is for the sole purpose of supporting the aircraft while it is on the ground. While in flight, the landing gear is

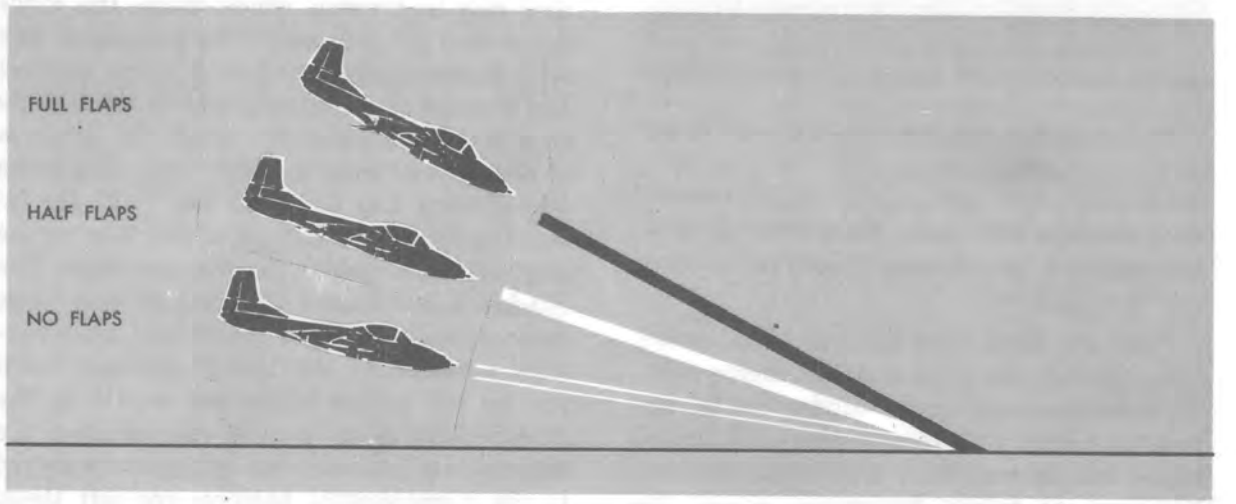


FIGURE 6–4 *Effect of Flaps on Gliding Angle*

merely excess weight and drag. Although we cannot relieve the aircraft of this weight, we can retract the gear inside the aircraft out of the slipstream, thus eliminating drag.

From the above it may be seen that the extended landing gear does affect the flight of the aircraft. With a constant power setting and maintaining level flight, the airspeed will decrease as the gear is extended.

The landing gear controls consist of two interconnected levers with clear plastic wheel-shape knobs mounted on the extreme left and in the center of the instrument panel. Each landing gear lever has two marked positions, UP and DOWN. Positioning either landing gear lever to the UP or DOWN position causes all three of the landing gear to retract or extend. In addition to these controls, an indicator is located on the instrument panel to show the position of the gear.

Operation of the gear should be at or below an airspeed of 150 knots. Operation at a higher airspeed may cause damage.

SPEED BRAKE AND THRUST ATTENUATORS

The speed brake and thrust attenuators are operated simultaneously by a single switch located on each right-engine throttle control.

The speed brake is a drag device located on the bottom side of the nose section just aft of the nose wheel well. It may be extended into the airstream at any airspeed and will provide rapid deceleration from high airspeeds when desired.

The thrust attenuators are metal tabs that extend into the jet exhaust which reduce effective thrust while a given range of engine RPM is maintained. They extend whenever the speed brake is out and either throttle is between IDLE and 70% rpm. Their main purpose is to increase the approach angle of the aircraft by reducing effective thrust and maintaining a power setting high enough to afford rapid acceleration. Jet engines do not accelerate very fast from low power settings.

Extending the speed brakes causes very slight changes in pitch attitude and trim. The trend is slightly nose down.

Actuating the thrust attenuators causes no immediate change in pitch or trim.

CHAPTER 7

TAKEOFF

The takeoff is the movement of the aircraft from its starting position on the runway to the point where the climb is established. Since the takeoff involves both ground roll and inflight operation, you must be able to make the transition from ground to inflight functions of the controls with maximum smoothness and coordination. Skill in blending these functions will greatly improve your ability to control aircraft direction on the runway.

PREPARATION FOR THE TAKEOFF

You must prepare both yourself and the aircraft for the takeoff just as you would before executing any other maneuver. This is especially important since the takeoff normally constitutes your initial operation of a special aircraft and requires your complete attention. Make absolutely certain all applicable procedures and checks have been completed before taxiing into the takeoff position. Consult the Flight Manual of your aircraft for the proper BEFORE TAKEOFF procedures and checks. Since your checklist will only tell you what to check and not how to check it, you must be thoroughly familiar with the appropriate section of the Flight Manual. Do not try to memorize the checklist but use it as a guide to insure thorough coverage.

Friction Lock Adjustment

A friction locking mechanism, located on the lower part of the left throttle quadrant, is provided so that you may adjust the tightness of the throttles. By rotating the friction lock knob forward, toward the instrument panel, you can increase the friction until the throttle cannot be moved. By rotating the knob backward, toward your body, all friction can be relieved and the throttles may be moved with the slighest pressure.

Prior to takeoff you should adjust the friction lock so that the throttles will be held firmly in the position that you place them. Friction must be tight enough to overcome any tendency of the throttles to "creep," especially during the takeoff. Make certain your adjustment is adequate.

Takeoff Trim

During the transition from ground operation to flight, you will not have time to trim the aircraft while the controls are attaining their maximum effectiveness. You will have to exert pressures on the flight controls to hold the aircraft in the proper takeoff attitude. However, if you pre-trim the aircraft by setting the trim tabs in the positions normally required to maintain a climbing attitude prior to takeoff, you can alleviate much of the pressures needed.

To facilitate the takeoff, you should adjust the trim tabs to the neutral position. This is done by visually checking the aileron trim while actuating the trim tab switch on the control stick grip and by checking for a green elevator trim light on the instrument panel while actuating the elevator trim. The rudder trim should be in the neutral position and is part of the preflight inspection. You still will have to apply some pressures on the controls and make further trim adjustments after the takeoff climb has been established.

Your instructor will demonstrate takeoffs with improper trim settings so that you may realize the effect of adverse control pressures.

EXECUTING THE TAKEOFF

Prior to this point you have checked the aircraft and equipment thoroughly, and assured yourself that you are ready for takeoff. Your primary concern now is flying the aircraft off the ground.

Although the takeoff is one continuous maneuver, it will be broken into four separate steps for purposes of simplicity and explanation: (1) application of power, (2) the takeoff roll, (3) leaving the ground, and (4) techniques after becoming airborne. This treatment is in separate parts but you should always think of and fly the takeoff as one maneuver.

Application of Power

When cleared and before taxiing onto the active runway, check canopy locked, warning light out. Acknowledge the clearance with the call "694, canopy down and locked—light out." Look around to make sure that you will be clear of all other aircraft. Insure that you will have adequate time to take off before any aircraft in the traffic pattern turns onto the final approach and that the runway you intend to use is clear. Do not start a takeoff immediately behind another aircraft. The preceding aircraft should be airborne before you start your roll.

Taxi onto the runway and align the aircraft with the lane (lengthwise section of the runway) that you are going to use. Prior to engine runup, travel straight ahead a short distance to make sure that the nosewheel is straight. Check the directional indicator for alignment with the known runway heading, and select convenient ground reference points to be used as aids to directional control during the takeoff. Pump up the brakes and advance the throttles smoothly yet firmly to the full OPEN position, while monitoring the EGT for maximum limits. After both engines have accelerated to 100%, check your instruments, engage the nosewheel steering and release brakes. Maintain direction by smooth, positive rudder application.

NOTE: Excessive exhaust gas temperatures decrease engine life. Therefore it is important that you do not permit the exhaust gas temperature to exceed the maximum acceleration limits during takeoff, go-arounds, etc.

The Takeoff Roll

At the start of the takeoff roll let the elevator control seek a neutral position. Since the aircraft has not gained sufficient speed for this control to become effective, there is no need to apply pressure. Such practice will only aggravate the takeoff and prevent you from recognizing when pressure is actually needed. Continue to maintain directional control by cross checking your ground references (those selected after aligning the aircraft with the runway), your runway marker lights, and your Directional Indicator. Correct any deviation from the desired heading with smooth rudder application.

As the speed of the takeoff roll increases you will begin to feel pressure on the flight controls. It is at this point, in the taxi-flight transition, that the aircraft is being flown more than taxied. As this occurs you need to make progressively smaller rudder corrections to maintain direction. Rudders will become effective above 60 knots. When you feel good response to the elevator control, check the airspeed and at approximately 65 knots disengage nosewheel steering, apply back pressure to the stick and raise the nose wheel off the runway, establishing the takeoff attitude.

Since a good takeoff depends on the takeoff attitude, it is important to know how this attitude is attained. The ideal takeoff requires minimum pitch adjustment after the aircraft becomes airborne. Keeping this in mind, you can understand that the takeoff attitude is approximately the same as the initial climbing attitude. Your instructor will demonstrate the takeoff attitude. Use whatever back pressure is necessary to hold this attitude. Keep the wings level by applying aileron pressure as needed. At this takeoff point all flight

controls are effective in maneuvering the aircraft.

Leaving the Ground

Maintain the takeoff attitude and when the airspeed reaches approximately 90 knots, the aircraft will fly off the ground. Be careful not to force it into the air prematurely by applying too much back pressure which results in too high a pitch attitude. Although the aircraft can be forced into the air near the stalling speed, this is an unsafe practice and should be avoided.

As the aircraft leaves the ground you are concerned primarily with holding the correct flight attitude and maintaining direction. If you force the aircraft to leave the ground by using too much back pressure before adequate flying speed is gained, it may settle back to the runway or you may cause the nose to rise so high immediately after leaving the ground that a stall will result.

If you fail to hold enough back pressure to maintain the correct takeoff attitude after becoming airborne the aircraft may settle back to the runway. This would occur because the angle of attack is descreased and lift is diminished. Just remember to hold the attitude constant throughout the takeoff.

After Becoming Airborne

The aircraft will pick up speed rapidly after becoming airborne. When you are certain that the aircraft will remain airborne and have attained a minimum of 100 knots airspeed, retract the landing gear. Check gear indicators to see that the gear is up and locked. Check the airspeed for safe flap-up speed, 110 knots, and retract the flaps. Keep the wings level after takeoff and throughout your straight climb.

Remember, when retracting the landing gear, the configuration of the aircraft is being changed. The trim which was set up before takeoff will be incorrect. Readjust the elevator trim to relieve the pressures on the control stick.

After becoming airborne you will be utilizing the flight instruments to a greater extent. You will not only be checking outside reference points to maintain the proper attitude but also checking the flight instruments. Do not stare at any one instrument. You must learn to cross-check the references rapidly and correctly. As you become more proficient, the speed of your cross-check will be increased.

After the gear and flaps are up and while waiting for climb airspeed, hold the vertical velocity between 500 and 1,000 feet per minute. This will assure proper acceleration as well as a positive climbing attitude.

The flight instruments should be used to supplement the outside references for maintaining the desired aircraft attitude. Pitch information will be provided by the Attitude Indicator, the Airspeed Indicator, the Altimeter and the Vertical Velocity Indicator. Bank information will be provided by the Attitude Indicator and the Turn-and-Slip Indicator.

Do not stare at the Airspeed Indicator when making pitch corrections, but check the attitude of the aircraft by combined use of outside and instrument references. Make whatever pitch change you think is necessary and hold this new attitude constant. Wait momentarily, then check the Airspeed Indicator to see if the correction had the desired effect. Due to inertia the aircraft will not accelerate or decelerate rapidly after a pitch change has been made. If you have over- or under-corrected, the Airspeed Indicator will show it by reading high or low as the case may be. When this occurs, simply repeat the process until you have the desired climbing attitude.

When you have attained the correct pitch attitude, hold it constant by combined use of outside and instrument references. The Attitude Indicator should be used in conjunction with outside references to make small pitch corrections and to keep the wings level. Learn to fly the aircraft by establishing correct and constant attitudes for the climb immediately after takeoff, and the airspeed will be correct.

When an aircraft has taken off immediately ahead of you, anticipate the possibility of jet-wash, especially if the wind condition 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 jet-wash; then realign the aircraft with the original flight path. If a cross-wind is present, make the turn upwind, since the jet-wash will be blown downwind or away from your flight path.

Upon reaching an airspeed of 200 knots and a minimum altitude of 500 feet above the terrain, adjust the throttles to 96% rpm and establish the bank for the first turn out of traffic as directed locally.

MONITOR THE THRUST

The earliest possible recognition of power failure cannot be overemphasized. In multi-jet aircraft, loss of thrust is usually detected by referring to the engine instruments (Tachometer and Exhaust Gas Temperature) rather than from engine sound or change in aircraft direction. This is especially true when thrust loss occurs slowly and smoothly. Failure to attain or maintain airspeed may also be a clue. During phases of operation where loss of thrust is critical, such as takeoffs, the need for monitoring engine instruments assumes even greater importance. Therefore, you should learn to cross check engine-performance instruments during takeoffs.

CROSSWIND EFFECT ON TAKEOFF

A crosswind will affect the aircraft during takeoff just as it does in taxiing. The takeoff has been identified as part taxiing, part flying, and a transition between the two. With this idea in mind, you can see that the crosswind-correction technique for takeoff is a progressive modification of the crosswind-correction techniques for taxiing and those for takeoff. Crosswind taxi technique was covered in Chapter 5 (Aileron and Elevator Usage for Taxiing). The effects of crosswind during the takeoff and climb are covered in the following sections.

Since you are familiar with crosswind techniques for taxiing, the next step to be explained is for crosswind during the takeoff roll and when leaving the ground.

Takeoff Roll (Crosswind)

As you taxi to takeoff position, it is essential that you check the wind tee or other wind directional indicators or get wind data over the radio so that you may recognize and anticipate the presence of a crosswind.

The initial takeoff roll technique for a crosswind is the same as a normal takeoff except that full aileron is held into the wind as the takeoff roll is started. This is to reduce the impact of wind striking underneath the wing. The ailerons should be held in this position until they become effective in maneuvering the aircraft about the longitudinal axis. Since full power is applied, there can be no adverse effects from a headwind or tailwind and the elevator control should remain in the neutral position.

As the aircraft approaches flying speed, the pressure exerted to hold the ailerons into the wind must be reduced. Banking action will begin if you continue to hold full aileron. As the ailerons become more effective it will be necessary to reduce aileron pressure to keep the wings level, but some aileron pressure will have to be maintained throughout the takeoff roll. This aileron pressure will be necessary because the upwind wing will develop more lift, causing it to "fly" or begin rising before the downwind wing. The use of aileron pressure is simply to keep the wings level.

If the upwind wing rises, thus exposing more impact surface, a "skipping" action may result. 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 these bounces will develop into side-skipping. This skipping imposes stresses on the landing gear which



FIGURE 7-1 *Skipping on Take-Off*

could result in materiel failure. In addition, the tendency of the aircraft to weathervane (streamline itself into the wind) is increased.

Hold sufficient aileron into the wind to keep the wings level and maintain directional control. Hold the nosewheel on the ground until nosewheel lift-off speed is reached; then when takeoff speed is attained, make the pull-off definite to avoid side-skipping as the aircraft becomes airborne. Refer to the T–37 Flight Manual—*Takeoff and Landing Crosswind Chart*—for Nosewheel Lift-off Speed in a Crosswind Condition.

Leaving the Ground (Crosswind)

As the wheels leave the runway, the aircraft will start drifting slowly with the wind. Smoothly apply control pressures to execute a coordinated turn into the wind.

When you have turned sufficiently to counteract all drift, roll the wings level with coordinated control pressures. Continue to climb on this heading in a drift-correcting "crab" or upwind tack. Re-check your Directional Indicator to determine the number of degrees you are correcting and hold the new heading to make good a course identical to the runway direction.

The remainder of the takeoff climb is the same as explained in "After Becoming Airborne."

TRAFFIC EXIT

After takeoff, climb straight ahead to a minimum altitude of 500 feet above the terrain or higher as specified for traffic exit at your base. (This information is published in local directives. Your instructor will make certain that you are familiar with all traffic pattern procedures.) Upon reaching this altitude and while maintaining a constant climbing attitude, adjust the throttles to 96% rpm, then visually clear the new direction and execute a medium-banked (approximately 40°) turn in the direction of the traffic pattern. Check the Attitude Indicator to help establish the desired angle of bank. Plan and execute the rollout from this turn so that the aircraft's ground track is perpendicular to the takeoff runway.

The term "ground track perpendicular to the takeoff runway" may be somewhat confusing to you, since at first glance you might suppose this would mean simply "make a 90° medium-banked turn." If the wind is calm, this is what would be done, but when taking off into a headwind, the aircraft will drift downwind toward the runway if the turn is exactly 90°. Therefore, the aircraft's ground track would not be perpendicular to the takeoff runway but at an acute angle. So when a takeoff is made into a headwind, roll out of

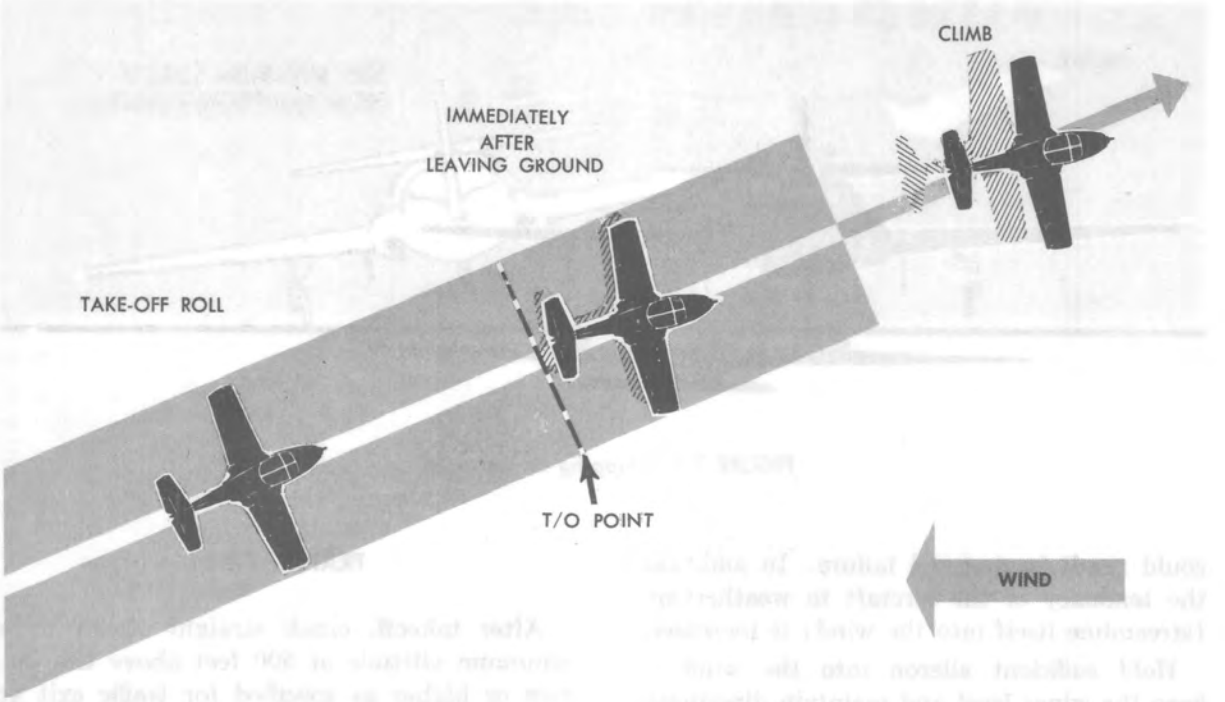


FIGURE 7–2 *Crabbing into Crosswind after Take-Off*

the first turn a few degrees short of the 90° point, thus applying a drift correction. If familiar points on the ground or horizon are visible try to use them for reference to make good a perpendicular track. Use the Directional Indicator to maintain the desired heading after drift correction is determined. Drift can be readjusted as necessary.

CHAPTER 8

FUNDAMENTAL MANEUVERS OF COMPOSITE FLIGHT

COMPOSITE FLIGHT

A modern concept in contact flying (see Glossary) combines the use of outside references and flight instruments to establish and maintain desired flight attitudes. This method of aircraft control when outside references are available is known as composite flight and will be practiced throughout your flight training.

All maneuvers are accomplished by establishing attitudes and progressively changing these attitudes throughout various stages of the maneuvers. An attitude can be established and maintained by positioning the nose and wings of the aircraft in relation to the horizon. This can also be accomplished by reference to the flight instruments. Very small changes in attitude may not be readily noticed by outside reference to the earth's horizon but will be noticed immediately by reference to the flight instruments. However, reference solely to instruments imposes several disadvantages. The most serious of these is the inability to observe proximity of aircraft, and other hazards to flight. Maintaining flight attitudes by outside references serves the additional purpose of maintaining clearance within the area from any hazard to flight. Repeated reference to flight instruments is necessary to ascertain that desired attitude, heading, and airspeed are being maintained. More accurate and precise flying will be accomplished by using both outside and flight-instrument references, checking one against the other. More exclusive reference to instruments will be necessary during restricted visibility, and night operations.

Reference to any instrument or group of instruments must be rapid so that all necessary information is obtained without prolonged disregard of important visual cues available from outside the cockpit. Another reason for this is the increased air traffic and the rapid rate of closure of modern high-speed aircraft. Vigilance must be maintained to avoid mid-air collision and identify landmarks to keep from becoming lost.

STRAIGHT-AND-LEVEL FLIGHT

Straight-and-level flight demonstrates some of the basic fundamentals of flying. It is just what the name implies—flight in which a constant altitude and direction are maintained. Your objectives in this training exercise are to learn the use of the controls, to combine the use of outside and instrument references for maintaining aircraft attitude, and to learn to divide your attention by constantly checking all available references without concentrating on any one.

Before practicing straight-and-level flight you must be familiar with the flight instruments to be used. You must understand the effect and use of the controls, be properly and comfortably seated in the aircraft, and be relaxed and at ease.

Being relaxed and at ease in the aircraft means that your body is free of muscular tension. When your body is free of tension you can more readily feel any pressure exerted by centrifugal force or gravity and also the amount of pressure that you are applying to a control. It is imperative that you maintain a good posture while seated in the aircraft so

that your body will be relaxed and your references will always appear the same. Being relaxed and maintaining a good posture will help avert fatigue and thereby add significantly to the enjoyment you get from flying. Remaining relaxed, looking around, dividing attention, and translating visual information into smooth control responses are all very important in this exercise. The power setting for straight-and-level flight is 90%.

Attaining level flight, at first, is a matter of consciously fixing reference points on the aircraft in relation to the earth's horizon and comparing or cross-checking this relationship with the indication of the flight instruments. The combined use of outside and instrument references (through proper cross-check) will develop a good composite flight technique for this exercise. These outside and instrument references will be used in varying degrees in all maneuvers and will be invaluable to you in developing precision composite flying. The use of combined outside and instrument references is the easiest and best method of determining the attitude of the aircraft under contact flight conditions.

You will establish straight-and-level flight by becoming familiar with the proper outside and instrument references and learning to keep them in their proper relationship. The apparent position of the outside references will depend on seat adjustment or eye level. The instructor will show you these instrument references and their use. You will see the relationship between them and also that the attitude of the aircraft can be easily controlled by either outside references or instrument references but that the method of controlling the attitude by outside *and* instrument references will result in more precise aircraft control.

The instruments referred to for control of pitch attitude are the Attitude Indicator, Altimeter, Vertical Velocity Indicator, and the Airspeed Indicator. The Attitude Indicator gives a direct indication of the pitch attitude of the aircraft and is the instrument referred to in making a precise pitch change. By using the outside references *and* the Attitude Indicator in controlling the pitch attitude, you can quickly place the nose of the aircraft in approximately the correct pitch attitude for straight-and-level flight and hold it there. The Altimeter will be a guide to determining whether the attitude established is correct. If it is correct, the altitude should remain constant, and any subsequent deviation from the desired altitude shows the necessity for a change in pitch. If you are losing altitude, raise the nose (increase the pitch attitude); if you are gaining altitude, lower the nose (decrease the pitch attitude). The rate of change of the Altimeter indications will aid in determining the amount of deviation from the desired attitude and the amount of pitch correction needed. A slow change indicates a small deviation and a fast change indicates a large deviation.

The Airspeed Indicator in steady level flight at a constant power setting will indicate a constant reading. An increase in airspeed would indicate a nose-low attitude, and a decrease in airspeed would indicate a nose-high attitude.

The Vertical Velocity Indicator is a sensitive instrument and in composite flight is best used as a trend instrument. In attempting straight-and-level flight any appreciable displacement of the needle from the zero position indicates a need for a pitch change.

The instructor will demonstrate each instrument in conjunction with the outside references. Do not concentrate too much on one reference or stare at a particular reference seeking information. This will not only hinder your progress, but will create a dangerous situation in that you are not assuring that your intended flight path is clear of other aircraft or clouds (which you must remain clear of until you learn instrument flying). Check each outside and inside reference in turn and interpret each as a guide to minor control adjustments. You must have thorough knowledge of the facial design, location, and interpretation of all reference instruments to enable you to develop an accurate but rapid cross-check of composite flight references.

Familiarity with these instruments will enable you to determine the control pressures necessary to control the attitudes and the direction of the aircraft. Control pressures should be smooth and applied with confidence. The beginning student often overcontrols due to lack of experience, but this tendency can be minimized through practice of smooth application. Good control is never a static situation but a continuous succession of minor, almost imperceptible, corrections to keep the aircraft in the desired flight path.

Pitch

Control of the aircraft pitch attitude about the lateral axis (wingtip-to-wingtip) to achieve level climbing or descending flight can be accomplished by maintaining the nose of the aircraft in a fixed position in relation to the earth's horizon. There are many other outside references which are used in combination to determine pitch attitudes, such as the wingtips or the glare shield in relation to the horizon. Desired pitch attitudes can also be set by reference to the flight instruments. As in level flight, a combination of outside and instrument references will be used to control the pitch attitude of the aircraft. These outside and instrument references for climbing and descending flight will be shown to you by your instructor. Continuous cross-checking of all pitch references (outside and instrument) will result in better control of the pitch attitude of the aircraft and enable you to vary your altitude as necessary or desirable—getting the most advantageous performance from your aircraft and maintaining the desired flight path.

Bank

Controlling the bank attitude of the aircraft about the longitudinal axis (nose-to-tail) to achieve straight-and-level flight can be accomplished by positioning the wing tips in relation to the horizon. Both wing tips should be an equal distance above or below the horizon. Other combinations of inside and outside references may also be used to determine this attitude. Similarly, level flight about the longitudinal axis may be accomplished by reference to the appropriate flight instruments. The instrument most referred to for control of bank attitude is the Attitude Indicator, but indirectly the Directional Indicator and the Turn-and-Slip Indicator may also be used. The Attitude Indicator gives a direct indication of bank attitude. A bank will be indicated when any deviation from a wings-level attitude is depicted. By using the outside references *and* the Attitude Indicator in controlling the bank, you can readily place the aircraft in an approximate wings-level attitude and keep it there.

Any change in the Directional Indicator gives an immediate indication that the wings have moved from the level position and the aircraft is turning—by showing a deviation from the desired heading. Remember that anytime the aircraft is in a bank it will automatically turn in the banked direction if the rudder is neutral. A small angle of bank will result in a slow departure from the desired heading and a large angle of bank will result in a rapid change in heading. In interpreting the Directional Indicator, visualize your bodily position as being in the center of the instrument, with your nose pointed in the direction of the pointer.

Likewise, the Turn-and-Slip Indicator gives an indirect indication of the bank attitude of the aircraft. When the Turn Indicator is exactly centered, the aircraft is in straight flight, and if the Ball is also centered the wings are level. When the Turn Indicator is deflected, the aircraft is banked in the direction of the deflection (if the Ball is centered). In well-coordinated flight, the Ball will always remain centered regardless of the maneuver you are performing.

The instructor will demonstrate the correct use of the instruments in conjunction with the outside references.

Yaw

Level-flight control of aircraft yaw (or pivot) about the vertical axis (more accu-

rately, the axis perpendicular to the longitudinal and lateral axes) can be accomplished in the following manner: Select an outside reference over the nose of the aircraft; control the pivotal movement of the nose in relation to this reference by use of the rudder. Drift, which will be explained later, may be mistaken for yaw. When yaw exists the ball in the Turn-and-Slip Indicator will be displaced from center. Also, you will find that yaw causes your body to lean toward one side of the cockpit as when rounding a corner in a car. Coordinated flight should be free of yaw even in a steep bank, and your body will retain a comfortable, upright position.

As you look around and check your flight attitude, you will find many references that can be used to detect yaw. Distant landmarks on the ground or clouds on the horizon offer excellent checks. Other forward references such as fields, towns, rivers, lakes, or converging section lines paralleling the fuselage of the aircraft may also be used. Instrument references will be the Turn-and-Slip Indicator and the Directional Indicator.

To attain precision in straight-and-level flight, you should divide your attention continually between all outside and instrument references. The sooner you learn to look around and divide your attention properly, the sooner you will advance to another maneuver.

CAUTION

Be alert, and do not concentrate on any one reference for long periods of time, as it is imperative that you 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 them to confirm the accuracy of your control pressures or the need for a further correction. This process is continually repeated in composite flying.

During your cross-check you should occasionally include engine instruments, fuel gauges, etc. The thoughtful pilot has a mechanic's appreciation of his engine and miser's concern for fuel. Check fuel balance in tanks and monitor the fuel consumption. Keep the aircraft trimmed so that flight attitudes will be maintained without holding control pressures.

Power

If you hold the altitude constant with elevator control, power setting determines the airspeed. For example, if you accurately control pitch to maintain a constant altitude, a higher power setting results in a higher airspeed. Any reduction of power results in a reduction of airspeed and a consequent requirement to hold back-stick pressure to maintain a constant altitude. This compensation for loss of power will hold altitude until the aircraft approaches a stall. There are no outside references to control power. The instruments used for power control are the Tachometer and the Airspeed Indicator. You will become familiar with the minimum power settings which will permit level flight.

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 to establish pitch, bank, and direction simultaneously. Power changes and trim technique will become second nature. A trim change is called for when you find you are having to hold continuous stick or rudder pressure away from the neutral position. This is tiresome, and you will learn to trim instinctively.

The weight of your right arm upon the stick may cause the ailerons to become slightly effective and result in flying with the right wing low. In most cases, this will result in a very slight turn to the right. To keep the aircraft from turning, a steady left-rudder pressure would have to be used. This would set up an undesirable cross-controlled condition. The solution to this is to place the weight of your elbow on your thigh and thereby relieve

any tendency to be heavy-handed. Remember to check your references frequently to determine any tendency toward heavy handedness.

One of the common faults of a student pilot is his 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 cannot be done with any degree of accuracy, particularly in the T–37 which has a rounded canopy sill, and it may result in flying with one wing low. As in the preceding paragraph, this wing-low attitude would require the use of additional rudder to maintain straight flight and would give a false conception of neutral control pressures as well as an uncomfortable seat position. This is another case of what can happen if you do not cross-check all references or look around enough.

Let your eyes sweep along the horizon picking up the wingtips as you do and make a mental note of required corrections. In the process, look for other aircraft that might be flying in your area while you check your outside references and make your corrections. Return then to inside references to confirm your corrections. Then outside again in a continuous process. Soon it will become second nature and effortless.

Straight-and-level flight requires almost no pressure on the controls, provided the aircraft is properly trimmed and the air is smooth. When you are flying through turbulence of varying intensity, the flight attitude may change abruptly. Do no fight the controls to prevent these changes from occurring. Ride it out like a boat on a rough sea and make smooth but firm adjustments, as needed.

TURNS

A turn is a basic maneuver used to change the direction of the aircraft. It involves the close coordination of all three controls—aileron, rudder, and elevator. Since turns are incorporated in almost all of the other maneuvers, it is important that you learn to perform them well.

There are three types of turns—level, climbing, and descending—with variations of each. For instance, there are three defined variations of level turns—shallow, medium, and steep. The level turns are the basic turn maneuvers and all other turns are variations of them.

Lift Components of a Turn

Turns are made in an aircraft by banking. This is done by using the ailerons to roll the aircraft in the direction that you desire to turn. Banking causes the components of lift to become intentionally unbalanced—wing to wing. This lift imbalance rolls the aircraft in the direction of the bank until the desired degree of bank is reached, and then you must consciously undo it and neutralize the aileron control to stop the roll and maintain the bank you have established.

When an aircraft is flying straight-and-level, the lift component is acting perpendicular to the wings and the ground. When the aircraft is rolled into a bank, the lift is still perpendicular to the wings but moves off the perpendicular to the ground. This may now be divided into two components: one, the vertical component, perpendicular to the ground; the other, the horizontal component, parallel to the ground. Since the vertical component is something less now than the total lift from which it is derived it would seem that it could not be sufficient to hold the weight of the aircraft. And this would be true if there were no means of increasing the total lift to the point where the vertical component is equal to the weight of the aircraft. Fortunately there is a very simple means, namely, by increasing back stick pressure and thereby increasing the angle of attack between the aircraft's path and the relative wind. Total lift increases, and the vertical component is again equal to the weight of the aircraft while the established horizontal component is like the tether on a captive model airplane—holding it in the turn. Many a pilot knows instinctively that he must hold back stick pressure in a turn without knowing the reason for it.

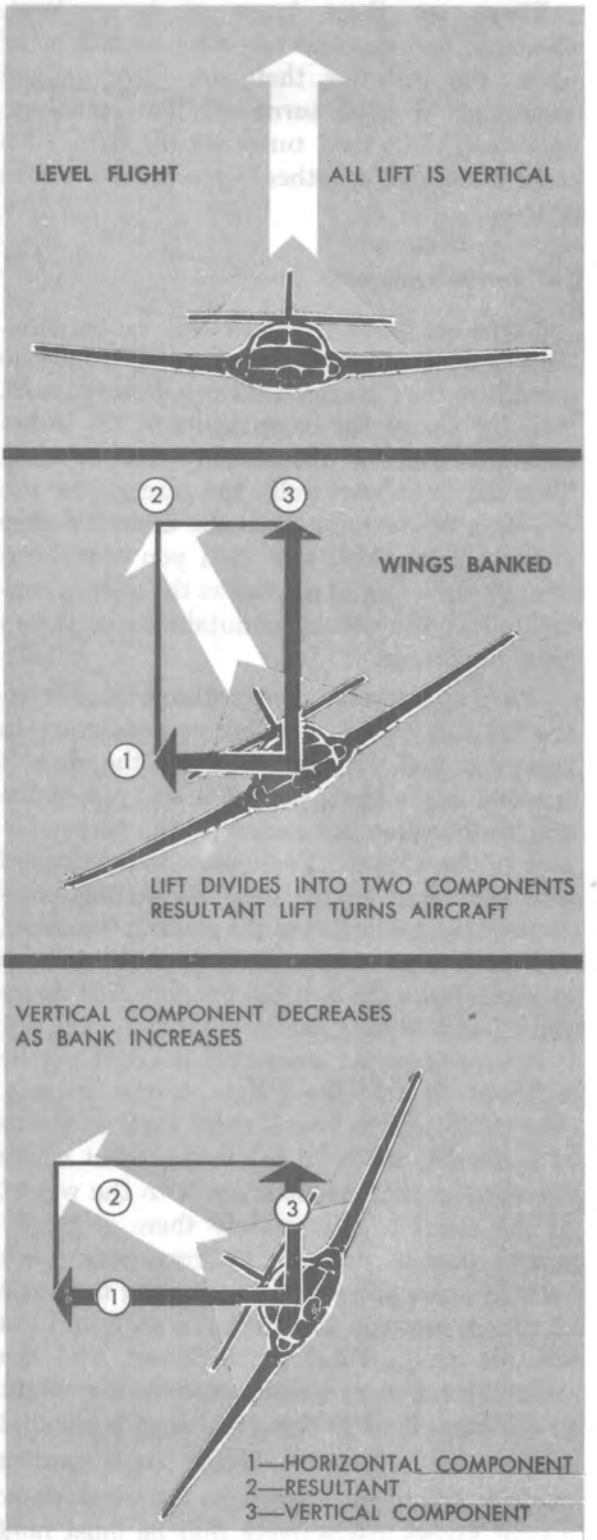


FIGURE 8–1 *Lift Components of a Turn*

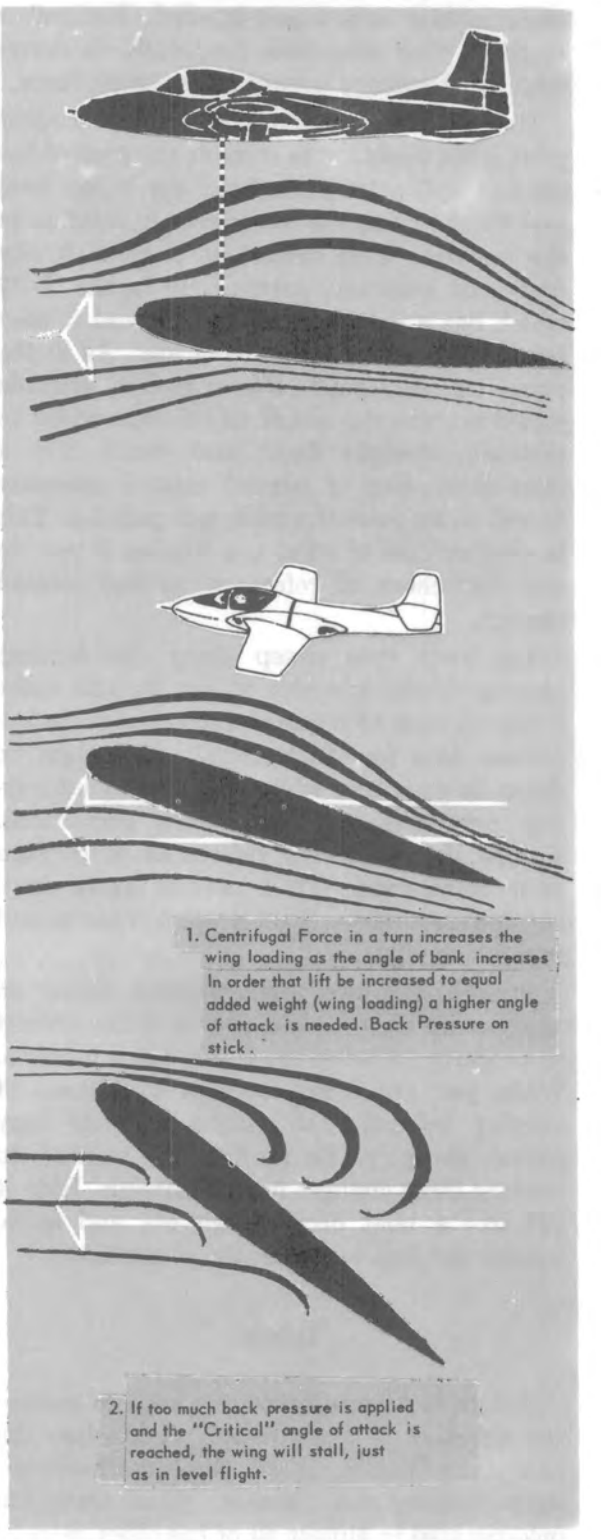


FIGURE 8–2 *Increase Angle of Attack in a Turn*

Effects of Lift-Component Variations

As the angle of bank increases, the vertical lift component decreases still more and the horizontal component increases. This requires another chain reaction of more back stick pressure and more angle of attack for enough total lift (perpendicular to the wings) to produce a sufficient vertical component to again equal the weight of the aircraft in order to hold it up at the desired altitude. Meantime, this results in a loss of airspeed and a further increased horizontal lift component pulling even stronger to reduce the radius of turn. The famous Air Force aerobatic team "The Thunderbirds", features this principle in their steep-turn maneuver in which they make a complete 360° turn within the boundaries of an average-sized airport. It is a very difficult maneuver requiring muscle and technique to establish and maintain sufficient additional angle of attack, lift and power to maintain altitude at a low-enough speed for a tight turn without reaching the point of a stall. With an increase in bank and angle of attack, the resultant lifting force will be more inclined to the horizontal and the rate of turn will be faster.

When you turn your aircraft without adding power, you will find that a greater angle of attack is necessary to keep the nose higher than is needed for straight-and-level flight in order to produce the required increase in total lift to sustain level flight in the turn. Sufficiently increasing back pressure will keep the nose up until you approach a bank angle of 90° at which point there can no longer be a substantial vertical component to keep you from falling. Chances are, however, that you will either stall the aircraft by reaching the critical angle of attack or else relinquish altitude as the 90° bank attitude is approached.

Effects of Power Changes in a Turn

As explained previously, the wings during a turn must produce total lift sufficient to produce a vertical component equal to the weight of the aircraft plus a horizontal component which is the force causing the turn. Increasing total lift can be accomplished with other factors constant by increasing either the angle of attack or the thrust or both.

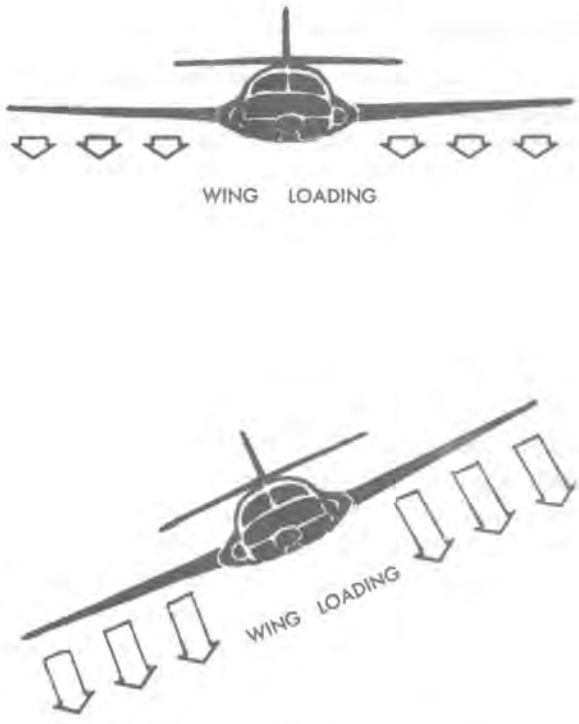


FIGURE 8–3 *Centrifugal Force Increases Wing Loading in a Turn*

Since increasing the thrust when making a turn is sometimes impractical, the increased lift is obtained by applying back stick pressure to increase the angle of attack. This pressure must increase as the turn steepens. (Obviously it must be released as the aircraft returns to straight-and-level flight; otherwise the increased total lift which is again essentially vertical will cause you to climb.) Keep in mind however that an increase in power or thrust can be and often is used to compensate for loss of airspeed and vertical lift in a turn up to the limit of the additional power available (100% rpm). More often, though, it is a combination of back stick pressure and added power which is used to keep the aircraft in a level turn. Both must be reduced upon rolling out in order to return the aircraft to its former straight-and-level flight condition.

Aileron Drag (Adverse Yaw)

You were given a brief description and explanation of aileron control in an earlier chapter under "Effect and Use of Controls". You learned that the aileron surfaces move simultaneously but in opposite directions when pressure is applied to the control stick. It is the ailerons which produce wing-lift differential, causing the aircraft to rotate about the longitudinal axis.

Initially, 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 a greater drag. With this condition existing the aircraft does not turn immediately in the direction of aileron movement, but tends to turn the opposite way because of the increased drag or backward force on the down aileron. Let us analyze why this occurs and determine what can be done to counteract it.

In viewing a profile of the wing, you will notice that there is a difference in the curvature of the upper and lower surfaces. The bottom is fairly straight, but the top is distinctly curved. Applying Bernoulli's principle of airflow ("Why the Aircraft Flies" theory), it becomes apparent that the air flow over the top surface travels a greater distance than that along the bottom. The resultant difference in air flow speed over the surfaces result in pressure differences, with the higher pressure area along the bottom surface.

In using ailerons to effect a bank, the aileron that goes "down" moves into an area of higher pressure density than the one that is raised, creating a greater amount of drag. The resultant aileron drag attempts to turn the aircraft in the opposite direction (adverse yaw) while the banking action is taking place. After an appreciable bank has been established, the turn resulting from the horizontal component of lift begins to overrule, although the tendency toward adverse yaw continues to have some effect until the desired bank is reached and the ailerons are neutralized.

The amount of aileron drag is dependent on the speed of the aircraft. At low or near-stalling speeds it is very noticeable, whereas at extremely high speeds it may be unnoticeable. This is true because the movement required of the aileron surfaces is greater at lower speeds. They 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, the greater the pressure on the bottom side of the wing until the stalling speed is reached and the airflow disrupted. At high airstream speeds a

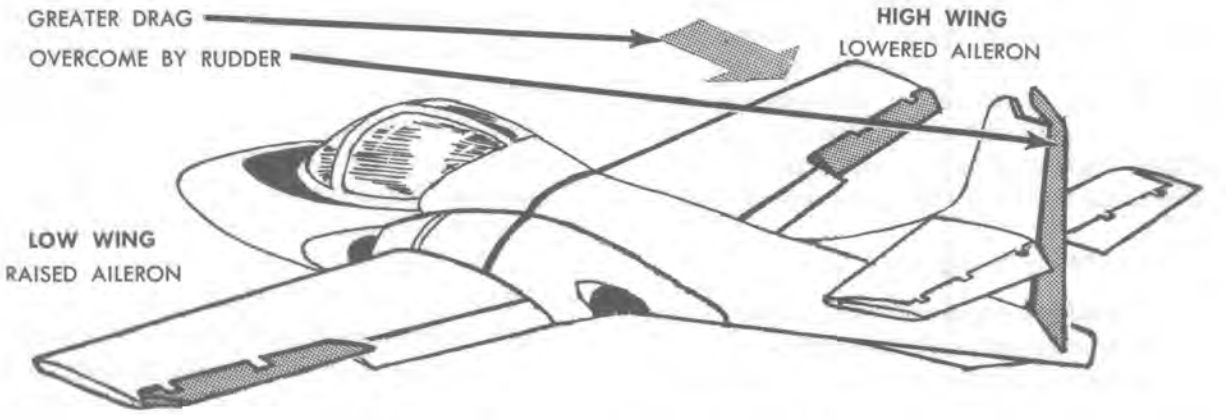


FIGURE 8–4 *Rudder Overcomes Aileron Drag*

small airstream alteration has the characteristic of generating more lift than in a slower airstream. Hence, less aileron is needed in order to lift the wing.

Now we see what can be done about adverse yaw to keep it from interferring with your turn. You overcome aileron drag or adverse yaw by using the rudder. As you apply right or left aileron pressure, simultaneously apply rudder pressure on the same side. The rudder is designed to yaw the aircraft, so you oppose yaw with yaw. 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 will be a guide to using the correct amount of rudder.

Always 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 particular design of aircraft you are flying. Also, remember that aileron drag effect is present during recovery from a turn as well as during the entry. So rudder must again be used in the same direction as aileron stick pressure to again counteract adverse yaw. Generally speaking, the only time you use rudder is when you are applying aileron to bank or unbank.

Governing the Speed of the Roll

When you use pressure on the controls, corresponding control surfaces are extended into the airstream. This causes the aircraft to change its attitude in proportion to the amount of pressure applied and the duration of its application. The response of the aircraft depends on how much pressure is applied.

If you desire a slow rate of roll, you should use light, smooth pressures. If you desire a fast rate of roll, you should apply greater pressures. Pressure on the controls should be in proportion to the amount and the rapidity of the change desired.

In the early part of your flight training, practice rolling into your turns slowly until you have learned to feel the pressures. As your proficiency increases, you may roll into the turns faster. This also applies to recoveries from turns.

Shallow, Medium, and Steep Turns

The shallow turn is a turn of approximately 20° bank. This angle of bank is used for climbing turns, and power-on, turning stalls.

The medium turn is a turn of approximately 40° bank. This type of turn will be used more frequently than other types throughout your training. Common usages are traffic turns and clearing turns.

The steep turn is a turn of approximately 60° bank. This angle of bank is used for rapid changes of direction, clearing turns, and maximum-performance maneuvers.

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 that the area is clear of other aircraft or clouds that may interfere with safety in executing the maneuver.

When the area has been cleared, simultaneously apply pressure to both the stick (aileron) 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. 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. In establishing this bank attitude, outside and instrument references will be used. Outside and instrument references for pitch control are the same as those used in straight-and-level flight.

As the bank is initially established to enter a turn, the nose of the aircraft should stay the same distance below the horizon that it was in level flight. As the bank increases, the pitch attitude will have to be increased to compensate for the loss of vertical lift and to overcome centrifugal force. In shallow and medium turns, the increase in pitch attitude is very slight if noticeable at all. As bank increases from medium to steep, the required

increase in pitch attitude becomes more pronounced. Also, in steep turns it will be necessary to increase power significantly in order to avert a substantial drop in airspeed.

Just as in straight-and-level flight, outside references can be found in any direction. The best outside references for the degree of bank will be those on the high-wing side and also the angle of the earth's horizon across the windscreen. The best instrument reference for angle of bank is the Attitude Indicator.

As the desired angle of bank is established, release the aileron and rudder pressures at the same rate they were applied. This will stop the bank from increasing as the aileron control surfaces are returned to their neutral or streamlined positions. The elevator pressure is not released but is held constant to maintain a constant pitch attitude. Throughout the established turn, the angle of bank should be held constant with adjustments of the ailerons, just as the wings were kept level in straight-and-level flight.

To correct a nose-low attitude in a steep turn, reduce the angle of bank with coordinated aileron and rudder pressure. Simultaneously use back pressure to raise the nose to the desired pitch attitude. After accomplishing this, re-establish the desired angle of bank. Don't try to make corrections solely with any one of the three controls. Use them together.

The roll-out from a turn is much the same as the entry except that control pressures are used in the opposite direction. Apply aileron and rudder pressure in the direction of the roll-out or 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 correspondingly reduced.

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

NOTE: Your posture while seated in the aircraft is very important in all maneuvers. Don't lean forward or backward or from side to side. Instead, sit erect and move your head around freely. During turns, maintain this position. Don't lean away from the turn or attempt to keep your body vertical with the horizon. Relax and ride with the turn. If you don't maintain a constant position in the cockpit, your outside references will continually change. A relaxed pilot is usually a good pilot because he is free to think and can feel the pressures on the controls.

Plan all of your turn exercises so that you make precision turns; that is, a constant angle of bank and a definite amount of turn, such as 90°, 180°, 270°, or 360° turn. To make a precision 90° turn, align the aircraft with a road or section line on the ground and turn perpendicular or parrallel to it. In the absence of any ground reference, pick out a point on the horizon that is directly off a wing tip, then turn to that point. This should be accomplished as you look around to clear the area. Cross-



FIGURE 8–5 *Coordinate Controls in a Turn*

reference to the Directional Indicator will assist you in making precision turns.

Constantly cross-check the outside and instrument references to maintain a constant altitude.

A common student misconception is that a steep turn is entirely different from a shallow or medium-banked turn. This mistaken idea probably results from the fact that all of the aerodynamics of a turn are more prominent in a steep turn. Basically, the only difference in steep turns and the other turns is the angle of bank and amount of back-stick pressure needed. A common student error is the misuse of controls when entering a steep turn. Some students apply control pressures very rapidly and abruptly, using strong back pressure prematurely. This is sometimes caused by the natural tendency of the arm to move backwards as it moves to the side. Steep turns will be easy to perform if you roll into them as into shallow and medium turns by simply increasing the back pressure and adding power smoothly as the angle of bank increases.

SKIDS AND SLIPS

In a coordinated level turn with a constant angle of bank, the flight path of the aircraft is a true circle with respect to the air mass in which it is turning. The flight path is not necessarily a true circle over the ground because of the effect of drift. Variation in the circular path will result from uncoordinated control usage or erratic bank.

Skids

A skid occurs when the aircraft slides sideways away from the center of the turn. It is caused by two much rudder pressure in relation to the aileron pressure used. If you increase the rate of turn by use of rudder without increasing the angle of bank, the aircraft will skid sideways away from the center of the turn.

In a turn, the rudder must be streamlined with the flight path of the aircraft. After a turn is established, if you hold more rudder pressure in the direction of turn than is necessary, a skid will result. A skid will also occur in level flight if the nose of the aircraft rotates sideways about the vertical axis when the wings are level. This condition would occur when rudder pressure is inadvertently held or when the aircraft is improperly trimmed.

Slips

A slip occurs when the aircraft slides sideways and downward toward the center of the turn. It is caused by an insufficient amount of rudder in relation to the amount of aileron used when establishing a turn. That is, if you roll into a turn by applying more aileron than rudder, or if a turn has been established and rudder is held against the direction of turn, the aircraft will slip sideways and downward toward the center of the turn, thus losing altitude.

NOTE: In a skid, centrifugal force will incline your body away from the direction of turn, and in a slip, gravity will incline you toward the center. If you sit at ease in the aircraft you can feel any pressures that may be exerted on your body.

BUILDING CONFIDENCE

At the beginning of your flight training, you find that you are being introduced to new principles and skills in a new medium or element. The commonplace experiences of everyday living give way to new experiences peculiar to flying. Up to this point you have been introduced to the basic principles of flight. You have had only a taste of flying. With each succeeding day you will gain confidence in your new medium and apprehension will disappear. Primarily, you will have to develop confidence in three things—your aircraft, your instructor, and yourself. You will generally find your confidence improving in these three in the same order that they are stated here.

First, you will gain confidence in the aircraft by learning the principles by which it

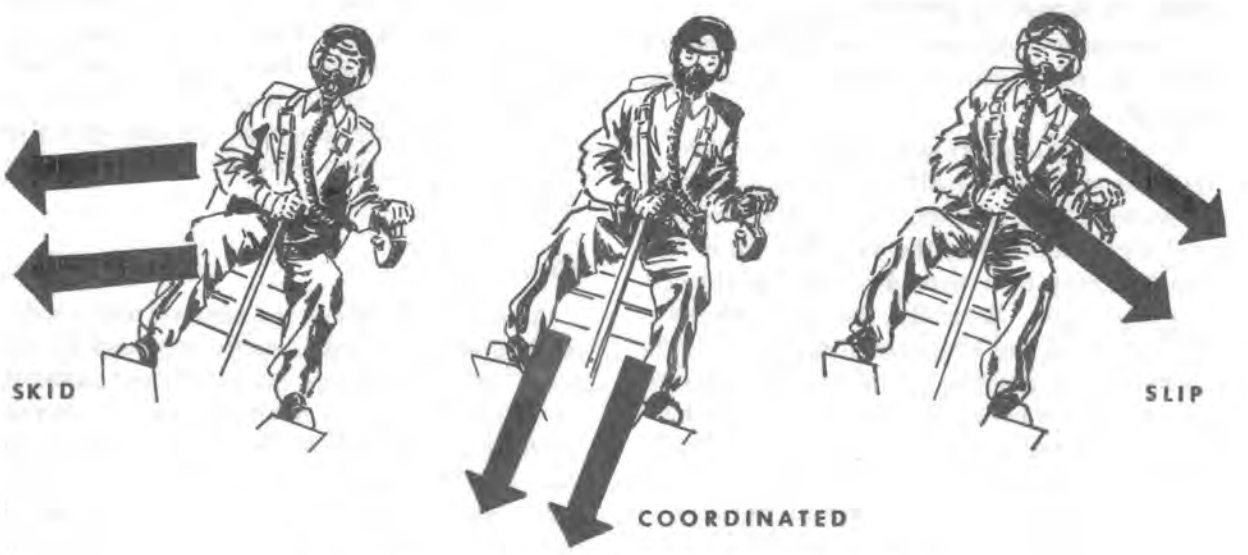


FIGURE 8–6 *Direction of Force on a Body in Various Turns*

flies. As you gain experience, you will overcome any fears that the aircraft will fall out of the air. You will see that it is actually difficult to make the aircraft fall, and for the most part only you, the pilot, can bring about the conditions that will cause this.

Next, you will gain confidence in your instructor by observing the positive manner in which he flies the aircraft and controls it at all times.

Last, but not least, you will gain confidence in yourself and your ability to fly as your proficiency increases. This is one of the many rewarding experiences you will derive from flying.

The purpose of confidence maneuvers is to aid you in developing faith in the aircraft. These maneuvers will give you a practical demonstration of some of the aerodynamic reasons why an aircraft flies as it does. Most of these confidence maneuvers will deal with stability of the aircraft. They will show you how the aircraft is constantly attempting to keep itself flying. Stability, for our purposes, may be defined as the tendency of an aircraft to return, without the aid of the pilot, to condition of steady flight from which it was disturbed. Stability may be further broken down into two types—static stability and dynamic stability.

Static Stability

If a stable aircraft were being operated in a straight-and-level flight attitude and some external force (such as a sudden gust) were applied to disturb it from this attitude, a restoring force would automatically be set up in the proper direction to return it toward the original attitude. Design of the aircraft determines these restoring qualities. Wing dihedral and size of the stabilizers are factors considered in stability. If the aircraft tends to return to the original attitude, it is said to be statically stable.

Dynamic Stability

Dynamic stability is generally dependent upon static stability. We have learned that when a statically stable aircraft is disturbed from its condition of steady flight, a restoring force is inherently set up to move it back *toward* the original attitude. Ordinarily this force will not only carry it back but will usu-

ally carry it *slightly beyond* the original attitude. Since the aircraft is statically stable another restoring force will tend to oppose this first restoring force after the original attitude is exceeded and try to return the aircraft again to the original attitude. This may be repeated several times, with the aircraft oscillating past the neutral position. If the aircraft is dynamically stable these oscillations will diminish and gradually damp out. If it were not dynamically stable, the aircraft would continue to oscillate or yo-yo. The aircraft is said to be dynamically stable if the restoring forces of static stability cause the oscillations to diminish and eventually disappear.

Your instructor will demonstrate these characteristics to you by placing the aircraft in various attitudes and then letting it return toward its original flight attitude and become stabilized by itself.

Hands-Off Flight

First, the instructor will trim the aircraft so it will fly in straight-and-level flight without assistance. This is called "hands-off flight." Then he will exert a sudden slight back pressure on the stick causing the nose to start to rise slightly. He will immediately take his hands off the controls and tell you to do the same. Because of the construction of the aircraft with its inherent stability, the nose will begin to go down. It may continue down past level flight and go slightly lower. The nose will remain at its lowest position momentarily, then start to rise. These oscillations may continue several times, decreasing (or damping) each time, until the aircraft no longer oscillates. This is recognized as longitudinal stability about the lateral (wingtip-to-wingtip) axis. A similar damping of oscillations would occur if the instructor had placed the aircraft in a nose-low attitude and released the stick.

Next, your instructor will demonstrate directional stability. He will apply pressure to one rudder pedal and then release the pressure. When the pressure is applied, the aircraft will yaw in the direction of the pedal that was depressed. When the pressure is released, the nose of the aircraft will start back. It may oscillate a few times, but these oscillations will damp out, and the aircraft will stabilize.

All of these conditions and effects result from the inherent stability designed into the aircraft.

COORDINATION EXERCISE

A coordination exercise is a precision maneuver consisting of a series of level, medium-banked turns executed through 20° of turn each side of a central point. It is used to practice coordination of the control pressures in level turns. This maneuver will increase your ability to remain oriented in turns, and will improve your planning and judgment in executing turns as well as improving your coordination. Since a coordination exercise is a series of precision, level, medium-banked turns, it is necessary that you have a complete understanding of them and attain a fair degree of proficiency in their execution. Turns have been explained in detail earlier. Study them thoroughly before practicing the coordination exercise.

Since a constant altitude is maintained in the coordination exercise, the power setting is the same as for straight-and-level flight. To execute the maneuver, establish straight-and-level flight and trim the aircraft to maintain this attitude without any pressure on the controls. Select a point on the horizon for the central point of the maneuver, then turn the aircraft so that the nose is centered on this point. This point may be an actual terrain feature, a cloud, or it may be imaginary. In your early practice of coordination exercises, it is well to align the aircraft with a road or another prominent terrain reference. If you do this, you can use the ground reference to maintain your orientation. Of course, if you look around enough, this will not be necessary because you can maintain your orientation just as well from other references. After you have selected the central point, select two

more points on the horizon approximately 20° either side of the nose. These two points are the limits for the turns. Now execute level medium-banked turns from one point to the other as you check your orientation. Since the maneuver is started from the central point, the first turn is only 20° of turn. This may be either a left or right turn. All other turns are executed through 40° of turn except the last one back to the central point.

Before starting the maneuver look around to clear the area thoroughly and to recheck the 20° point toward which you are going to turn. Then begin the turn by simultaneously blending rudder and aileron pressures in that direction. As the angle of bank increases, blend in back pressure to maintain a constant altitude. When the medium bank has been established, neutralize the aileron and rudder pressures smoothly and hold the angle of bank constant. As you approach the 20° point, start the roll-out so that the wings will become level just as the nose reaches the point. Continue the roll to establish a medium-banked turn in the opposite direction. This is a critical point in the maneuver because you must look around to clear the area before you enter the turn in the opposite direction, and also, you must vary the back pressure to maintain a constant altitude. You will remember that during roll-out from a turn you release the back pressure smoothly because centrifugal force and the loss of vertical lift is gradually being removed as the wings approach level. As the roll continues beyond the wings-level attitude, back pressure must be reapplied to maintain a constant altitude.

Continue making medium-banked turns from one 20° point through the central point to the other 20° point. Keep the central point in mind at all times to maintain your orientation. Keep the rate of roll constant as you roll from one medium bank into the other. The coordination exercise may be practiced as long as you desire.

Although the coordination maneuver is usually practiced from level flight, it may be practiced in other attitudes as well. As your proficiency increases your instructor may have you vary the maneuver to give you practice in some other particular attitude of flight, such as a climb or a descent. The angle of bank may be varied from a shallow to a steep turn. The amount of turn may be varied but should be equidistant from a central point. If your coordination needs improvement in any attitude of flight, your instructor will change the coordination exercise to give you practice in that particular attitude.

As you practice this exercise, do everything in terms of "constants." During changes of bank attitude, roll at a constant rate. While in the turn, maintain a constant angle of bank and thereby keep the nose of the aircraft moving at a constant rate. Throughout the maneuver maintain a constant altitude unless it is being practiced in a climb or descent. In these cases, maintain a constant pitch attitude.

CLIMBS AND CLIMBING TURNS

Before practicing these maneuvers, you should have received instruction and practice in straight-and-level flight, level turns, and confidence maneuvers. You should have a fair degree of proficiency in control touch, coordination, and muscular sensitivity. You should also have sufficient understanding of flight instrument indications to establish and maintain a desired attitude by a quick reference to these instruments combined with outside references.

Straight climbs and climbing turns are executed to gain altitude in a safe, orderly manner. The flight procedures for both straight climbs and climbing turns are the same. The only difference in these maneuvers is that the climbing turn utilizes a shallow-banked turn and minor additions to the cross-check.

A straight climb after takeoff is explained in Chapter 7; see After Becoming Airborne.

General Information

A normal climb is a climb made at an angle or attitude and airspeed which, when maintained, will give the best gain in altitude with the climb power setting of 96% rpm. The

indicated airspeed should be gradually decreased 2 knots per thousand feet (10k per 5000′) beginning at 200 knots at sea level. For example, your best climb speed at 15,000 feet would be 170 knots. This is called a "tech order climb" because it is the technique prescribed in T. O. 1T–37B–1, based on flight test.

As the aircraft enters the climb, the angle of attack is momentarily increased. The resulting increase in total lift inclines the flight path upwards. The angle of attack and total lift then stabilize and are essentially the same as in level flight at the same airspeed. The effect of gravity has a component acting opposite to the flight path due to the increased inclination of the airfoil. The excess thrust available for climb overcomes this force and provides the energy required for the climb.

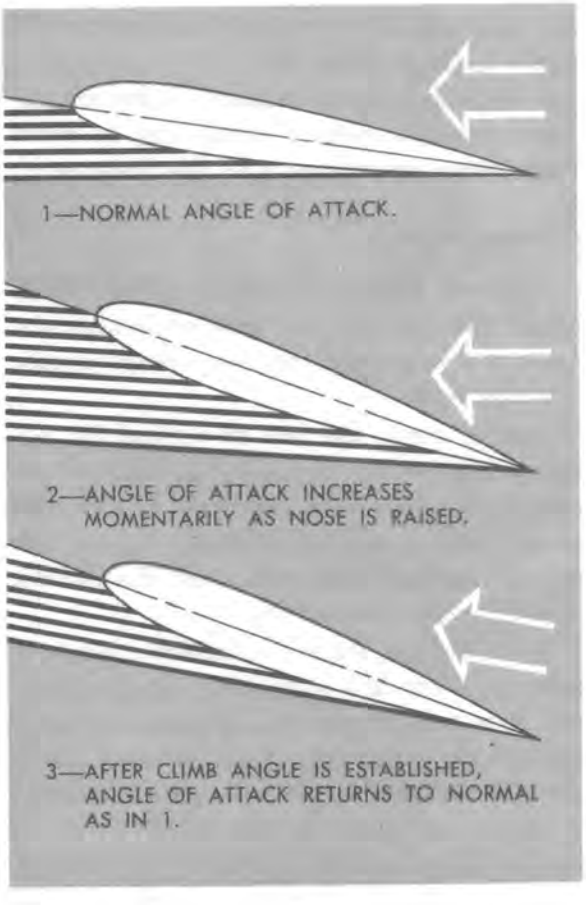


FIGURE 8–7 *After the Climb is Established, the Angle of Attack will Stabilize*

As the climb is started from cruising airspeed, the indicated airspeed gradually diminishes to the tech order airspeed requirement for the altitude. This change in airspeed is gradual, rather than immediate, because of the momentum of the aircraft and the added power for climb. Continue to climb at the tech order airspeed.

The thrust which will maintain straight-and-level flight at a given airspeed is not sufficient to maintain the same airspeed in a climb; climbing flight at any selected airspeed requires more power than straight-and-level flight at the same airspeed.

Trim is an important consideration during a climb. When you have established the the climbing attitude, trim the aircraft to relieve all pressures from the controls. Trim should be a repeated process throughout the climb and level-off. When adjustments are made in the flight attitude and/or in power, the aircraft must be retrimmed, but in the early part of your flight training do not trim the aircraft while it is turning. If you trim while in a turn, you will experience different pressures during the roll-out and find it necessary to retrim when the wings become level.

Straight-Ahead Climbs

To establish a straight climb from level flight, advance the throttle to 96%. At the same time, you must maintain a constant heading with the wings level, and raise the nose to a climbing attitude. A constant heading can be maintained by reference to section lines or other outside references and by reference to the Directional Indicator. A wings-level attitude should be maintained by outside references and Attitude Indicator.

The climbing attitude at different altitudes will be shown to you by your instructor, and he will point out the outside references and indications of the Attitude Indicator which can be used to maintain it. The wing tips should be equidistant from the horizon and a

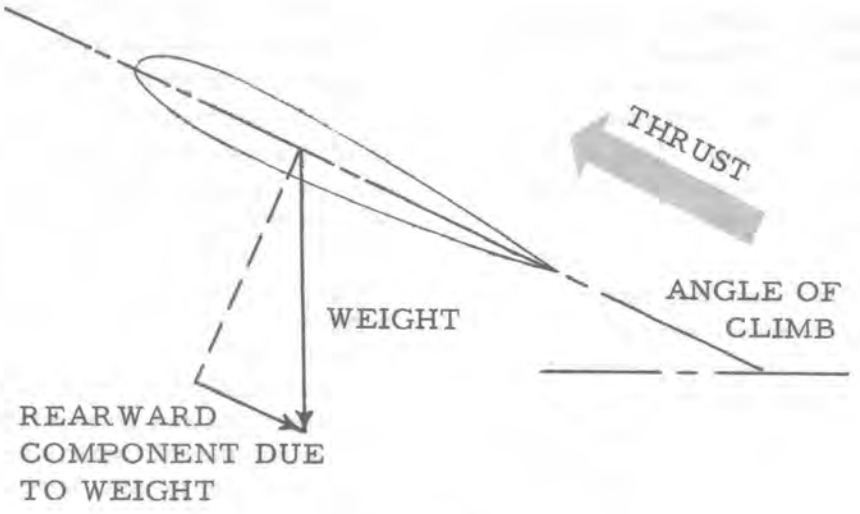


FIGURE 8-8

wings-level attitude should be indicated on the Attitude Indicator.

As the climb is established, back pressure must be used to keep the pitch attitude constant. When the airspeed decreases to the desired reading, the amount of back-stick pressure to hold the desired airspeed will become constant. Elevator trim must be used to compensate for this so that the attitude will be maintained without holding pressure on the stick.

After you have attained the desired flight attitude and airspeed, continue to look around. Although your outside and instrument references are different than in straight-and-level flight, maintain a constant cross-check of them just as you did while flying straight-and-level.

The desired climb attitude will result in a given rate of climb which will be indicated on the Vertical Velocity Indicator. Note the vertical rate and refer to the Attitude Indicator and the Vertical Velocity Indicator to assist you in maintaining this rate and the proper climbing attitude. Remember that the vertical velocity will gradually decrease with any substantial increase in altitude. All pitch changes should be made by outside references and the Attitude Indicator. Small pitch changes will not be indicated immediately on the Airspeed Indicator due to the momentum of the aircraft. Since the initial movement of the Vertical Velocity Indicator is instantaneous, a need for a pitch change can be noted immediately by reference to this instrument.

Climbing Turns

Since a prolonged straight-ahead climb might take you into the path of another aircraft, it is important that you always execute climbing turns.

During turns, the loss of vertical lift becomes greater as the angle of bank is increased, so shallow-banked turns will be used to maintain a good rate of climb. If a medium or steep-banked turn were used, the aircraft would not climb as rapidly.

There are two ways to establish a climbing turn. You can first establish a straight climb and then turn, or you can establish the pitch and bank attitudes simultaneously from straight-and-level flight. Since the first method is the easiest, your instructor will have you practice it in the early part of your training. After you have attained a degree of proficiency in this method, he will have you use the second method exclusively. This second

method is preferred because you can clear the area as you establish the climb.

Climbing Turns from Straight Climbs

To establish a climb turn from a straight climb, simply maintain a constant climbing attitude and roll smoothly into a shallow-banked turn just as you would from straight-and-level flight. The outside and instrument references for the angle of bank are variations of those used for the level turn.

To make precision turns, use a road or section line for a reference and turn perpendicular to or parallel with this line. Reference to the Directional Indicator will assist in making precision turns. In the absence of section lines, you may make 90° precision turns by selecting a point directly off one wing tip and turning to that point. This is a good method because you will automatically clear the area in the direction of the turn when you select the 90° point.

Making precision 90° climbing turns as much as possible, though clouds and other aircraft may at times prevent this. 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.

Climbing Turns from Straight-and-Level Flight

To establish a climbing turn from straight-and-level flight, use essentially the same procedure used to establish a straight climb, but as the nose rises, coordinate control pressures so that the bank will be established simultaneously. If the climbing turn is perfectly established, the desired pitch and bank attitudes will be attained at exactly the same time. Since this does not always occur, hold the one attained and then effect the other. Trim the aircraft as the turn is established. Remember that if the aircraft is trimmed in the turn, it will provide increased elevator displacement to compensate for loss of lift factors not associated with straight climbs. When you roll out of the turn you will have to retrim.

Things to Remember

Fly in terms of constants. Roll in and out of turns at the same smooth constant rate. Maintain a constant pitch attitude and keep the aircraft nose moving along the horizon at a constant rate throughout the turn. Make precision, shallow-banked turns.

Hold a constant angle of bank with whatever aileron pressure is necessary. It is impossible to say whether the angle of bank will tend to increase or decrease. This depends on the rigging of the aircraft and the factors affecting the turn.

Early in training, hesitate after each climbing turn to check attitude, airspeed, and power-setting, and clear the area for the next maneuver. Always sit relaxed in the aircraft so that you can feel the control pressures and maintain a constant cross-check of the outside and instrument references.

Level-Off from Climbs

To stop your climb at a selected altitude and establish straight-and-level flight, use your Altimeter to start the level-off at a distance below the desired level-off altitude which is approximately 10% of the vertical velocity reading. For example: If you are climbing at a rate of 2000 feet per minute, start the level-off 200 feet below the desired altitude. At this lead point, start to level the wings and lower the nose to the level-flight attitude. Lower the nose gradually, because a loss of altitude will result if you decrease the nose-high angle to the level-flight attitude without allowing the airspeed to increase proportionally. As the nose is lowered and the wings leveled, trim the aircraft. Reference to the Attitude Indicator and Vertical Velocity Indicator will assist you in maintaining the proper altitude. Refer to the Attitude Indicator for the proper wings-level attitude and the Directional Indicator for proper heading.

When the airspeed reaches 10 knots above climb speed, reduce the throttles to 90% and retrim the aircraft. Trimming is a continuous process from the time you lower the nose until the airspeed increases to cruising speed.

After proficiency has been attained in this maneuver, the level-off from a climbing turn may be accomplished in any one of three ways: (1) stop the turn—then level-off, (2) level-off—then stop the turn, or (3) stop the turn and level-off simultaneously.

DESCENTS

A descent is a maneuver in which the aircraft loses altitude while in a controlled attitude and will be practiced at a controlled rate. The descending maneuver that will be practiced for proficiency in your flight training is the power let-down. Later you will be given dives as part of aerobatics and maximum-performance maneuvers. Before going into the study of this maneuver, you must have a knowledge of how the forces acting on the aircraft affect its performance.

As in entering climbs, the forces acting on the aircraft go through definite changes when a descent is entered. When the descent is entered without a reduction in power the angle of attack is reduced and, as a result, the lift of the airfoil is less. This reduction in lift is momentary because after the flight path changes the same thrust at a reduced angle of attack causes an increase of airspeed and this begins to generate more lift. At first, downward acceleration is caused by the lift becoming less than the weight of the aircraft as the angle of attack is reduced. This unbalanced condition of lift and weight causes the aircraft to follow a descending flight path. As the flight path changes to a descent and the airspeed (and consequently lift) increases, the lift again equals the weight and the downward acceleration ceases, but a constant rate of descent at a constant (increased) airspeed remains. Lift and weight are equal as in level flight and Newton's laws are satisfied—that equal and opposite forces produce no acceleration but may permit a constant velocity (in this case at a downward angle). You may ask why the airspeed increased. A study of your *Principles of Flight* text will explain this. One of the reasons is that induced drag is reduced as the angle of attack becomes smaller. The overall effect is that of increased net forces in the direction of flight which in turn causes the increase in airspeed associated with descents at the power used in level flight.

(the power must be reduced as the descent is entered. In dives,)

For descents at the same or lower airspeed than used in straight-and-level flight, the power is left constant and the pitch attitude is adjusted to attain the desired airspeed.

POWER LETDOWN

The power letdown is primarily used to descend to traffic altitude after upper airwork has been completed. Plan the letdown so that you will be in a position to enter the 45° entry leg of the traffic pattern.

To enter a power letdown, simultaneously lower the nose and reduce the power to 65%. This is called a power letdown to distinguish it from a gliding letdown in which idle power (38%) is used. The speed brake may be extended in a power letdown. As the letdown is initiated, start a turn in order to clear the area. Never descend straight ahead. Do not exceed a 60° bank below 6000′ above the terrain.

The airspeed used in the power letdown will be 200 to 250 knots. However, this higher speed range is not to be interpreted as permitting erratic or inconsistent pitch attitudes throughout the letdown. It is merely to allow the pilot to perform the most desirable and expeditious letdown for the given condition. Make pitch adjustments smoothly by referring to both outside and instrument references.

Make shallow, medium, or steep-banked turns in accordance with your plan to reach your desired position and altitudes. Your instructor will demonstrate the proper letdown attitude.

A given power setting and airspeed will result in a specific rate of descent. Reference to the Attitude Indicator and Vertical Velocity Indicator will assist you in maintaining the proper attitude and airspeed. Outside and instrument bank references in descending turns are variations of those used in level flight turns.

LEVEL–OFF FROM A POWER LETDOWN

To accomplish the level-off, you may: (1) stop the turn, then level-off; (2) level-off, then stop the turn; or (3) stop the turn and level-off simultaneously. Begin the level-off so as to lead the desired level-off altitude by approximately 10% of the indicated vertical velocity in order that your descent will be stopped exactly at the desired altitude. Advance the throttles smoothly to the desired RPM, and simultaneously retract the speed brake if extended. As you approach the level-off altitude gradually bring the nose of the aircraft to the level-flight attitude and trim the aircraft. To level-off at an airspeed lower than descending airspeed, speed brake retraction may be delayed until approaching the desired airspeed.

CLEARING THE AREA

There are two general methods of clearing the area. The particular method to be used will depend upon the maneuver, the configuration of the aircraft, and many other flight planning factors.

The approved methods are:

1. Perform at least two fairly steep bank turns in opposite directions at any desired amount of steep bank and hold each long enough to scan the area. These may be performed fairly rapidly and still permit the pilot to clear below, above and all around.

2. Make one or more precision turns utilizing at least a medium bank. At least 90° of turn will be considered the *minimum* when clearing in this manner. For gear-down maneuvers, the clearing turn will normally be a 180° turn simulating the pitch-out for landing.

CHAPTER 9

STALL MANEUVERS AND SLOW FLIGHT

Stall maneuvers and slow flight will enable you to recognize attitudes and characteristics leading to unsafe flight conditions. A thorough knowledge of these maneuvers will develop proper techniques for coping with extreme flight attitudes when they occur. This knowledge will develop confidence in your ability as a pilot and trust in your aircraft.

THEORY OF STALLS

An aircraft will stall when the smooth air flow over the wing surfaces is disrupted sufficiently to destroy effective lift. When an aircraft stalls completely, it becomes essentially a free-falling body and is no longer flying. In a partial stall, the controls are partially effective.

An aircraft will stall any time its critical angle of attack is exceeded. When the airspeed is extremely low or the load conditions are great enough and additional lift is needed, the angle of attack may be increased beyond the critical (stalling) angle. This will cause the smooth airflow to be disrupted, the lift to decrease rapidly, and the aircraft to stall. With these thoughts in mind, remember that AN AIRCRAFT CAN STALL AT ANY AIRSPEED, IN ANY ATTITUDE, OR AT ANY POWER SETTING if you demand with elevators a sufficiently large and drastic increase in the angle of attack with the relative wind.

To become a proficient pilot, you must recognize the flight conditions that are conducive to stalls and know how to apply the necessary corrective action. You will be taught to recognize an approaching stall by sight and feel.

Sight. You can see the abnormal nose-high attitude or the rapid movement of the nose in excessive back-pressure turns under near-steady flight conditions or conditions of moderate attitude change.

Feel. 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 forcing you into the seat as well as the excessive pressure you are applying to the controls.

When an aircraft stalls the three control surfaces lose some, if not all, of their effectiveness. It is important that you know which control surface loses its effectiveness first. There is a definite order in which this occurs: *ailerons, elevators* and *rudder.* The order in which they regain their effectiveness is just the reverse: rudder, elevators and ailerons. Your instructor will demonstrate the loss and recovery of control effectiveness prior to concentrated stall practice.

Stall Warnings

A stall warning is an indication you receive that the aircraft is approaching a stalled condition. Since you are not provided with an instrument to tell you when this occurs, this recognition must be made through one or both of the two senses—sight and feel. The use of these senses in recognizing a stall has been explained briefly.

The T–37 has proved itself to be a very stable aircraft. Stalls are characterized by buffeting, exceptionally good lateral control, and rapid recovery. No uncontrollable rolling

tendencies occur. Elevator control is very good throughout the stall. However, it is important that you understand the techniques involved in recognizing an approaching-stall condition. This knowledge will be invaluable in performing the stall maneuvers and will ultimately make you a better and safer pilot.

The stall characteristics of the T–37, as in all types of aircraft, will differ slightly in the power-on and power-off conditions of flight. The technique of recognizing an approaching stall by the sight and feel method requires more concentration in the power-on maneuvers because there is a lack of noticeable aircraft "buffeting" (trembling, shaking, or vibrating sensation). Buffeting is a positive indication of an impending stall. However, since this pronounced stall warning does not always occur, you cannot depend solely on it, but must rely on other indications especially in power-on maneuvers.

For example, in the power-on stall series you can recognize the approaching stall by the high pitch attitude and the "loose" feeling of the stick. Either one of these should tell you that your aircraft is being flown into a stalling condition, even though there is a complete absence of aircraft buffeting. This also holds true in a high-speed stall condition. You can see the rapid movement of the nose, recognize the heavy seat pressures, and feel the excessive pressure that you are applying to the stick. Any of these are indications of an approaching stall.

The factors that affect the stalling characteristics of your aircraft are: balance (load); bank (wing loading); pitch (critical stall angle); coordination (abrupt control movement); drag (use of gear or flaps); and power. Each of these will be explained thoroughly in both academic training and on the flight line and are of utmost importance. Learn how to identify each and what should be done to effect the proper correction. Remember, a stall can occur at any airspeed, in any attitude, or at any power setting, depending on the combination of factors affecting the aircraft.

There are many attitudes and conditions of flight in which you will not experience buffeting prior to a stall. However, it is very unlikely that you could place the T–37 aircraft in an attitude or condition of flight where at least one of the two senses would not warn you of the impending stall. Knowing this, you should understand the necessity for developing the technique of sight and feel, rather than depending solely on a mechanical means, such as the airspeed indicator, to warn you of an approaching stall.

Introductory Stall Recovery Information

Two stall-recovery expressions commonly used throughout the remainder of this manual must be more fully explained. A better understanding of them will prevent any misconception and allow the instructor to communicate with you more effectively. It may also help you to recognize points for improvement in your stall recovery technique.

1. "Advance the throttle smoothly to 100% rpm." Correct use of power (thrust) will compensate for small errors in judgment. Since the throttles are your only direct control over thrust, it is important that you use them correctly. During stall recoveries, the throttles should be advanced smoothly to 100% rpm.

2. "Return the nose to the straight-and-level flight attitude." *After* the stall recovery, the aircraft should be returned to normal cruising flight. Since this is not accomplished automatically by placing the nose in the cruising attitude, further explanation must be given to this expression.

If an altitude is to be held constant, there can be only one pitch attitude for a specific airspeed, assuming all other factors remain the same (power setting, etc.). If the nose is placed in cruise attitude when the power is less than that for normal cruising, altitude will be lost. The lift then created by the airflow over the wings will be insufficient to maintain altitude and the pitch attitude must be increased to give a sufficient angle of attack to create enough lift for level flight. To prevent a loss of altitude immediately after a

completed stall recovery, the nose must be placed in an attitude considerably higher than cruising. As the airspeed increases, the pitch attitude should be lowered accordingly.

In the initial phase of your training in the power-on and traffic pattern stall series, your instructor will require that you use a recovery attitude of slightly below normal cruising speed attitude for straight-and-level flight. He will demonstrate that the pitch attitude must be lower to effect a smooth recovery from a fully stalled condition than if the recovery were made at the first indication of a stall. This delayed recovery technique will result in a greater loss of altitude than is necessary. Later on you will be required to recover with a minimum loss of altitude.

POWER–ON STALLS

The power-on stalls are proficiency maneuvers designed to show you what will happen when the aircraft climbs too steeply in either a straight-ahead or turning attitude. This condition would be undesirable during the takeoff climb or traffic exit. You must be thoroughly proficient in executing safe recoveries; therefore, it is important that you practice these stall maneuvers.

Power-on stalls will be executed in a series of three: one straight-ahead, one to the left, and one to the right. Although the straight-ahead stall is usually executed first, the sequence is not important.

Adjust the power to 85% and clear the area. It will not be necessary to clear before each individual stall maneuver unless you pause too long between them and fly out of the area that you have previously cleared.

Straight-Ahead Stall

To execute the straight-ahead power-on stall, raise the nose to approximately a 40° pitch attitude. Your instructor will point out the outside references to use. He will also show you how to maintain this pitch attitude by reference to the Attitude Indicator. Control the direction with rudder and keep the wings level by use of aileron. Hold this attitude constant until the stall occurs.

Recover by releasing all back pressure and smoothly advancing the throttles to 100% rpm. Apply rudder pressure as necessary to keep the nose of the aircraft from yawing. Apply aileron pressure as necessary to keep the wings level.

Allow the nose to lower until you feel positive pressures on the controls which indicate that the aircraft has regained flying speed, then return the aircraft to the straight-and-level flight attitude, stop the Altimeter and retard the throttles to 85% rpm.

Turning Stall

The turning stalls are executed in much the same manner. The outside and instrument pitch references used in the straight-ahead stall can be used in the turning stalls. You can use the same outside and instrument bank references that are used in shallow bank turns. From a straight-and-level flight attitude, simultaneously roll into a shallow-banked turn as you raise the nose to approximately a 40° pitch attitude. After this attitude has been established, hold it constant until the stall occurs. Then recover straight ahead as you did in the straight-ahead stall.

Continuity

Do not pause too long in straight-and-level flight before going into the other stalls in a series. It is unnecessary to gain cruising airspeed after each recovery. Go immediately into the next stall regardless of the airspeed. At the competition of the Power-On Stall Series, you may continue to hold altitude and perform a complete level-off procedure at a desired airspeed, or you may maintain altitude until climbing airspeed is attained, reduce power to 96% and establish a climb. If maintaining altitude is not of prime importance, you may perform a descending turn to increase the airspeed, adjusting power as required.

The Use of Aileron in Stall Recoveries

The possibility of a wing dropping during a stall and the proper corrective action require some discussion. Most modern aircraft are so constructed that the wing will stall progressively outward from the wing root to the wing tip. This is caused by building the wing in such a manner that the wing tip has less angle of incidence that the wing root. This construction is called "wash-out" and causes the tip to have a smaller angle of attack.

A stall is caused by an excessive angle of attack. The wing root will exceed the critical angle before the tip and will stall out first. The aircraft wings are constructed in this manner so that aileron control will be retained as long as possible, giving the aircraft more stable characteristics. When a stall is broken and the wings resume their lifting function, the return of lift begins at the tip and progresses back toward the root.

A complete stall is averted when a recovery is effected promptly by stick action, power and rudder. Although the aircraft is rapidly approaching a completely stalled condition, the wings provide some lift and the control surfaces will be effective. When the back pressure is released, the stall is broken. This means that the wing tips and ailerons regain lift and control immediately. When the stall is broken, the ailerons can be used to level the wings. This can be accomplished as the nose-high attitude is being decreased.

It is important that you use the rudder properly to keep the aircraft traveling straight ahead during both the entry and recovery from a stall. The primary use of the rudder in stall recoveries is to maintain direction.

If the wings were completely stalled, the use of aileron would be ineffective and aggrevate the stalled condition regardless of the finesse with which the aileron was applied. The correct recovery technique would be to initiate the proper stick action to break the stall and maintain direction with rudder until the aircraft begins "flying," then use aileron to level the wings.

Because of the feel and timing required to use the ailerons properly in stall recoveries, your instructor may not let you use them during your initial training. He may teach you to break the stall by simply releasing all back pressure and not use the ailerons to level the wings until the nose approaches the horizon. As you become more adept at stall recoveries, you will be required to use the ailerons properly whenever you make a recovery.

Effective Control Pressure During Turning Stall Maneuvers

When the aircraft is in a nose-high turning attitude, you will find that the angle of bank has a tendency to increase. This is because the airspeed is decreasing and the aircraft begins flying in a smaller and smaller circle. The outer wing has an increasingly greater relative lift than the inner wing causing an overbanking tendency.

Because of the decreasing vertical lift on both wings, the pitch attitude tends to lower.

In order to compensate for these characteristics and to maintain a constant flight attitude until the stall occurs, you will have to vary aileron pressure continually to keep the bank attitude constant. At the same time, you must constantly increase back pressure to maintain the pitch attitude. If you allow the bank to become too steep, the vertical component of lift decreases and makes it even more difficult to maintain a constant pitch attitude.

You should understand that it is necessary to increase control pressures to maintain a constant flight attitude whenever you are performing turning stalls. Do not level the wings prior to the stall. The aircraft should stall while in the specified degree of bank for the maneuver. When the aircraft stalls, recover as you did in the straight-ahead stall.

During the approach to the turning stalls, maintain a constant pitch attitude and degree of bank using whatever control pressures are necessary. Good coordination is gauged from the reaction of the aircraft and not by the position of the controls.

TRAFFIC-PATTERN STALL SERIES

You will practice traffic pattern stalls to become proficient in recognizing and recovering from stall conditions that could occur in the traffic pattern. These stalls simulate a traffic pattern and landing situation when you will be cross-checking rapidly all available outside and instrument references.

This stall series incorporates a number of procedures and techniques as well as several maneuvers. For instance, you will practice the pitchout, gear lowering procedures, simulated turn to final approach, simulated landing touchdown, go-arounds, and proper stall recoveries for different flight conditions. One very important learning objective of this series is recognition of the landing characteristics of your aircraft.

Since this stall series actually incorporates four different flight conditions, it may be thought of as a four-in-one maneuver. In order to practice each stall condition, both to the left and right, two separate series will have to be flown. Whether these will be flown within one flying period is optional.

High-Speed Stall

Establish 200 knots, using speed brake or diving as necessary. On a simulated initial approach leg as for a normal traffic pattern, adjust power to maintain 200 knots. Execute a pitchout turn (clearing the area) simultaneously reducing power to the landing gear warning tone (approximately 60% rpm) and extending speed brake. After the turn is established, steadily increase the back pressure until you recognize a stall indication. At this point, execute an immediate recovery by relaxing back pressure. Continue the turn to the 180° point, simulating a downwind leg.

Nose-High Final-Turn Stall

On the simulated downwind leg, place the landing gear handle down when airspeed is 150 knots or less. Continue to maintain altitude and make all gear-down checks (handle, indicators, light, and warning tone). Place the flap handle down when the airspeed is 135 knots or less and immediately initiate a turn to a simulated final approach, but with nose higher than normal. Establish the bank for the turn, then steadily increase bank and back pressure until you recognize a stall indication. Recover by simultaneously releasing back pressure, advancing power to 100%, retracting speed brake, and leveling the wings. Return to level flight as soon as possible. Recovery is not complete until the altimeter is stopped. Do not lose any more altitude than is necessary.

Nose-Low Final-Turn Stall

At 120 knots, reduce the power to 60%, extend the speed brake and begin a turn to a simulated final approach but with nose lower than normal. Establish the bank for the turn, then steadily increase the bank and back pressure until you recognize a stall indication. Recovery is the same as for nose-high final turn stall.

Landing Attitude Stall

Reduce power to 60%, extend speed brake and establish 100-knot simulated final approach. Simultaneously retard power to IDLE and execute a normal roundout for landing. Hold the landing attitude constant until you recognize a stall indication. Execute the recovery as in the nose-high and nose-low stall, then perform a simulated go-around at altitude.

Continuity and Variations

Clear the area while performing turning stalls, and execute additional turns between stalls if necessary to clear the area. The stall series is designed to simulate conditions that may arise in the traffic pattern, although the flight path during the series need not resemble a pattern.

After the nose-high and the nose-low turning stalls, the nose may be lowered to attain entry airspeed for the next stall.

Normally, all turning stalls in a series will be in the same direction.

When you next practice the traffic pattern stall series, make the first turning stall in the opposite direction. This will afford you practice in recovering from stalls that might occur from either right- or left-hand traffic patterns.

The traffic pattern stall series will also be practiced with flaps up and speed brake in. In this case, the spoilers and thrust attenuators will be inoperative.

DETERMINING LANDING CHARACTERISTICS OF AN UNBALANCED AIRCRAFT (CONTROLLABILITY CHECK)

Should your aircraft become unbalanced during flight, the following procedures are outlined only as a guide. THEY ARE NOT A SUBSTITUTE FOR GOOD JUDGMENT.

When you know that your aircraft is unbalanced, you should, if possible, make a straight climb to a safe altitude.

Check the aircraft controls for response and effectiveness. In the event you cannot maintain adequate control over the aircraft, you should bail out. If adequate control can be maintained, you should check the aircraft for response during the type of turns that will be necessary for the traffic pattern and landing.

After reaching a safe altitude, retard the throttles smoothly and allow the airspeed to decrease to approximately 120 KIAS. Then raise the nose of the aircraft to the landing attitude and at the first indication of a stall, recover as in the traffic pattern stall maneuvers. Never allow the aircraft to fully stall as you may lose control. All you wish to determine is that the aircraft is controllable at approach speeds.

Next, lower the landing gear in straight-and-level flight and determine the characteristics of the aircraft in a landing attitude. Repeat this procedure using flaps. By performing these procedures, you will be able to determine the correct aircraft configuration and minimum final approach airspeed. DO NOT STALL the T–37 in a badly unbalanced condition. Determine the minimum control-label airspeed, and maintain at least 20 knots above that speed until you have flown your aircraft to within one or two feet above the runway.

SECONDAY STALL

This is a form of high-speed stall and is caused by excessive elevator control. It is called a secondary stall since it occurs after a partial recovery from a preceding stall. It is caused by attempting to hasten a stall recovery when the aircraft has not regained sufficient flying speed.

This maneuver is designed to show you what will happen if you become too anxious to return to straight-and-level flight after a stall or spin recovery. It also teaches you the value of smooth back pressure at critical airspeeds, and the importance of allowing an aircraft to begin "flying" again before completing a stall recovery.

The secondary stall maneuver is usually demonstrated after a partial recovery from a power-on stall, but may be demonstrated from any other type of stall recovery. For purposes of training and standardization the power-on stall will be the preceding maneuver and the power setting will be the same. (It should be noted that the throttles will be full forward when the secondary stall is actually entered.)

Clear the area and perform a normal power-on stall maneuver. When the stall occurs initiate a recovery. Then steadily bring the stick back as if you were trying to hasten the return to straight-and-level flight. Continue to increase back pressure until the aircraft buffets. When this occurs again release the back pressure as for a normal stall recovery. When sufficient airspeed has been regained, return the aircraft to straight-and-level flight and continue the same as in completion of the power-on stall series.

SLOW FLIGHT

Slow flight will acquaint you with the characteristics of the aircraft at minimum flying speeds and illustrate the importance of smooth coordination. It simulates the control pressures and flight conditions usually encountered during the early part of a go-around procedure. Slow flight is practiced to develop your sense of "feel" and ability to use the controls correctly. This will improve your proficiency in performing maneuvers in which low airspeeds will be encountered.

Establish level-flight conditions (90%)—no specific airspeed. Clear the area by executing a 180° turn, simulating pitchout for normal landing. In straight-and-level flight, place the landing gear down when the airspeed is 150 knots or less. Maintain altitude and make all gear down checks. Lower flaps when the airspeed is 135 knots or less.

Continue to maintain altitude while the airspeed diminishes. When the airspeed has decreased sufficiently, adjust the power to the minimum which will maintain altitude and keep the aircraft just above a stalling condition. The term "just above a stalling condition" does not refer to a specific indicated airspeed because stall speed varies with weight. You may check the airspeed indicator occasionally, but you should not rely entirely upon its indication. Trim the aircraft as often as necessary throughout these changing flight conditions.

Your instructor will demonstrate straight-and-level slow flight, control effectiveness and aileron drag. At minimum flying speed, there is less airflow over the wings, and to get effective control response, the controls must be displaced further so that more surface is exposed to the relative wind. During the practice of slow flight, you will recognize the need for coordination and become aware of the large range through which the controls must be moved to obtain the desired aircraft response.

When the desired pitch attitude has been determined, crosscheck the Attitude Indicator, Altimeter, Airspeed Indicator and outside references.

The rate at which the aircraft turns is determined by the angle of bank and the airspeed. If the bank is increased, the rate of turn will increase, or, if the airspeed is increased while the bank is held constant, the rate of turn will decrease. The slower an aircraft is moving through the air, the greater the rate of turn for any given angle of bank. Your instructor will demonstrate and let you practice slow-flight turns with varying angles of bank.

Your instructor will demonstrate the results of making a level steep turn. When the aircraft is near a stall condition, an increase of wing loading in a steep turn will precipitate a stall. He will demonstrate abrupt or rough control movements at near-stalling speed which will also cause the aircraft to stall. He will demonstrate the effects of suddenly raising the flaps in a slow-flight condition. By changing the configuration of the airfoil to one with a lower critical angle of attack, the aircraft will stall. To further develop your proficiency in controlling the aircraft at low speeds, you will practice a slow-flight coordination exercise using shallow-banked turns, turning approximately 20° to each side of a central reference point.

To return the aircraft to straight-and-level flight from slow flight conditions, perform a go-around and level-off procedure.

CHAPTER 10

GROUND-TRACK MANEUVERS

Ground-track maneuvers are performed at a relatively low altitude. Drift correction is applied as needed to make good a predetermined track or path over the ground. These maneuvers are designed to accomplish a dual purpose. First, they will develop your ability to fly the aircraft almost automatically while dividing your attention among other factors, such as: planning ahead of the aircraft, orientation in relation to the ground, and flying headings to make good a desired ground track. Second, they will increase your ability to recognize the effect of drift and how to correct for it.

Since most of your flying thus far has been at higher altitudes, you may not have been aware of your proximity to the ground. These maneuvers will help you become accustomed to the apparent increase in speed near the ground, helping develop your ability to think ahead of the aircraft (plan your maneuvers for timely execution).

The ground-track maneuvers to be explained in detail are S-turns Across a Road and "8's" Along a Road. Although these maneuvers may not be demonstrated, they will be discussed in sufficient detail to assure understanding. Your instructor may devise other ground track maneuvers to fit your particular need.

The altitude for these maneuvers is 1000 feet above the terrain. Do not select an area which will take you over cities or towns.

DRIFT AND GROUND–TRACK CONTROL

Whenever any object frees itself from the ground, it can only be affected by the medium in which it is immersed. This means that a free object must be affected by the direction and speed of the medium.

Such an example is a raft crossing a river. If the river were still, you could pole or paddle to a point on the opposite shore without drifting. However, if the river were flowing swiftly, you would have to take the drift of the current into consideration and keep the raft pointed upstream as you crossed to the opposite bank. In addition to your progress across the river, you would have to attempt to move upstream at the same rate that the river was moving you downstream. You would then make good your desired path or track across the river bed from your departure to destination. Should you fail to point your raft upstream, you would drift with the current and land downstream on the opposite bank. A similar problem is encountered in aircraft.

As soon as an aircraft becomes airborne, it is free of ground friction. Externally, it is affected only by wind which is simply the movement of the air mass in which it is flying. You will notice that the aircraft does not always follow the ground in the direction that the nose is pointed. When flying down a straight road with the longitudinal axis of the aircraft aligned with the road, you may suddenly realize that the aircraft has moved away from the road without any turn having been made. This would indicate that the air mass was moving. Since the aircraft thrust is strictly forward in this body of air, its sidewise movement is caused by the movement of the air in which it is flying. Study the principle of vectors in your *Principles of Flight* text.

The correct way to prevent drift, when you are flying straight-and-level and wish to follow a selected ground track, is to turn the aircraft into the wind. This may require a

turn of only a few degrees. This causes the aircraft to fly into the wind at the same rate that the wind is moving the aircraft sideways. Since drift has now been nullified, the aircraft will make good a desired ground track. The nose of the aircraft, however, is not pointed in the direction of the ground track. This compensation for drift is known as "crabbing," because the aircraft is flying sideways in relation to the orientation of its fuselage centerline.

Consider a flight with a wind velocity of 30 knots from your left and 90 degrees to the direction of the aircraft. After one hour, the body of air in which you are flying will have moved 30 nautical miles to your right. Since the aircraft is in this body of air and moving with it, it will have drifted 30 nautical miles to the right. In relation to the air you moved forward. In relation to the ground you moved forward and 30 nautical miles to the right. This effect is known as drift and must be compensated for in order to cause the aircraft to pass over a desired ground track.

There will be times when you will want to correct for drift while in a turn. The wind will be acting on the aircraft from constantly changing angles while the aircraft is turning. The amount of bank used and the length of time you remain in any part of a turn, to make good a desired curved ground track, is governed by the wind direction and velocity. At times, the wind will be opposite to the way you are turning. At other times, in the same direction. The effect of the wind (using a constant bank and airspeed) will cause the ground track to vary from the desired circular path. In order to make good a desired ground track in a turn, you may have to increase or decrease the rate of turn. The rate of turn is governed by the angle of bank and the airspeed. With a constant airspeed, you can change the rate and radius of turn by changing the angle of bank. The greater the bank, the faster the rate of turn (shorter radius); the shallower the bank, the slower the rate of turn (longer radius).

Let us analyze the ground tracks created by performing turns with and without a wind existing. The first time this maneuver is demonstrated, you will be better able to visualize the ground track and the turns if there is no wind. Later, you will benefit more from the maneuver if it is performed with a strong wind causing noticeable drift.

Assume there is no wind. It would be simple to make arcs of 180 degrees over the ground, because the air path and projected path are identical. Approach a road from a 90 degree angle (perpendicular) and when you are over the road, roll into a turn and maintain the same angle of bank until you reverse your direction (180 degrees of turn). If the bank is steep, the turn will be fast. If the bank is shallow, the turn will be slow.

Ground

Lead the rollout so the wings become level as the aircraft reaches the road; then roll immediately into a turn in the opposite direction with the identical amount of bank. This would cause the aircraft to turn 180 degrees in the opposite direction and make exactly the same size semicircle and be back to the road just as the turn is completed. This would be an ideal situation. It would be possible only if there were no wind and if the airspeed, angle of bank, and rate of turn remained constant throughout the entire maneuver.

If you maintain a constant degree of bank with a wind perpendicular to the road, you will make a true semicircle within the air mass, but its movement (the wind) will cause your projected ground path or track to differ from a true semicircle. The greater the wind velocity, the greater the difference between the desired ground track and the actual path over the ground.

To counteract this drift, you can vary your flight path in such a manner as to nullify the drift effect of the wind and cause the ground track to be a true semicircle.

The drift effects and techniques just discussed will apply in principle to all maneuvers where a ground is maintained. You should have a thorough understanding of drift and

drift correction in straight-and-level flight and in turns.

Your instructor will show you the effects of drift and the method of drift correction while flying normal traffic. If a crosswind condition is not encountered while flying normal traffic, he may take you out of traffic and give you concentrated practice. He may set up a simulated traffic pattern with a crosswind or devise other maneuvers to fit your particular needs.

Drift correction for takeoffs and landings is further explained in Chapters 7, 12 and 13.

5–TURNS ACROSS A ROAD

An S-turn across a road is a maneuver in which the ground track of the aircraft describes semicircles of equal radii on alternate sides of a selected straight line. It consists of a series of 180° turns across this line. The straight line may be a road, fence, railroad, or section line oriented perpendicular to the wind and should be of sufficient length for several turns. This maneuver presents one of the most elementary problems in the practical application of the correction for drift in turns. It will teach you to compensate for drift, orient the flight path with ground objects, and to divide your attention.

Select a straight reference line on the ground that lies 90° to the direction of the wind; check the area to insure that no other aircraft is using the same reference line; then enter a power let-down to traffic altitude (1000 feet above terrain) on the downwind side of the road. The aircraft should now be set up for *traffic pattern airspeed (approx. 80% RPM).*

Approach the road from the downwind side, flying directly into the wind. When you are directly over the road, start a turn in either direction. Since you are flying into the wind, it slows your forward motion in relation to the ground. You will have to start the turn with a shallow bank because you are not ready to set up a fast rate of turn. This degree of bank should be that necessary to effect the arcs of a predetermined radius. Start a turn, to fly the aircraft away from the road at a given rate of departure. Visualize the track and the approximate place on the road where the 180-degree turn should be completed. Fly the aircraft to follow this visualized ground track.

To accomplish this, you will find it necessary to keep the bank fairly shallow until the aircraft has turned approximately 90 degrees. It is now flying almost parallel to the road and perpendicular to the wind. The wind is now affecting the aircraft directly from the side, drifting it toward the road. Since the turn is continuing, the rate of closure with the road will be more rapid than the rate of departure. Consequently, the turn must be accelerated so that the aircraft turns 180 degrees as it reaches the road. This is accomplished by continually increasing the angle of bank to medium and steadily to steep in the remainder of the turn. Lead the rollout so the aircraft is in straight-and-level flight just over the road, with the longitudinal axis perpendicular to the road.

Immediately roll into a turn in the opposite direction. With the aircraft flying downwind, the rate of departure from the road is rapid. You must roll into a bank at least as steep as that used in the last part of the first semicircle. This bank prevents drifting too far from the road and keeps this semicircle the same size as on the upwind side. Hold a fairly steep bank until the aircraft has again turned almost 90 degrees, visualizing the proposed ground track as you did in the upwind semicircle.

When the aircraft has turned almost 90°, the wind will be affecting it from the side and will hold the aircraft away from the road. This means that the rate of closure will be slower than the rate of departure. If the bank were maintained, the aircraft would turn too fast for the rate of closure, and would be prematurely turned perpendicular to the road. Because of the slower rate of closure, it will be necessary to reduce the bank to medium and then to shallow during the remainder of the second semicircle, in order to slow the rate of turn and make it correct for the rate of closure.

Lead the rollout so that the aircraft is back in straight-and-level flight as it reaches the road. Maintain a constant altitude and airspeed throughout the maneuver. The bank should be changing constantly to effect a true semicircle ground track. Composite references should be utilized throughout the maneuver to insure proper aircraft control.

"8's" ALONG A ROAD

An "8" along a road is a maneuver in which the ground track of the aircraft describes circles of equal radii on each side of a straight line on the ground. This ground track resembles a figure "8."

An "8" along a road teaches you to solve problems of turning in relation to the ground. It is more advanced than the S-turn and requires a high degree of orientation and division of attention. In this maneuver you will be required to cope with the problems of drift through 360° of turn. The wind, in relation to the ground, acts on the aircraft from all directions.

The "8" along a road, discussed here, will be practiced along a road that is perpendicular to the wind. Since we have already discussed in detail the effects of wind in the S-turn maneuver, references will be made to that maneuver without repeating the principles already explained. Select a road, section line, or other straight ground reference that lies perpendicular to the wind. Enter a power let down to traffic altitude (1000 feet above the terrain) and set up the aircraft for traffic pattern airspeed (approx. 80% RPM).

Maneuver the aircraft parallel to and directly above the road. Since the wind is from the side, it will necessitate a "crabbing" attitude in order to stay above the road.

The first turn should be started into the wind. A moderately steep bank should be used initially to cause the aircraft to leave the road with a given rate of departure. You are turning into the wind and it is attempting to hold the aircraft back in relation to the ground. Continue this turn for approximately 90°, visualizing the proposed circle you intend to make good over the ground. When you have turned 90°, you should shallow the bank to slow the rate of turn. At this point you are in the same relative position that you were at the beginning of the S-turn, while flying into the wind. Remember, you had to make a shallow bank to adjust the rate of turn to comply with the rate of departure. Use the same technique here as in the S-turn to keep the aircraft turning in a circular pattern.

Hold the shallow bank until the aircraft has turned almost 180°. You should now be flying almost parallel to the road which you can now see off your wing tip with the wind acting directly on the opposite side of the aircraft. At this point, visualize the remaining 180° of turn and try to fly a ground track that will return the aircraft to the same place over the road from which it started.

Since the turn is being continued, the wind will now be attempting to push the aircraft toward the road, causing the rate of closure to increase. You must increase the rate of turn since the rate of closure is increasing. To accomplish this, increase the bank to medium and steadily to steep in this third 90° of turn. When this has been completed, you will have to shallow the bank from steep to about medium in the last 90° of turn to fly the aircraft back to the starting point. In this last 90°, vary the bank to make up for any errors in turning rates. Lead the rollout to cause the aircraft to be straight-and-level over the starting point, with enough drift correction to hold the aircraft over the road. Roll immediately into a downwind turn. You are now beginning the downwind circle. The wind will push the aircraft away from the road and a shallow bank will suffice to cause the aircraft to leave the road with the desired rate of departure. Start the turn with a shallow bank and increase it quickly medium and then to steep by the time you have turned 90°. Prior to reaching the 180° point, the bank should be reduced to about medium; thence, gradually to shallow to complete the turn. Both the upwind and downwind circles should be the same size.

In the third 90° of the downwind turn, the wind attempts to hold the aircraft away from the road. This causes the rate of closure to be slow; consequently, the rate of turn should be slower to cause the aircraft to follow the proposed ground track.

In the last 90° of turn, adjust the rate of turn to bring the aircraft over the starting point on the road. Roll out with a wind correction so that the aircraft is straight-and-level and following a ground track parallel to and over the road.

Continue "8's" along the road. Visualize the intended ground track and then vary the bank and rate of turn to cause the aircraft to follow this track. To insure a true circular ground track, the bank should never be constant. A constant altitude and airspeed should be maintained throughout the maneuver. Composite references should be used throughout the maneuver to insure proper aircraft control.

CHAPTER 11

STANDARD TRAFFIC PATTERNS

When several aircraft are operating from the same field, it is necessary that each conform to a standardized traffic pattern and procedure. Collisions would be inevitable unless such safety measures were observed. It is essential that you become thoroughly familiar with the details of the traffic patterns established by the fields from which you fly.

To give you practice in takeoffs, landings, and traffic patterns, you will use both the auxiliary field and the home field in a program of concentrated training with other students. Much of your traffic pattern work may be practiced at the auxiliary fields, especially during the dual phase of training.

The ultimate goal of your flight instructor is to train you to become a highly proficient military pilot, capable of analyzing any situation and making correct decisions. During the early part of your traffic-pattern training, you may erroneously feel that you are being developed into a mechanical pilot. This feeling may be prevalent since your instructor will use phrases such as "Put the entry leg over the highway," "Start the pitch when even with the swimming pool," "Start the 180° turn to final when over the stadium." It is important that you realize that your instructor is using these references as instructional aids. Any time he gives you a ground reference, he means that it is appropriate for the existing conditions. He does not mean that these references will be applicable for all landing situations. You should use these instructional aids to develop judgment. The highway, swimming pool, and stadium will not move with you to your next station, so you must be able to estimate distance and glide ratio without aids by the judgment you will develop in repeatedly setting up proper distance relationships with the use of aids.

LOCAL TRAFFIC AND THE STANDARD OVERHEAD LANDING PATTERN

The 360° standard overhead pattern is used to insure safe and proper traffic procedures so as to handle a maximum number of aircraft with minimum congestion.

This type pattern is used for many of the operational aircraft that you will be assigned to fly after becoming a rated pilot and will be used throughout your pilot training.

Before Traffic Entry

When returning to the home field from the auxiliary field, you should, before entering traffic, turn the radio to the proper home field channel and adjust the volume to a comfortable level. Do not ask for landing instructions unless it is necessary. The landing direction can usually be determined by watching other aircraft or by noting the position of the runway control units. If it is necessary to fly over the field to determine the direction of traffic you may do so, but you must maintain at least 1000 feet above pattern altitude or higher as directed locally.

Traffic-pattern altitude will be reached before turning onto the entry leg. Make frequent clearing turns, usually in the direction of traffic, while descending to enter traffic and avoid letdowns into a congested area. Accomplish the applicable checks outlined in the current Aircrew Checklist before reaching the traffic-entry leg.

45° Entry Leg

The initial approach portion of the traffic pattern will always be entered from a 45° angle, called the 45° entry leg. On this leg of the traffic pattern, as well as all others, watch for drift and make necessary correction so that the desired 45° track along the ground will be maintained. Refer to the Directional Indicator to assist in correcting for known wind and maintaining the ground track. Adjust your spacing from other aircraft so that they will not interfere with your pattern. If you are too close to an aircraft on the entry or initial approach, you are going to be too close on the final approach. The 45° entry leg should be aligned so that the initial approach is intersected at a 45° angle at least one (1) mile from the end of the runway. The altitude for this leg is 1000 feet above the terrain and the airspeed is 200 knots (approximately 80% rpm). The speed brake may be used momentarily to dissipate excess airspeed if necessary after letting down.

Initial Approach

The initial approach is made upwind 1000 feet above the terrain in the same direction as the landing runway. It begins at any point one nautical mile or more from the runway and terminates at the pitch point over the landing end of the runway. The turn from the entry to the initial approach should be at least a medium-banked turn with the rollout executed so that the ground track will be aligned with the center of the runway. The turn onto the initial approach will be in the same direction as the traffic pattern. For example, if a left-hand traffic pattern is in use, the turn onto the initial approach will be to the left. Maintain 1000 feet above the terrain and an airspeed of 200 knots on this leg of the pattern.

The Pitchout, Downwind Leg and Final Turn

Over the approach end of the runway, simultaneously extend the speed brake and roll smoothly into a bank of approximately 60°, retarding throttles until the landing gear warning tone sounds (approximately 60% rpm). Continue a level 180° turn to the downwind leg and roll the wings level in preparation for gear and flap lowering. Do not vary the angle of bank during the 180° turn to downwind leg in an attempt to compensate for wind conditions. The point where the "pitchout" is started should be varied to compensate for high winds. A headwind will increase ground speed on the downwind leg, so the pitchout turn should be started farther down the runway than for a calm wind. A tailwind has the reverse effect, so the pitchout should be started before reaching the runway.

If a cross-wind component exists, roll out on the downwind leg with a cross-wind correction established as necessary. When the airspeed is 150 knots or below on the downwind leg, lower the landing gear. When lowering the landing gear, grasp the handle and place it firmly in the down position. Do not slap the gear handle down. Continue to maintain altitude and make all gear-down checks (handle, indicators, light, warning horn, hydraulic pressure). Use power as necessary to maintain altitude and a minimum airspeed of 120 knots on downwind leg. Added power will be an almost certain requirement if it is necessary to extend the downwind leg before starting the final turn.

After the gear is down and checked and you are in position to start the final turn, the wing-flap handle will be placed in the down position at an airspeed of 135 knots or less just prior to the descending 180° turn to final approach. When placing the flap handle down, hold your hand on the handle as you start your turn. This precaution is necessary in the event of a split-flap condition which you would recognize immediately by a tendency of the aircraft to roll. In this case you would reverse the flaps immediately. After starting your turn, cross-check your flap indicator. If flaps have started down and aileron forces are normal, return your left hand from the flap lever to the throttles and proceed with your final turn.

During the 180° turn to final approach, the bank may be varied up to a maximum of 45°

in order to roll out in line with the runway. Although this is a continuous 180° final turn, there has developed a confusion of nomenclature in which this turn is sometimes erroneously referred to as the "base turn." If you hear this incorrect expression, just remember it is merely another name for the final turn. Gradually decrease the airspeed to 110 knots during the final turn, using additional power if required to adjust rate of descent and maintain a circular flight path. Recheck the gear and flaps down and make the radio call as soon as possible after starting the final turn. The call is as follows: "694 gear check." If it is apparent that you are not well-aligned or that you are too low or are going to overshoot the final approach, apply power and go around. Your rollout on final approach should be at least 300 feet above the ground and 2,500 feet (about ½ mile) from the runway.

The Final Approach

The final approach begins when the wings are level after final turn. The roll-out on the final approach will be completed at least 300 feet above the terrain and at least 2,500 feet from the approach end of the runway. The longitudinal axis of the aircraft should be aligned with an imaginary line that runs the entire length of the runway so that any drift will be recognized immediately. Since the velocity of the wind may vary as the aircraft continues down the final approach, the longitudinal axis should be kept aligned with the runway throughout the approach and landing. Unless the runway on which you are landing is very narrow, you should plan to land on one side in order that you may pass the aircraft ahead in the event he blows a tire or suddenly aborts his takeoff. Also, this technique is usually helpful in avoiding the "jet wash" of other aircraft so as not to interfere with your landing.

The proper way to correct for a crosswind on the final approach, roundout, and throughout the after-landing roll will be explained fully in Chapter 12 under the section of CROSSWIND LANDINGS. At this time, we will consider only an approach where the wind is calm or straight down the runway.

Before going into the flying technique used on the final approach, it is important that you understand what is meant by the *glide ratio* of the aircraft and how it is affected by airspeed. The lift and drag created by the use of flaps must also be considered.

Glide Ratio

The glide ratio of an aircraft is the horizontal distance the aircraft will travel in relation to the altitude it loses. For instance, if an aircraft travels 13,000 feet forward while descending 1,000 feet, its glide ratio is said to be 13 to 1. Technically, it is practically impossible to know exactly what the glide ratio of your aircraft will be because so many things affect it; however, it is very important that you be familiar with how far the aircraft will glide under certain conditions.

The glide ratio of the aircraft is affected by all four fundamental forces that act on the aircraft (lift, drag, thrust, and weight) as well as changes in wing-loading (e.g. centrifugal force factor) during changes in attitude. If all factors affecting the aircraft are constant, the glide ratio will be constant. Therefore, in order to judge the gliding distance of your aircraft, you must be aware of the effect of these forces. Although the effect of wind will not be covered thoroughly in this section, it is a very prominent force affecting the gliding distance of the aircraft relative to its movement over the ground. This is easily understood because you know that you would not glide as far into a headwind as you would with a tailwind.

From your study of aerodynamics, you know that the weight (due to gravity) of the aircraft changes only with fuel consumption. Thus, for all practical purposes, we can consider the weight of the T–37 constant during the final approach. You also know that the thrust of the aircraft is dependent on the power setting. During a power-off approach to a landing, the throttle is closed so that thrust is small but constant. Likewise, during a power-on ap-

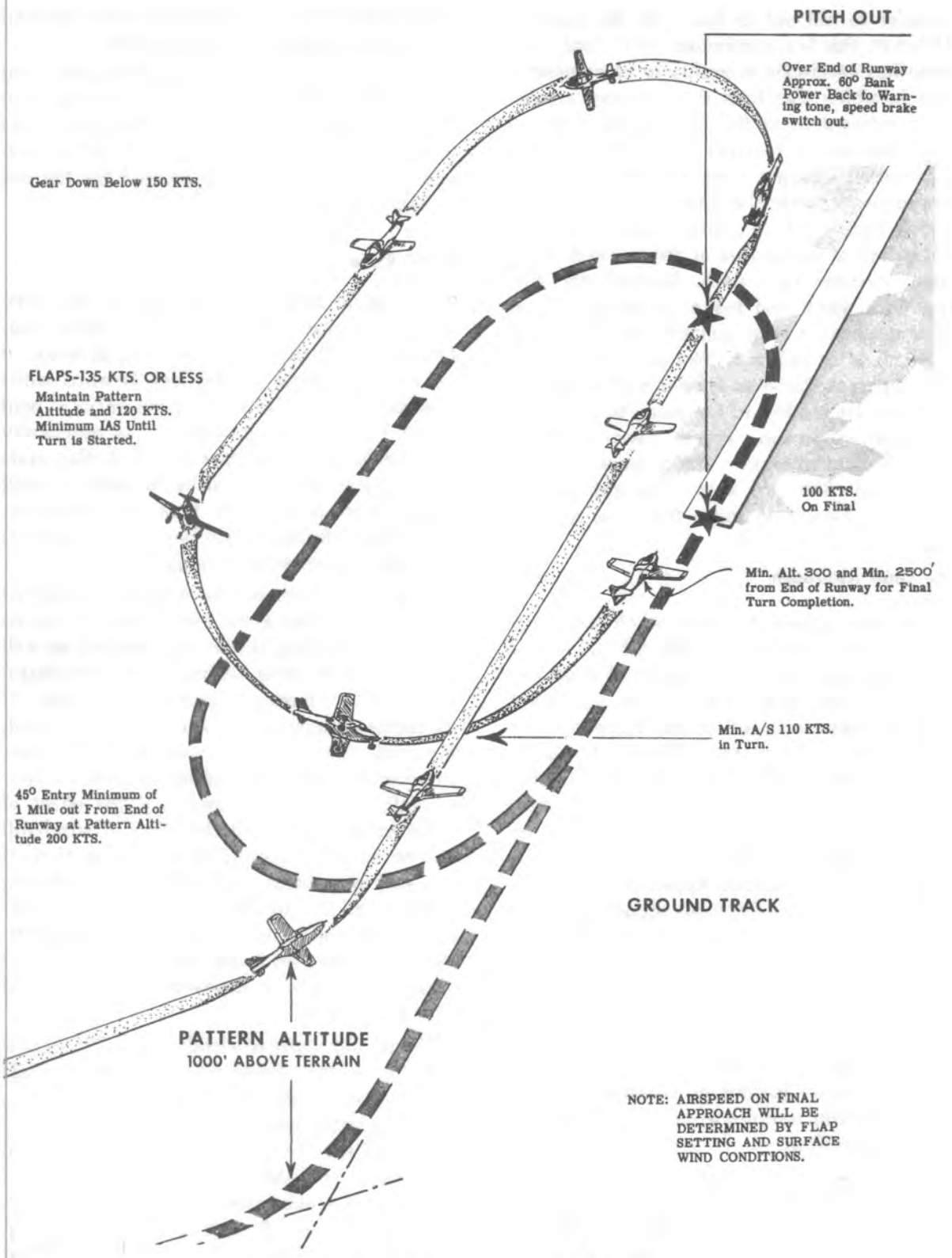


FIGURE 11–1 *Traffic Pattern T–37*

proach the thrust will be greater but constant when the power setting is constant.

From your study of climbs and descents in Chapter 8, you learned that the lift of the aircraft will remain constant for any one airspeed and angle of attack. At a constant power setting and constant airspeed, angle of attack of the airfoil remains the same. This results in a constant rate of descent. Since we are required to hold a constant airspeed on final (100 knots), the only way we can raise our glide path if we are descending too steeply with proper airspeed is to increase power and pitch. Conversely, the only way to increase rate of descent at a constant airspeed is to decrease power and lower the nose. The easiest way to fly a power-on final approach is to keep the airspeed constant with elevator (pitch) adjustments and adjust your sink rate with power (throttle).

CAUTION

Never retract the flaps on the final approach. Since the flaps will come up rapidly, the lift of the airfoil will decrease rapidly and considerable altitude will be lost. If the airspeed were low at the time, the aircraft might stall. This is extremely dangerous when close to the ground.

As you learned in the study of turns, the wing loading of an aircraft is proportionate to the rate of the pitch change. The effect of centrifugal force is negligible on the final-approach; but on roundout, centrifugal force will have a very prominent effect on the glide ratio and sink rate of the aircraft unless it is executed smoothly. This will be explained in the landing section of Chapter 12. Sink rate, as the term implies, is the rate at which altitude is lost in a glide with a constant power setting.

In summing up the factors that affect the glide ratio of the aircraft on the final approach, for all practical purposes there is only one glide ratio for one combination of pitch attitude, airspeed, power setting, flap setting, and wind condition. Under stabilized conditions (thrust, wind, etc.), when you maintain a constant pitch attitude, your airspeed and glide ratio will be constant, thus allowing you to estimate where the aircraft will land. Adjustment can be made as explained above and a new estimate made after the adjustment. If the approach is well set up, changes will be few.

Changes in the gliding airspeed will result in proportionate changes in your glide ratio. As the airspeed is reduced after final turn, the glide radio is increased (glide distance lengthened). The final-approach airspeed is 100 knots. This speed will give you a good rate of closure with the runway and a moderate sink rate, will provide you with a safe margin of flying speed above a stall, and will keep the aircraft from floating during the roundout to the landing. If the final-approach airspeed is less than 100 knots, the aircraft will settle very rapidly on roundout. For this reason *never* try to stretch a glide. Maintain the correct airspeed with pitch and add power as soon as the need is detected. The slower the gliding speed below 100 knots the faster you will lose altitude.

Technique on the Final Approach

Roll out on the final approach so that the longitudinal axis of the aircraft is aligned with the appropriate side of the runway. Adjust the pitch attitude to attain 100-knot final approach airspeed after the wings are level. Start your final approach by holding the pitch attitude constant so that with a constant power setting the airspeed will stabilize at 100 knots. If you are too high and the power is reduced on the final approach, the pitch attitude must be lowered accordingly to maintain 100 knots. Check the airspeed indicator frequently and adjust power and pitch as required to maintain 100 knots and the proper sink rate. You should constantly analyze your approach and make small adjustments as necessary so large corrections will not be needed. This constant process is known as remaining

"ahead of the aircraft" and is a skill that must be developed in all good pilots.

Always try to maintain constant flight attitudes by checking outside references first and then the flight instruments. Trim the aircraft after each adjustment of pitch or power.

Keep the longitudinal axis of the aircraft aligned with the runway throughout the final approach, roundout and landing. Adjustments to "groove" the final approach should be completed high enough above the ground so that all of your attention as you near the ground may be given to executing the roundout and landing.

Power settings may be varied as necessary around the pattern. Exact settings are not important; use sufficient power to fly the pattern at the designated airspeeds. Power reduction and roundout should be made simultaneously.

On the final approach you must estimate where the glide radio will cause the aircraft to touchdown. If you think that you are going to touchdown too far down the runway, reduce power and lower the pitch attitude. If the flight path is too low, or if you think that you are going to undershoot, add power and raise the pitch attitude slightly. Maintain power until the landing is assured. If there is any doubt about the approach being properly established or if large corrections are needed close to the ground execute a go-around and set up a new pattern. Remember, the best way to fly a final approach is to get your aircraft on the desired flight path and maintain 100 knots airspeed with elevator (pitch) adjustments while adjusting the rate of descent, (glidepath) with the throttle. Add power to flatten the glidepath; reduce power to steepen it.

VISION

During the approach, roundout, and landing, your vision is of prime importance. To make possible a wide field of vision and to augment your judgment of height and movement, let your head assume a natural straight-ahead position. This enables you to cover the area on both sides of the aircraft's nose by moving the eyes. If you look out both sides of the cockpit alternately by moving your head you will spoil your judgment, because your perspective out of one side may not be the same as out of the other. This might lead to confusion and erroneous corrections.

Your focus should not be fixed on any one side or spot ahead of the aircraft, but your *focus* should be changing slowly and constantly from side to side, as well as from an angle just below the nose of the aircraft up to the horizon. Keep your head in one position and let your eyes rove from one point to another so that your brain can record the relation of your flight attitude to these different points. Without your realizing it, there will be a number of these points that your eyes and brain will use for comparisons.

Never stare at flight instruments. As your eyes rove from one outside reference to another, glance quickly down at the applicable flight instruments. Interpret what you see and take corrective control action if necessary.

Concentration of vision too close to the aircraft will result in a "speed blur" of objects and colors on the ground. You have experienced this when looking down from a fast moving automobile. Concentration on objects too far ahead will not provide any criteria to judge or determine relative speed and depth perception. During the roundout, the landing attitude should be achieved and maintained through ground coverage a moderate distance ahead of the aircraft. This coverage, where objects and color patterns are distinct, provides a good reference for judging distances and speeds.

NO–FLAP LANDINGS

The ground track of the no-flap pattern differs from the 360° overhead pattern in that it is slightly larger. The absence of flaps and speed brake will increase the radius of turn.

The procedures for entry and initial approach prior to pitchout are the same in the no-flap pattern as in the normal overhead pattern.

As you approach the end of the runway, roll smoothly into a bank of approximately 60° and retard the throttles to *Idle*. Continue a level 180° turn to the downwind leg. Roll out on the downwind leg, establishing drift correction if necessary. When the airspeed reaches 150 knots or less, lower the gear and perform all gear-down checks. Advance the throttles as necessary to maintain a minimum of 120 knots and traffic altitude until the 180° turn to final approach is started. The downwind leg should be longer than the normal overhead pattern because the glide angle on the final approach is shallower than when using flaps. The turn to final approach should be started between three quarters of a mile and one mile from the point on the downwind leg opposite the end of the runway. Plan definitely for a long final approach. During the final turn, adjust power as necessary and decrease airspeed to 110 knots. Roll out of the final turn at 300 feet or more above the terrain but farther than the normal distance from the end of the runway. Increase or decrease power as required to maintain a constant shallow descent toward the runway at 110 knots final approach airspeed. Correct use of the throttles will prevent a low, dragged-in final approach.

NOTE: It is much easier to keep an aircraft in a shallow power-on descent at approach airspeed than it is to keep an aircraft in level flight at that airspeed. Do not set up an approach that requires a nose-high, low-level, slow-speed "buzz job" from a half mile or more out. The important thing is to be sure that airspeed is reduced to proper final-approach speed early on a long final approach; altitude may then be lost at a constant rate.

Plan the final approach so that you cross the end of the runway a few feet above the ground. Reduce the throttles to idle when the landing is assured. The aircraft will float with the landing attitude slightly nose high when compared to a landing with flaps.

CLOSED TRAFFIC

The closed traffic pattern was devised for the purpose of getting the aircraft on the ground from a go-around with a minimum amount of fuel expended. It is normally used only in an emergency or to prevent an emergency, but practice is required in order that you may become proficient in it. There will be times when, even though you are low on fuel, you must go-around. This requires planning, judgment and composure, because each time you have to go-around, your situation becomes more critical.

You will practice closed traffic from time to time with your instructor after performing touch-and-go landings. This will permit you to learn the mechanics of a closed pattern and to set up a landing approach from a closed pattern as naturally and well as from a normal pattern.

The proper way to perform the closed traffic pattern from a touch-and-go landing is to accomplish the normal go-around procedure, (Power, speed brake, gear, and flaps). With an airspeed of *150 knots*, start a climbing turn to the downwind leg. Do not exceed 60° of bank during this climbing turn. As you approach pattern altitude, reduce power as necessary to maintain 150 knots on the downwind leg. When you roll out on the downwind leg, make a call to mobile: "694 closed downwind." The mobile controller will then instruct you to continue or break out. If he instructs you to break out, follow the local procedures at your base for leaving traffic from a closed pattern. If you are instructed to "Continue," exercise a careful "lookout" for other aircraft and when opposite the mobile control unit, retard power until the warning tone sounds, extend the speed brake, lower the gear and check it down; then place the flap lever in full-down position just prior to starting the 180° turn to final approach. Be sure to hold your hand on the flap lever as in a normal approach until you have determined that a split-flap condition does not exist and you have cross-checked the flap indicator to be sure

they have started to lower. From this point, continue normal approach and landing procedures.

At times, it will be necessary to go around from final turn or final approach when you are actually planning a full-stop landing or a touch-and-go landing. If your instructor desires a closed pattern out of this condition and receives necessary clearance from mobile control, continue normal go-around procedures, attaining an altitude not exceeding 500 feet and an airspeed of 200 knots. After passing the upwind end of the runway, start a climbing turn with power at 100% RPM. Your airspeed will be higher than normal in this case; however, as before, reduce power as you approach the downwind leg, make the same radio call when you roll out on the downwind leg, and lower the speed brake so that airspeed will be 150 knots by the time you are opposite the mobile control unit. At this time reduce power until the warning tone sounds, if not already sounding, and lower the gear. Place the flap lever in the full down position just prior to starting the 180° turn to final approach.

Since practice closed patterns flown the same as emergency closed patterns, could interfere with normal traffic and create a flying safety hazard, we must make a compromise for all practice work and give priority to normal traffic over practice closed patterns. For these reasons the closed pattern after a go-around from the final turn will not be performed as a practice maneuver but may, of course, be performed in an actual emergency such as low fuel state. Normally, closed traffic will be *practiced* only after touch-and-go landings.

NOTE: Remember, the emergency closed pattern is used when your fuel is low or anytime you cannot safely go-around and re-enter on the initial approach. Also remember that in an emergency situation you need not go to the far end of the runway before starting the climbing turn to the downwind leg. In an emergency, advise mobile of your intentions, clean up the aircraft (speed brake, gear and flaps - UP), attain 150 knots and fly far enough down the runway so that you can pull up and roll out on the downwind leg in a position to lower speed brake, gear, and flaps and continue with approach and landing. Other than the position where you start the pull-up, the mechanics of the emergency closed pattern are the same as those you have employed in practice closed patterns after touch-and-go landings. Do not try to make either downwind leg or final turn too close and tight or you may be faced with another go-around at a time when you can ill afford it.

FINAL TURN RADIO CALL

The final turn radio call is an important part of the traffic pattern procedure because it is the one thing that tells the mobile controller where you are as well as what your intentions are:

It will be made as soon as possible after starting the 180° turn to final approach.

If you desire a full-stop landing your call will be "694, gear check, full stop".

If you desire a touch-and-go landing your call will be "694, gear check."

If you desire a touch-and-go landing followed by a closed traffic pattern your call will be "694, gear check, request closed".

CHAPTER 12

LANDINGS AND GROUND CONTROL

In this chapter you will study the aerodynamic factors that affect an aircraft during a landing and the flying techniques you must use to control these factors. The aerodynamic principles covered will be applicable to any type of landing.

So that you may better understand the factors that will affect your judgment and pilot technique, the landing will be divided into three phases—the roundout, the touchdown, and the after-landing roll.

The roundout is that part of the final approach that begins when back pressure is applied to the stick to initiate landing attitude and is completed when the gear touches the landing surface.

The touchdown is the point where the wheels of the aircraft actually contact the landing surface.

The afterlanding roll is the forward roll of the aircraft on the landing surface after the touchdown has been executed. It continues until the forward speed has slowed to normal taxi speed or until the aircraft is brought to a stop.

NORMAL LANDING

A normal landing could be defined as "a condition in which an aircraft settles onto a landing surface in a landing attitude, from a low-airspeed, high-angle-of-attack condition and rolls to a stop or begins to taxi."

During any landing the longitudinal axis of the aircraft should be aligned with the landing runway throughout the approach, touchdown, and after-landing roll. As the aircraft settles to the landing surface it is not fully stalled because the aircraft still has flying speed and the controls are effective. The settling condition is the result of a decrease in lift and thrust coupled with an increase in drag. The landing roll dissipates the flying speed until taxi speed is obtained.

The Roundout

On the final approach and roundout, as you descend toward the runway, you will have the impression that you are sitting still and the ground is moving upward. As the aircraft approaches the runway, apply smooth back pressure to slowly increase the pitch to the landing attitude. Trim may be used if desired. This will cause the nose of the aircraft to rise gradually, breaking the final-approach angle and initiating the roundout. The roundout consists of arresting the rate of descent as the runway is approached and then smoothly continuing the back pressure on the stick as the wings are held level in order to hold the aircraft just off the runway until the proper landing attitude (pitch attitude) is reached. Plan your roundout so that the apparent rate of movement of the ground upward will gradually be decreased until you attain a landing attitude just above the runway surface. This is done by gradually increasing the pitch attitude throughout the roundout. The throttle should be reduced during the roundout so as to be in the idle position on touchdown.

When the nose of the aircraft is raised in a roundout the lift is momentarily increased and the rate of descent is decreased. (The ground does not appear to be coming up as rapidly.) Since power is not used to increase the thrust during a landing, the airspeed will constantly

decrease. This in turn will cause the lift to decrease unless the angle of the relative wind (angle of attack) is increased. When making a roundout you are decreasing the airspeed to touchdown speed while increasing the lift to decelerate the descent so the aircraft will settle gently onto the runway. The roundout should be executed so that the landing attitude and an airspeed slightly higher than stalling speed are attained just above the runway surface. From this height the aircraft will gently settle onto the runway.

The roundout should be started gradually. Higher speeds and different wing loadings will cause the height of the roundout to vary. You must learn to judge the height of the buildings, trees, etc., to use them as visual references in determining the proper height to start the roundout. Your instructor will show you, by the use of references, the height at which a roundout should be started, both with and without flaps. Landings without the use of flaps are learned in the event flaps fail to extend.

Since it is not always possible to execute a perfect roundout and landing, you must know how to make corrections. Several of the common difficulties you may encounter through misjudgment are outlined and explained in the next chapter.

Judging the Rate of the Roundout

The rate at which the roundout is executed depends on the conditions of flight, the height of the aircraft above the ground, and the rate the aircraft is descending. A high roundout must be executed more slowly than one from a lower height to allow for a greater loss of altitude. Execute your roundout at a rate proportionate to the apparent rate of upward movement of the ground. When the ground appears to be rising very slowly, and you are still 5 to 10 feet off the ground little or no increase in the pitch attitude should be made until you are close enough to the ground to establish the final landing attitude.

Use of Throttles

Power can be used effectively during the roundout to compensate for errors in judgment. Since it increases both speed and lift, power can be used to decrease the rate of descent as well as prevent a stall. Any time that the control pressures feel "mushy" and it is apparent that you are losing control of the aircraft, apply power to execute a go-around and cushion any ensuing touchdown. When you have reached a landing attitude and are slightly high, hold the landing attitude and apply sufficient power to ease the aircraft to the ground in the landing attitude. The added thrust will delay the stall. After the landing has been made, close the throttles so that the added thrust will be removed and the aircraft will stay on the ground. If it becomes apparent that you are going to land long do not hesitate to go around.

Use of Flaps

The attitude of the nose in a full-flap approach prior to roundout is considerably lower than in a no-flap approach. To attain a landing attitude the nose must travel through a greater degree of change when full flaps are used.

You must increase the pitch attitude a little faster when full flaps are used. The roundout should still be executed at a rate proportionate to the apparent upward movement of the ground.

The Touchdown

The touchdown is the gentle settling of the aircraft onto the runway from a landing attitude. As it settles, the landing attitude must be maintained by whatever back pressure is necessary. Simply hold the aircraft off the ground as the airspeed dissipates. You will find that you won't need full back pressure to maintain this attitude. After the landing has been made, lower the nose wheel easily to the runway while you still have ample elevator control.

In the event power has been maintained during the roundout to decrease the rate of descent or to prevent a stall, the throttles should be completely closed at touchdown so that the aircraft will stay on the ground.

Do not "jerk" back on the stick just after touchdown, it is possible to drag a tail skid in this manner. Also, do not hold the nose as high as possible during the landing roll, as it will eventually come down with a hard impact if you do. Especially, do not apply brakes with the nose gear in the air. The nose gear should be allowed to descend gradually to the runway as airspeed is reduced; otherwise it will fall unnecessarily hard.

If the nose wheel 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 angle of attack—one which will lift you too high and then stall and drop you unceremoniously.

The After-Landing Roll

The after-landing roll is not completed until normal taxi speed is reached or until the aircraft is brought to a stop.

You should be familiar with the factors that influence the controllability of the aircraft after the landing has been made. Some of these factors are the center of gravity, strong crosswinds, gusty winds, swerves (yaw and/or roll), and a low oleo strut. Strong crosswinds or gusty winds may cause one wing to be lifted to such an extent that the other wing may strike the ground. Special precautions will have to be taken during gusty or crosswind conditions.

Rudder, brakes, nose wheel steering, ailerons, and throttles can be used to control the aircraft on the ground.

Rudder and Nosewheel Steering

The rudder serves the same purpose on the ground as it does in the air—it yaws the aircraft. On the ground this yaw is transformed into directional control as the rudder is used to initiate, increase or to stop a turn. The effectiveness of the rudder depends on the speed of the aircraft.

Immediately after touchdown (when the speed is high) the rudder is very effective because the airstream exerts pressure on the exposed side of the rudder surface causing an immediate reaction. As the speed decreases and the nose wheel lowers to the runway, the nose wheel steering gives positive directional control, whereas the rudder at low speeds becomes almost ineffective. Both rudder steering and nosewheel steering are accomplished by movement of the rudder pedals with the feet. However, the nosewheel steering button on the stick grip must be held in the depressed position with the hand simultaneously in order to facilitate nosewheel steering; otherwise the nosewheel will be free and rudder pedal movement will affect rudder only.

Brakes

The brakes of an aircraft serve the same purpose as the brakes of an automobile. They are to reduce its speed on the ground. They may also be used as an aid in taxiing when a sharper turn is required than could be obtained with nose wheel steering alone. Unlike on an automobile, the T-37 brakes on the right and left side are operated separately by right and left toe pressure.

During any ground roll, you can change direction by applying pressure on a single brake or uneven pressures on both brakes. To preclude excessive wear on the brakes, nosewheel steering rather than brakes should be used as the normal means of directional control. Brakes should be used to correct for turns or swerves when the nosewheel steering is inadequate. You must exercise caution when applying corrective brake action to avoid overcontrolling.

To use the brakes, slide the feet up vertically on the rudder pedals to put the toes on the brake levers. The brakes are actuated separately with toe pressure. If rudder pressure is being held at the time the brakes are needed, try to hold the rudder pedals in a fixed relative position as you slide your feet

up to obtain braking action. The brakes work independent of rudder pedal position. For instance, it is quite possible to hold right rudder and left brake, although such a requirement is not likely to occur.

After the nosewheel is on the ground, gently and briefly apply the wheel brakes to check for positive braking action and then retract the speed brake. It should be remembered that the hydraulic pressure drop during retraction of the speed brake could render the nosewheel steering temporarily inoperative, requiring the use of brakes to keep the aircraft aligned with the runway until hydraulic pressure builds up again. Later in the landing roll, the brakes will be used to slow the aircraft. Use a smooth, definite pressure for about one to two seconds, then release brakes for about the same length of time or longer. This braking technique allows better cooling than frequently tapping or applying hard steady pressure on the brakes. Let the airplane slow down as much as possible from loss of momentum. Do not brake to a near halt and then taxi with power for the remainder of the landing roll.

At the end of the landing roll, look to the rear to clear behind you, and turn off on the taxiway to accomplish the after-landing check.

Ailerons

The ailerons serve the same purpose on the ground as they do in the air—they change the lift and drag components of the wings. During the after-landing roll they should be used to maintain a wings-level attitude and to correct any unbalancing influence of a crosswind. They should be used to level the wings in the same way they were used in flight.

If a crosswind exists there will be a difference in the lift on the wings. The upwind wing will receive the full effect of the wind, whereas the downwind wing will be blanketed out to some extent by the fuselage of the aircraft. The more the crosswind, the greater the difference will be in the lift on the two wings. For this reason, the aileron control will have to be held into the wind to a degree that will compensate for the effect of the crosswind. During strong, gusty crosswinds it may be necessary to use the aileron control quickly.

Aileron technique will be explained further in crosswind landings.

During the after-landing roll, if a wing starts to rise, use aileron to lower it.

Throttles

During turns or swerves, adding power will push the aircraft forward and resist the turning of the aircraft. As a safety measure, if used in time, the throttles will help get you out of almost any difficulty.

There is no established sequence for maintaining directional control and keeping the wings level. Use any one or any combination of the controls (brakes, nosewheel steering, rudder, ailerons and power). There are so many variables which can affect a landing that a mechanical sequence is impractical. It is important to keep a level head and do something besides hope.

CROSSWIND LANDINGS

Up to this point you have been studying the aspects of a normal landing with a normal approach, roundout, touchdown, and after-landing roll.

It is necessary that you have a thorough understanding of the techniques employed in the execution of a crosswind approach and landing. The crosswind landing will be broken into integral parts—approach, roundout, touchdown, and after-landing roll—and explained separately.

The Crosswind Approach

There are two ways of executing a crosswind approach, but only one is utilized in the pilot training program. This is the wing-low method.

It was selected, after considerable research, as the safest for all pilots, regardless of the

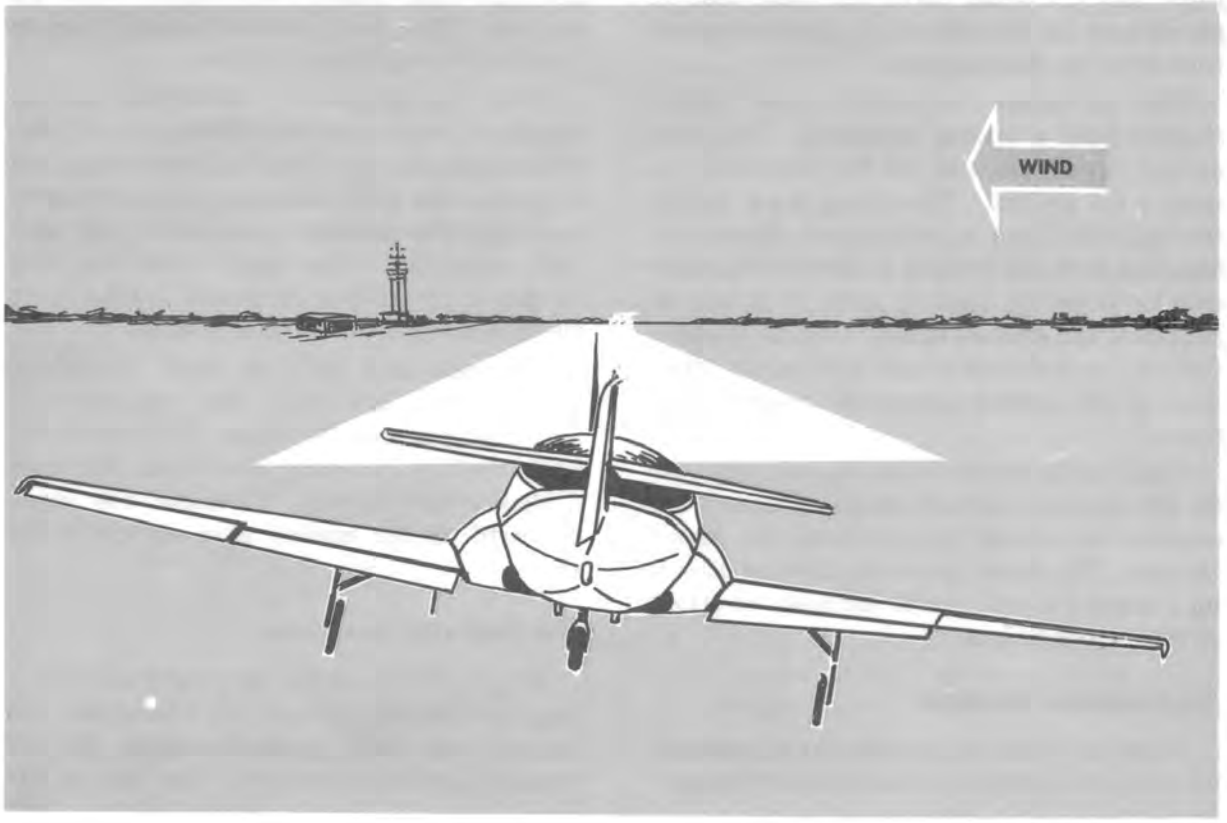


FIGURE 12–1 *Crosswind Final Approach (Wing-Low Method)*

type aircraft being flown unless the aircraft is equipped with a cross-wind landing gear. The merits of the wing-low method cannot be over-emphasized. It will compensate for wind from any direction and permit you to keep the fuselage aligned with the runway throughout the landing and after-landing roll. The same outside references can be used since it is very smiliar to the normal landing.

After lining up with the runway on the final approach, establish drift correction by lowering the upwind wing. The amount the wing is lowered is governed by the effect of the crosswind. In a strong crosswind it will be necessary to lower the wing more than in a light crosswind. Apply whatever opposing rudder pressure is necessary to keep the longitudinal axis of the aircraft aligned with the runway. THIS IS AN INTENTIONAL CROSS–CONTROL SITUATION.

When you roll into a turn with aileron alone, the aircraft will slip (sidewise) in the direction of the turn or toward the low wing. After the bank has been established the nose will begin to turn in that direction unless opposite rudder is used. This is what happens when you lower the wing for drift correction on a crosswind approach.

An aircraft drifts in proportion to the crosswind component of the wind. With a crosswind component on the final approach, you must apply a drift correction to prevent the aircraft from drifting away from the desired approach path. To maintain your desired approach path, slip the aircraft toward the upwind side to compensate for the rate it is drifting. This is accomplished by lowering a

wing into the wind. If the crosswind diminishes, this crosswind correction must also be reduced or the aircraft will begin slipping upwind from the desired path.

The procedure outlined above differs slightly from a normal approach. The pitch attitude and roundout are the same as if no wind were present. This wing-down (cross-control) condition is maintained throughout the roundout and landing to prevent excessive side loads on the landing gear. It is not injurious to the aircraft to land straight ahead—first on one main wheel and then on the other. This is the correct crosswind landing technique.

Wind conditions in which you will normally fly will require relatively small crosswind corrections and should give no cause for apprehension. The final approach airspeed should be increased *5 to 10 knots* for gusty or strong crosswind conditions.

The Crosswind Roundout

Make the roundout as in a normal approach while maintaining the crosswind correction—upwind wing down and rudder as necessary to keep the longitudinal axis aligned with the runway. The pitch attitude should increase smoothly to a landing attitude.

Since the airspeed is decreasing as the roundout progresses, the effectiveness of the rudder and ailerons is gradually reduced. You must increase their movement to expose more surface to the airstream to maintain the same drift correction. You must lower the wing further as the airspeed decreases to counteract the increasing effect of the crosswind.

You must keep the wing down throughout the roundout and while the touchdown is made. If you level the wings, the aircraft will begin drifting and may touchdown in a crab (sidewise movement). Excessive side loads are hard on the landing gear, especially the tires.

The Crosswind Touchdown

As the aircraft settles onto the runway in a wing-low landing attitude, the touchdown will be made on one of the main wheels. As forward momentum decreases, the loss of lift

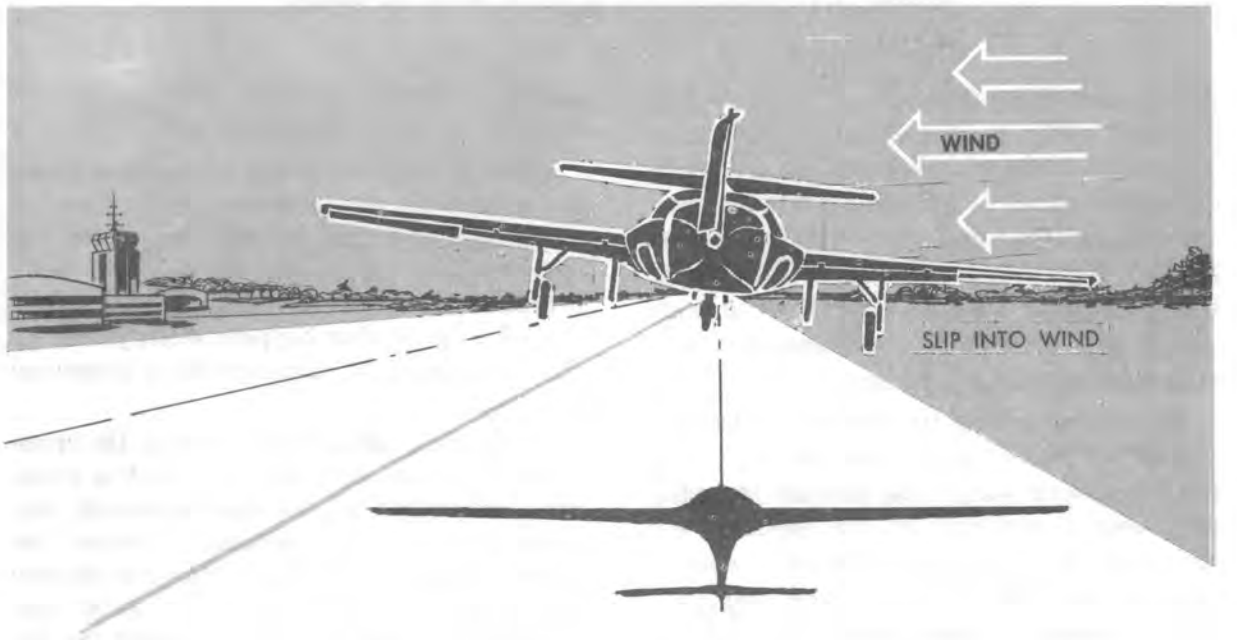


FIGURE 12-2 *Crosswind Touch-Down*

will cause the other main wheel to settle onto the runway. Thereafter, the crosswind landing is normal except that aileron should be held as if banking into the wind. The reason for this is explained earlier in this chapter (See NORMAL LANDINGS – Ailerons).

During gusty or high velocity crosswind conditions, extreme caution should be exercised to make certain that the aircraft is not drifting or crabbing as the landing is executed. Go around if necessary but do not land while drifting or crabbing.

The After-Landing Roll In a Crosswind Situation

Before explaining the techniques employed to control direction and to overcome the effect of a crosswind on the after-landing roll, you must first understand the effect wind has on the aircraft during the roll.

When an aircraft becomes airborne it moves with an air mass. That is to say, the only relative motion between the aircraft and air mass is that which is caused by the aircraft's own propulsion. This is true regardless of the heading and velocity of the aircraft or the movement of the air mass (wind velocity). The only wind flow relative to the aircraft is the longitudinal wind created by the aircraft's forward movement through the air. This is called *relative wind*. It strikes the aircraft from straight ahead during coordinated flight. Although the wing-low method of correcting for drift during a landing results in a slight slip, the relative wind may be considered as striking the aircraft from straight ahead while it is airborne.

When an aircraft is moving on the ground the tires prevent it from moving sidewise with the air mass. Therefore the crosswind, as well as the relative wind, is acting on the aircraft on the ground. The relative wind is from straight ahead, and the crosswind component is from one side. Somewhere between these two component winds there evolves a *resultant wind*.

The angle of this resultant wind to the aircraft *on the ground* depends on the velocity and direction of both the relative wind and the crosswind. As the aircraft slows down during the after-landing roll, the resultant wind moves more broadside (with the crosswind), because the relative wind is diminishing while the crosswind remains constant. It is important to understand that as you slow down and your flight controls are losing effect, the effect of the crosswind is increasing.

The T–37 is constructed so that there is more side 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 resulting leverage or impact of the crosswind on this side area will cause it to act as a weathervane and turn the aircraft into the wind. This tendency of the aircraft to turn into the wind is called "weathervaning."

From the explanation of the resultant wind component and your knowledge of vectors, it is easy to understand that this weathervaning tendency becomes greater as the forward speed of the aircraft decreases. You can therefore understand the importance of using rudder and/or brake to maintain direction during the after-landing roll.

In the after-landing roll the increasing angle of the resultant wind will require increasing aileron movement as the aircraft's forward speed decreases. It is important that the aileron not be used to the extent that the desired flight attitude is changed. Use enough aileron to prevent the crosswind from lifting the wing but not so much that the other wing will start to rise.

Another reason for using aileron on the after-landing roll is that the down-aileron on the downwind wing acts as a torque arm, helping to counteract weathervaning. The lowered aileron creates drag, and its location near the tip of the wing gives it a turning force. It assists the rudder in compensating for weathervaning.

HIGH GUSTY WINDS

Traffic patterns under these conditions will vary from normal technique in many ways.

The pitchout will have to be made farther down the runway. This will compensate for the decreased forward motion of the aircraft during the pitchout turn, and the higher ground speed on the downwind leg will have to be anticipated as the aircraft is traveling faster away from the end of the runway. If full flaps are used, the final turn will have to be much closer in than normal. If ½ flaps are used, the final turn will be more like that made with slight winds and full flaps.

The final-approach speed under high gusty wind conditions should be increased slightly above normal to give more positive control in turbulent air. For this reason 105–110 knots should be maintained on the final approach. In addition, there is a tendency for a pilot to round out high because of the steepness of his approach. This extra airspeed will be of great value in recovering from a high or abrupt roundout and will aid you in avoiding a dropped-in landing. In the event ½ flaps are used, the final approach glide will be nearer to the normal. However, the same airspeed will be used, as the stalling speed has increased only slightly and there is more tendency to overcontrol on the elevators when using less than full flaps, especially if approach speeds are high.

TOUCH-AND-GO LANDINGS

When touch-and-go landings are authorized, procedures will be the same as for go-arounds from the landing phase, except that the turn to clear the runway as soon as the go-around is under control will not be required.

The nose wheel will be held off as long as practicable, and directional control will be maintained with rudders.

Power should be applied for the go-around as soon as the main gear touches down. In the event touchdown has not been made by the time you pass mobile control, apply power and initiate a go-around. Because of the relatively slow acceleration of jet aircraft from low speeds, the aircraft may continue to settle and touch down before flying speed is attained. In this event, DO NOT TRY TO HOLD THE AIRCRAFT OFF THE RUNWAY IN A NOSE HIGH ATTITUDE. Merely maintain a landing attitude, allow a normal touchdown and "follow through."

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 resist the resulting climb tendency, but the force is not strong. DO NOT RETRIM THE ELEVATOR DURING THE GROUND ROLL.

PROFICIENCY LANDING STAGE

Periodically through your training you will be required to participate in concentrated landing practice, or proficiency stages, which are designed to develop your proficiency in the traffic pattern and landings.

The normal 360° overhead approach described previously will be used in your landing stages. All phases of the pattern and landing will be graded, including accuracy and consistency in touching down at the desired spot. Normally, a stage will consist of a minimum of *six* landings. However, if fuel and time permit, more may be accomplished.

Your instructor will show you how to fly the "outside pattern" that will keep you relatively close to the base. This will depend on local conditions but its main object is to provide for an orderly flow of traffic and to get you back to the landing pattern entry in a minimum amount of time consistent with safety. The outside pattern is merely a rectangular circuit of traffic to keep all aircraft in an orderly flow within sight of the airbase and within reach of the landing pattern.

CHAPTER 13

LANDING IRREGULARITIES, GO-AROUNDS AND SINGLE-ENGINE PROCEDURES

FACTORS AFFECTING LANDINGS

The factors that play a prominent part in landing irregularities will be defined and explained in this section. A thorough knowledge of how they affect landings will be invaluable in analyzing flight conditions and preventing accidents.

Center of Gravity

An aircraft's center of gravity is a point within the aircraft where its entire weight might be theoretically concentrated. In other words, it is the point of balance. As fuel is used or passengers are added, the center of gravity will change, but for any weight condition in the T–37, it does not shift with changes of configuration. It does not move when the angle of attack is changed, power adjusted, or by centrifugal force. Only a shift in load will change the center of gravity. The center of gravity of the T–37 is located at a point forward of the main landing gear.

Centrifugal Force

Centrifugal force is the force which draws or directs a body away from the center around which it revolves. It is the force that makes a fast-moving automobile go around a right turn on the two left wheels. In an aircraft, the effect of centrifugal force is felt about the center of turn in turn maneuvers and also about the center of the circular arc in loops or pitch-changing maneuvers, such as roundout for landing.

Effect of Flaps in a Crosswind Landing Roll

Since the flaps extend below the wing, they present more surface on which the relative wind may act. The further the flaps are lowered, the more wing surface is exposed. The use of flaps on the ground becomes an important factor any time a crosswind is present.

A crosswind acting on the flap surface will further aggravate the weathervaning tendency of the aircraft on the ground. The main landing gear acts as a fulcrum point, and the wind on the flaps causes the aircraft to turn or swerve into the wind during the ground roll. The greater the crosswind component, the less the flaps should be extended for landing.

COMMON ERRORS IN LANDING

Explanations of landings up to this point have been devoted mainly to ideal situations in which landings were executed correctly. There are several errors that student pilots might make while developing landing proficiency. It is important that you be thoroughly familiar with the causes, effects, and proper recoveries from these situations.

Low Final Approach

When you place the turn to final approach too far from the runway or dive the aircraft through this turn, excessive altitude may be lost and cause the final approach to be far below the desired approach path. Such a situation would require additional power to fly the aircraft up to the runway. This is called a "dragged in" final approach and should be

avoided. It is dangerous because you may not properly judge the extra amount of power needed to fly in this attitude. You have become accustomed to the amount required in final approach descent and may tend to use only this amount. The aircraft fails to respond to this inadequate power in nose-high level flight, and the stall is approached. Dragging the aircraft in with a dangerous nose-high attitude is not the proper solution for the error in judgment that was made on the final turn. Add an excess of power as soon as you start getting low on final approach; then retard 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, execute a go-around.

Too Slow on Approach

When you fly the aircraft too slowly on the final approach, your judgment of the glide ratio and the proper roundout height may not be accurate because the proper point to begin roundout is lower with low airspeed and requires more precise judgment. Also, the aircraft may stall, depending on the pitch attitude and control usage, especially if the wind is gusty.

When you recognize a slow approach, make the same recovery as for a low final approach. Apply power early—at an altitude high enough to reestablish the correct airspeed and attitude—or go around.

Roundout Too High

Sometimes when the ground stops moving toward you, your roundout has been too rapid, and you will be too high above the runway. To compensate for this you can maintain a constant pitch attitude by releasing a slight amount of back pressure until the airspeed diminishes slightly and the aircraft again starts descending; then continue the roundout. This technique should be used only when you have adequate airspeed and runway. If you have reached a landing attitude and are still well above the ground, don't wait for the aircraft to start descending again. Execute a go-around and plan another approach. Remember that when a landing attitude is attained, the aircraft is rapidly approaching a stall; the airspeed is decreasing and the critical angle of attack is being approached, even though you are no longer increasing the pitch attitude.

In your study of descents, you learned that, as the nose was lowered to a descending attitude, the pitch change caused the lift of the aircraft to decrease momentarily. This is also true during a roundout. Do not lower the nose of your aircraft to increase the rate of descent when fairly close to the runway. The momentary decrease in lift may be so great that the aircraft might land on the nose wheel, which could collapse. You should go around anytime that you feel the nose should be lowered excessively to avert a stall during the roundout. The need for substantial lowering of the nose is an indication that you may be too high above the ground and approaching a stall.

Anytime 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. Let it touch down if it wants to. The contact will be moderate if you have added power, and you will be safely airborne again shortly.

Rounding Out Too Late Or Too Rapidly

If you are too late in starting the roundout and pull the stick back too rapidly to prevent the aircraft from touching down, you can cause a high-speed (excessive back pressure) stall. The effect that centrifugal force has on the wing loading of an aircraft during rapid changes in pitch has been explained previously in Chapter 8—Fundamental Maneuvers of Composite Flight. This is a dangerous situation and may cause the aircraft to land extremely hard on the main landing gear and

bounce into the air. As the aircraft bounces into the air, the tail will be forced down very rapidly by the back pressure on the stick and inertia will cause the tail section to remain low while the resilience of the bounding wheels causes the forward part of the aircraft to rise. The net effect is to increase an already excessive angle of attack and stall the aircraft in an exaggerated nose-high attitude. This may or may not be a controllable situation, depending on the airspeed and the magnitude of the bounce. If this occurs, immediate use of power will increase thrust, lift and controllability and will enable you to recover and go around. The important things in this situation are (1) Don't panic, (2) Recognize the problem, and (3) Do something immediately—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 properly initiated recovery, your second contact will be moderate.

Floating

When you misjudge the final approach (reducing the power too late, using too much power on final approach, or failing to use the flaps properly) your tendency will be to dive the aircraft toward the end of the runway in an attempt to land. When you dive the aircraft there will be an increase in airspeed. This will cause you to float and possibly balloon or bounce. You will be well down the runway before a landing can be made.

Good judgment must be used any time the aircraft floats. You must gradually adjust (increase) the pitch attitude as airspeed drops and landing speed is approached. A small error in judgment may result in bouncing or ballooning.

The recovery from floating will depend on the amount of floating. Since prolonged floating requires considerable runway length, it should be avoided especially in strong crosswinds. If a landing cannot be made in the first third of the runway, make a go-around.

Ballooning

There are several factors that may cause an aircraft to balloon. All are results of poor judgment or over-controlling. Starting the round-out too rapidly or raising the nose to a landing attitude before the lift has decreased sufficiently will cause you to balloon. The altitude gained in each instance will depend on the airspeed or the speed with which the pitch attitude is increased.

When ballooning is slight, a landing may be made. Maintain direction, hold a constant landing attitude, and let the aircraft settle onto the runway. Rudder pressure is used to keep the aircraft straight as it settles onto the runway.

When ballooning is pronounced, make a go-around. Do not attempt to salvage the landing.

Be extremely cautious of ballooning when there is a crosswind. If the proper wing-low crosswind correction is not maintained until



FIGURE 13-1 *Ballooning Results from a Too Rapid Round-out*

touchdown, the aircraft will probably "balloon" because of the added lift as you level the wings. This puts you in double jeopardy because you will also be drifting again, once you level the wings. Make certain that the appropriate wing is down in a crosswind and direction is maintained with opposite rudder. If you balloon slightly, the wing will have to be lowered ever further to compensate for the relative increase of drift component at the lower airspeed. If there is any doubt, go around.

Bouncing

A bounce is very similar to ballooning. The difference is the initial cause factor. If the aircraft strikes the runway hard, it will bounce into the air just as a ball will bounce. The height it reaches depends on the force with which it strikes the runway and the amount of back pressure held. This height also depends on the speed at the point of touchdown.

A bounce occurs if the aircraft makes contact with the ground before the landing attitude is attained. A common student error is to use excessive back pressure. This is the result of realizing too late that the aircraft is settling too fast because it is not yet in the landing attitude. In attempting to correct it, you establish an increase of pitch attitude too late—just as the bounce occurs. Both factors tend to force the aircraft aloft again.

The corrective action for a bounce is the same as for ballooning and depends on its severity. When it is slight and there is no great change in pitch attitude, continue with the landing. This is accomplished by maintaining direction and smoothly adjusting the pitch to a landing attitude just prior to touchdown.

When a bounce is severe (you feel the aircraft rising rapidly) make a go-around immediately. Do not attempt to salvage the landing. Simultaneously apply power, maintain direction, and lower the nose to a safe pitch attitude. Follow through with the go-around even though another bounce may be encountered. Do not attempt a landing from a bad bounce. Since airspeed diminishes very rapidly as the aircraft rises, a stall may occur before a landing can be made. However, it is to be expected that you may contact the ground or bounce a second time during a proper recovery. But it will not be severe.

Extreme caution and alertness must be used any time a bounce is encountered when there is a crosswind. When one wheel strikes the runway, the other wheel will touch down immediately afterwards, and the wings will be leveled. The crosswind correction is lost if you bounce, and the aircraft will drift. You should re-establish the drift correction if the landing is continued and hold the wing low until first one wheel and then the other stays on the ground.

Porpoising

Porpoising is a condition encountered during landing wherein the aircraft bounces back and forth between the nose wheel and the main gear after initial ground contact. This porpoising condition is caused by an incorrect landing attitude upon touchdown, which brings the nose wheel in contact with the runway before the main gear touches down. This condition most likely will 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 oscillation of the aircraft about the lateral axis. These repeated heavy impacts of the aircraft on the runway ultimately will result in structural damage to the landing gear and airframe. Therefore, a proper landing attitude immediately prior to touchdown is imperative to preclude the occurrence of the porpoise.

If porpoising should be encountered, immediately reposition the controls (stick NEUTRAL or slightly aft) to establish the normal landing attitude. Maintain this attitude and simultaneously advance throttles to 100 percent RPM and go around. Do not attempt to counteract each bounce with opposite stick movement, because the combined reaction time of pilot and aircraft is such that the con-

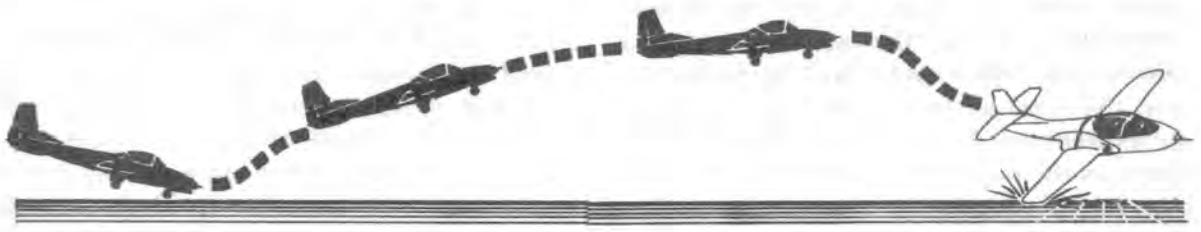


FIGURE 13–2 *Don't Hesitate to Go Around*

trol movement will aggravate the porpoising action. Repositioning and holding (restricting movement) the controls at neutral or slightly aft will damp out the oscillation as soon as it occurs.

Landing in a Drift or Crab

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

The method of correcting for drift on the final approach is the "wing-low method." This allows you to keep the longitudinal axis aligned with the runway throughout the final approach and landing.

During final approach, roundout and touchdown in a crosswind, there are two factors which should be well-understood: (1) that the path or track of the aircraft over the ground should be a straight line in the same direction as the runway; and (2) that the fuselage of the aircraft should remain lined up with the runway throughout. In other words, you should not angle toward the runway, and the nose should not be cocked. If you fail in this, it is probably caused by one of the following: (1) drifting, caused by insufficient or no wing-low crosswind correction; (2) crabbing, caused by weathervaning to correct for crosswind instead of the approved wing-low method; or (3) a combination of both, namely, wing not low enough and the fuselage not accurately aligned.

Wing Rising After Touchdown

During crosswind landings there may be instances when a wing will rise during the after-landing roll. Depending on the amount of crosswind and the degree of corrective action, a loss of directional control may occur. Let us first analyze a wing coming up when there is no loss of directional control.

When an aircraft is rolling along the ground in a crosswind condition, the upwind wing is receiving a greater impact air pressure than the downwind wing, because of the fuselage's interference with the relative wind over the downwind wing. This causes a lift differential. The wind is also striking the aircraft's fuselage on the upwind side. Since there is a greater exposed side-fuselage area above the center of gravity than below it, the tipping moment of the wind may further assist the raising of a wing by tending to tip or roll the fuselage.

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, it is possible that a wing will rise sufficiently to cause the other one to strike the ground. Throttle, rudder, nose wheel steering and/or brakes are used to maintain directional control. Ailerons are used to keep the wings level. In the event a wing starts to rise during the landing roll, you should immediately apply more aileron toward the high wing and continue to maintain direction.

The sooner aileron is applied, the more effective it will be. Apply aileron the instant a wing starts to rise. 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. In other words, as the raised wing is added to the fuselage area on which the crosswind is acting, the tipping moment becomes greater. This further opposes the corrective action available from the aileron.

Now let us analyze a situation where a wing comes up and there is also a loss of directional control. Not only are the same factors present that are attempting to raise a wing, but the crosswind is also acting on the fuselage surface behind the main wheels and is swerving (weathervaning) the aircraft into the wind.

Again you should apply aileron to lower the high wing and stop the swerve with the most effective control—in this case the opposite brake. Apply sufficient brake on the low-wing wheel to stop the swerve. When the wings are approximately level, maintain directional control until the aircraft has slowed to taxi speed or has stopped.

Occasionally, during the after-landing roll, a low strut will cause one wing to be lower giving the appearance that one of the factors previously mentioned is affecting the aircraft. In the absence of other factors, this will pose no particular problem except that you may need to apply brake a little harder on the high side.

After the nose wheel is on the ground, check your brakes by smoothly applying even pressure on both brake pedals, to insure proper functioning of each brake. Continue with your normal landing roll. This brake checking will be necessary only when making a full stop landing.

GO–AROUNDS

Sometimes during traffic pattern and landing practice, you will find yourself poorly positioned and have to discontinue an approach for reasons of safety and execute a go-around. You can imagine how dangerous a traffic pattern would be if all aircraft were allowed to land and depart from a field at will. In the interest of safety, precisely-established traffic patterns must be flown under the supervision of both a tower control and a runway control officer (mobile control). In these patterns, you are able to see and anticipate the movement of other aircraft and stay clear of them.

If an aircraft discontinues the approach and leaves the pattern, a dangerous situation is created unless an orderly system for go-arounds is prescribed. It is important that everyone engaged in flying at your base know the procedures for leaving traffic patterns. Since traffic patterns vary in minor details at each base, the correct procedures are outlined in local flying directives. It is your responsibility to know and follow these directives when you leave the pattern or make a go-around.

Although an approach may be aborted at any point, a go-around is usually executed from the turn to final, final-approach, or the roundout. The sooner a poor landing condition is recognized and the go-around started, the safer it will be. You should not wait until the last second to make a decision, and you should not try to salvage a bad approach. Occasionally, poor judgment or technique during the approach or landing may require a go-around; for instance, a bounce, a high level-off, or some unforeseen emergency. Regardless of the height above the ground, a safe go-around may be executed if properly flown and a sound plan followed.

Ideally, there should be little need for a mobile controller to direct go-arounds. The pilot of the aircraft is responsible for executing the go-around when a dangerous condition is encountered. Low final turns, overshot final turns, heavy jet wash, distracted attention, other aircraft too close, and many other conditions are dangerous.

The correct procedure for executing a go-around is:

Simultaneously advance the throttles to 100% and retract the speed brake.

When you are sure you will remain airborne and have 100 knots, retract the landing gear.

At a minimum of 110 knots, raise the flaps.

Clear the runway with a smoothly coordinated shallow bank and turn approximately 20° in the locally prescribed direction. When you are well clear of the runway, execute another shallow-banked turn to realign the aircraft parallel to the runway.

Climb to 500 feet above the terrain, or if already at this altitude, maintain it.

Each step of this procedure is important and a brief discussion of each follows.

Power Application

The thrust attenuators allow a higher power setting to be carried on the final approach without adversely affecting prompt airspeed control. This safety factor facilitates safer go-arounds by partially eliminating the slow-acceleration RPM range inherent in the jet engine. When the throttles are advanced beyond 70% rpm or the speed brake is retracted, the thrust attenuators will retract and power response will be rapid. Keeping this in mind, you can easily see the importance of retracting the speed brake as soon as possible after the decision to go around is made. This will give you more power immediately while advancing the throttles to 100%.

Retract the Landing Gear

The landing gear should be retracted *only after you are certain the aircraft will remain airborne* and not below 100 knots. There is no hurry about retracting the gear when a go-around is executed. In fact, after ballooning or a bounce, a second touchdown should be expected if you are close to the runway. This situation is routine if the aircraft is kept straight and a constant, safe pitch attitude is maintained. The aircraft is approaching full flying speed rapidly and the advanced power will cushion the second touchdown. Very little stress will be placed on the aircraft, and you will still have full control. Then, after a safe altitude and 100 knots have been reached, retract the gear.

Raise the Flaps

After the gear has been retracted and a safe airspeed of 110 knots has been attained, raise the flaps. As the flaps are retracted, raise the nose slightly. This offsets any tendency of the aircraft to sink.

Clear the Runway

After the gear is up and locked and flap lever has been placed in the "UP" position on a go-around, you should clear the runway to make certain you have not overtaken the aircraft ahead of you. Chances are he has made a normal landing and slowed down while you have applied power early and are overtaking him. Smoothly roll into a coordinated shallow-banked turn and turn approximately 20°. When you are well clear of the runway, execute another shallow-banked turn to realign the aircraft parallel to the runway. You will probably pass the aircraft which has made a normal landing.

The direction in which these clearing turns should be made will depend on traffic conditions at your base. Usually the first of the two turns will be made away from the traffic pattern toward an area in which no aircraft are flying. When there is dual (parallel) runway operation at your base, the first clearing turn will be made in the direction of the traffic circuit. When this is done, you must remain below 500 feet during the go-around climb until beyond the field boundary or as directed locally.

Climb

Unless you are cleared for closed traffic, allow the aircraft to accelerate to 200 knots for climb, and then reduce the power to 96%. Do not exceed 500 feet above the terrain until the upwind field boundary is reached. At this time, make your traffic exit turn in the direction of traffic.

A Go-Around Prior to Pitchout

If it is necessary to make a go-around prior to the pitchout, continue parallel to the initial approach at 1000 feet above the ground and at an airspeed of 200 knots. After crossing the field boundary, make the traffic exit turn, keeping alert for other aircraft that may have taken off below you.

A Go-Around After Pitchout, Before Final Approach

If it is necessary to discontinue a landing pattern after pitchout, continue in the normal traffic pattern, descending in the turn to final approach. Align the aircraft parallel to, but to the outside of the runway or as directed locally, and continue the descent to 500 feet above the terrain. At this time, advance the throttles smoothly to 100%, retract the speed brake, and raise the landing gear and flaps, if extended. Do not exceed 500 feet above the terrain and 200 knots until the upwind field boundary is reached. At this time, make the first traffic exit turn in the direction of traffic.

A Go-Around from Final Approach or Landing Phase

In a go-around from the final approach or landing phase, smoothly advance the power to 100%, and simultaneously retract the speed brake. At 100 knots, retract the landing gear. At a minimum of 110 knots, raise the flaps. Clear to the side of the runway as directed locally. Unless your next pattern is to be closed traffic, allow the aircraft to accelerate to 200 knots for climb, and then reduce the power to 96%. Do not exceed 500 feet above the terrain until the upwind field boundary is reached. At this time, make the first climb-out turn in the direction of traffic.

For closed traffic patterns, consult the appropriate section in this text.

Trim

The use of trim during go-arounds should be a continuing process as airspeed changes.

Simulated Go-Around at Altitude (Traffic Pattern Stalls and Slow Flight)

At any safe practicing altitude, you will set up a simulated landing approach and go-around. To start the go-around, advance the power to 100% and simultaneously retract speed brake. At a minimum of 100 knots retract the landing gear. Check indicators, and at a minimum of 110 knots raise the flaps. Simulate clearing a runway by performing two shallow-bank turns of about 20° in opposite directions. You may continue to hold altitude and perform a complete level-off procedure, or you may maintain altitude until climbing airspeed is attained, reduce power to 96% and establish a climb.

SINGLE ENGINE

Your instructor will give you simulated single-engine practice (dual only) by placing one throttle in the idle position. You will call out, perform and simulate the necessary procedures as directed by your instructor. *Minimum safe single-engine airspeed is 110 knots!*

Simulated Single-Engine Landing

Your instructor may at any time close one throttle to the IDLE position and request a simulated single-engine landing.

If you are beyond gliding distance from the field, you should maintain or climb to a safe altitude enroute. Advise your instructor of your emergency on interphone using the same radio procedure as you would in the event of an actual engine failure. Make a normal power letdown close to the field and plan for a normal initial approach. Your airspeed should be considered in determining the amount of bank to be used for traffic pattern turns, remembering that the steeper bank increases angle of attack, induced drag and stalling speed. Regardless of airspeed, bank should never exceed 60 degrees.

Over the end of the runway, simultaneously roll into a pitchout turn and retard the throttle to approximately 60% rpm. Do not extend

speed brake. Continue a level 180-degree turn to the downwind leg. The degree of bank will depend on your initial approach airspeed (the bank should be less at a lower airspeed). Also, your reduction of power will depend on airspeed at time of pitchout. If you have a low airspeed on the initial approach, you should delay your power reduction until well into the pitchout turn or even after you are on the downwind leg. Speed brake is not used in the pitchout, for if it were extended the idle engine would cause the thrust attenuators to remain out throughout the remainder of the pattern, regardless of how much power you use on the good engine. Putting speed brake down in a single-engine situation would be adding drag at a time when thrust is critical. This is poor judgment.

Roll out on the downwind leg, establishing correction for drift if necessary. With airspeed below 150 knots, place the landing gear handle down. Continue to maintain altitude and make all gear-down checks. After the gear is down and checked, the wing flap handle will be placed in the 50%-down position at an airspeed of 135 knots or less just prior to the 180° turn to final approach. Lowering 50% flaps increases lift and decreases stall speed without greatly increasing drag. Use power as necessary to maintain altitude and a minimum airspeed of 120 knots on downwind if it is necessary to extend the downwind leg.

The 180° turn to final approach is placed further out than in a normal pattern to allow for the increased glide ratio resulting from half flaps and the absence of speed brake. The final turn should be started approximately ½ to ¾ of a mile past the end of the runway.

During the 180° turn to final, airspeed may be gradually reduced to 110 knots. You should plan the pattern a bit wider than normal so that a shallow turn can be used in order to roll out in line with the runway. Maintain 110 knots (safe single-engine airspeed) throughout the final approach until the landing is assured.

Normally, only 50% flaps will be used to make a single-engine landing; however, you may use the speed brake on final approach after a safe landing is assured. Full flaps may be used after a safe landing is assured to prevent overshooting. Touch-and-go landings are authorized from simulated single-engine approaches, provided power is applied to both engines for the go-around.

Single-Engine Go-Around

The importance of an early decision to go around cannot be overemphasized due to greatly reduced performance with only one single engine available. The go-around, therefore, should be initiated early enough to assure safety. During go-arounds initiated below 300 feet above the terrain, it is highly probable that the aircraft will contact the runway regardless of the pilot's intentions. Single-engine go-arounds will not be conducted as practice maneuvers below 6000 feet above the terrain.

CAUTION

It is imperative that you retract the speed brake immediately upon deciding to go around.

Simulated Single-Engine Go-Around Demonstrations

Your instructor will demonstrate and have you practice, at altitude, the correct techniques of performing a single-engine go-around. The purpose of this maneuver is to emphasize the importance of maintaining safe single-engine airspeed and proper flap settings during a single-engine approach. Notice carefully the altitude loss and amount of rudder necessary to maintain directional control. This maneuver will be practiced at an altitude that will insure recovery at least 6000 feet above the terrain.

Clear the area visually and enter the maneuver as in a pitchout for a simulated single-engine landing. When on final approach 300 feet above simulated field elevation, apply 100% power smoothly to the good engine to initiate a go-around.

Raise the gear and flaps and trim the aircraft as necessary. Do not permit the airspeed to decrease below safe single-engine airspeed (110 knots). Notice that with proper technique only 100 to 150 feet of altitude will be lost.

The next demonstration will show you what happens if you attempt to go around with full wing flaps and 100 knots airspeed.

Clear the area visually and enter the maneuver the same as before. However, when on final approach, lower speed brake, full wing flaps and decrease the airspeed to 100 knots. When 300 feet above simulated field elevation, simultaneously retract the speed brake and smoothly apply 100% power to the good engine and start a go-around. Gain safe single-engine airspeed as soon as possible; then raise the gear and flaps; trim as necessary. Again notice the loss of altitude and the amount of rudder necessary to maintain directional control.

Your instructor will demonstrate the go-around described above while attempting to maintain altitude. This will emphasize that failure to lower the nose to gain airspeed will result in a *loss* of airspeed resulting in the aircraft entering the backside of the power curve. Review this principle in your "Principles of Flight" text.

To recover from any of the above demonstrations, you may apply 100% power to both engines, hold altitude and (1) perform a complete level-off procedure; or (2) you may maintain altitude until climbing airspeed is attained, then reduce power to 96% and establish a climb.

CHAPTER 14

SPINS, DIVES, AND INVERTED FLIGHT RECOVERIES

The phases of flight presented in this section are generally transitory in that they are either entered for short periods of time as part of a conventional maneuver—as a dive and inverted flight, for instance, compose parts of the Immelmann—or they may be entered intentionally or unintentionally in changing from one maneuver or flight condition to another.

The spin has little value as a maneuver except as a training exercise in which the student is taught to recognize it, control it, and respect it but not to fear it. It has little value, because it is a condition in which the controls have only partial effect, and it can accomplish nothing toward maneuvering the aircraft that the pilot can't perform better in another way with fully effective controls. You will learn to recognize the conditions that cause a spin and how to avoid it before it develops. And you will also be taught to spin and recover as part of your complete education as a military pilot.

Dives and inverted flight are commonplace to a military pilot because they are inherent to so many flight maneuvers. Nevertheless, there may be occasions when you would enter any of these flight conditions unintentionally or unexpectedly. So you are taught how this can happen and what to do about it. The one thing that these three flight conditions have in common is that a great deal of altitude can be lost in them by the pilot who doesn't know the proper recovery techniques.

SPINS

A spin is an aggravated stall that results in autorotation. The aircraft describes a corkscrew path in a downward direction. One wing has more lift than the other, and the aircraft is forced downward by gravity—rolling and yawing in a spiral path. The total lift from the wings is slight, and the average angle of attack may be 35°, or more. This angle is considerably greater than the angle of attack encountered in a normal stall.

When the aircraft has begun to spin, the difference between the angle of attack of the two wings is considerable. As the aircraft descends, the angle of attack of the inner wing is greater than that of the outer wing, causing the inner wing to be more completely stalled. Since the outer wing has more lift, it will have a tendency to fly up.

The relative wind is striking the aircraft from below and from the side. The outer wing, trying to fly upward, causes the aircraft to yaw. This rolling and yawing is called "autorotation."

When spinning, an aircraft descends vertically because of gravity, and at the same time rotates about a vertical spin axis. This axis is perpendicular to the surface of the earth. While spinning, the axes of the aircraft are all inclined toward this vertical spin axis. Thus, a spin is composed of pitching, rolling, and yawing.

In all normal spins, you have control of the lift and drag on both the rudder and elevators. By the use of these controls you may cause, maintain or remove the conditions of a spin. Being able to perform spins will actually increase your confidence in the aircraft and improve your ability to orient yourself in any attitude.

Your instructor will demonstrate four different types of spins during your course of training. They are Normal, Procedure I, Procedure II, and Accelerated spins. You will be required to attain proficiency in the Normal and Procedure I spin maneuvers. Procedure I spins will be emphasized in your pre-solo phase to insure recognition and prevention of spins. Later on, dual practice of other spin maneuvers will continue to develop proficiency in recovery procedures. Throughout the course, spin maneuvers will be varied by your instructor to the extent necessary for you to attain all learning objectives.

The minimum altitude for a spin entry will be 20,000 feet above the terrain or higher as directed locally.

Spins will not be performed with fuel load in excess of 1000 pounds.

Immediately before entry into each spin, check wing fuel balance. If there is a difference greater than 70 pounds indicated, do not spin.

Normal Spin

Prior to spin entry, make the required fuel check, clear the area visually, and trim the aircraft (elevator-trim green light on). Establish a nose-high pitch attitude of 15 to 50 degrees for the entry. When more than 30 degrees of pitch is used, a shallow bank (approximately 20 degrees) will be established in the direction of the spin, before the stall occurs. Any power setting from idle up to 90% may be maintained until the first stall indication occurs. Throttles will be at IDLE setting during the spin. At the first stall indication, reduce power to IDLE slowly and smoothly apply *full* back stick and *full* rudder in the desired direction of spin. Hold the stick and rudder firmly against the stops and keep the ailerons neutral. Continue to hold these control positions until the spin stabilizes. The nose drops down during the first half turn to almost vertical and then swings back up to, or above, the horizon at the end of the first turn. The nose then drops and the spin stabilizes at approximately a 45-degree nose-low attitude after two or two and one-half turns.

The altitude loss is approximately 500 feet per turn in a stabilized spin. After the spin has stabilized, recover by applying brisk full-opposite rudder to the maximum deflection—and hold. Slightly more than one-half turn later, the rudder will become effective and a slight buffet will be detected. At this time, apply forceful forward stick as rapidly as possible against the forward stop and then ease off slightly when the nose pitches down toward a vertical attitude. After the aircraft's spin rotation is *definitely stopped*, neutralize all controls as rapidly as possible and recover from the ensuing dive. *DO NOT* neutralize the rudders until the rotation has completely stopped. Use a three-"G" pullout after flying speed is regained and the maximum airspeed attained will not normally exceed 200 knots IAS. Reference the T–37 Flight Manual for supplementary spin information.

Procedure I Spin

The same procedures (entry altitude, fuel check, clearing turns, throttle technique, pitch attitudes, etc.) used in the entry to the Normal spin will be used in all Procedure I spins.

At the first stall indication, reduce power to IDLE and slowly and smoothly apply *full* back stick and full rudder in the desired direction of spin. As soon as full pro-spin controls are attained, and before the aircraft has completed three-quarters of a revolution, recover by smoothly relaxing the back pressure to break the stall; use rudder as necessary to control yaw; use ailerons as they become effective to stop roll. After rolling movement ceases, smoothly advance the throttles to cruise or climb power setting unless the aircraft is inverted and airspeed is such that a straight diving pullout is necessary.

The objectives of this maneuver are twofold. It is a maneuver used to teach you to recognize spin conditions before they become fully developed. It is also used to teach you that recovery from a spin in its early stage

is much easier in a T–37, and by recovering at this stage you can prevent the aircraft from actually entering a full spin from which recovery is more difficult. As you attain experience and proficiency in the aircraft and this maneuver, you should strive to effect recovery just as soon as full pro-spin (full rudder and full back stick) controls are applied. Refer to the T–37 Flight Manual for additional information.

Procedure II Spin

The same procedures (entry altitude, fuel check, clearing turns, throttle technique, pitch attitudes, etc.) used for the Normal and Procedure I spins will apply to the Procedure II spins.

Rather than recovering within three-quarters of a revolution, hold *full* pro-spin controls (stick firmly against the back stop and full rudder in the direction of rotation) until the aircraft has completed one full turn. Attempt a fly-out by executing the same stall-type recovery used in the Procedure I spin. As this is done, rotation will accelerate immediately and the spin becomes worse rather than corrected as in Procedure I; the spin has developed too far for a Procedure I recovery; so, without hesitation, re-apply pro-spin controls. After the rate of rotation and pitch attitude stabilize (approximately two additional turns), recovery from the spin by use of the aggressive technique employed in a normal spin recovery.

The objective of the Procedure II spin is to show what occurs when stall-recovery procedures are delayed until after the aircraft has completed one or more revolutions after spin entry.

If a spin is inadvertently entered and the stall type recovery used in Procedure I spins cannot be initiated within ¾ of a turn, apply and hold *full* pro-spin controls until the spin stabilizes. After the rate of rotation and pitch attitude stabilize, recover from the spin by use of the aggressive normal spin-recovery technique.

There is no excuse for accidentally entering a spin. It is very easy for even a student pilot to recognize the stall and approach to a spin and follow the proper corrective and preventive procedures.

Accelerated Spins

Your instructor will demonstrate how improper use of the controls can produce accelerated spins.

The same procedures and entry technique used for all previously described spins will be used by your instructor to set up an accelerated spin.

As the aircraft progresses into the spin, he will *hold* full pro-spin controls until the spin stabilizes. At this time, he will neutralize the rudders, then release the stick but guard it at all times with his hand. This change of control positions will cause the aircraft's rate of rotation to accelerate slightly, then remain constant in an accelerated spin. The pitch attitude will lower slightly, then oscillate slowly between 40 and 50 degrees. A slight buffeting of the rudders will occur, and the stick, after it is released, will either oscillate between the full back and neutral positions or remain at the rear stop. When the stick oscillations occur, the stick conforms to the aircraft's pitch variation.

To recover from this maneuver, he will aggressively apply *full* pro-spin controls. This produces a noticeable stabilizing effect, decreases the rate of rotation and raises the pitch attitude of the aircraft. Once the spin has stabilized, the rate of rotation may be somewhat faster and the pitch attitude may be lower than that experienced in a normal stabilized spin. It is imperative that full pro-spin controls be maintained until the spin stabilizes before applying aggressive anti-spin controls to complete the recovery. The aggressive technique, as always, is employed to effect the recovery from this spin. Usually 3500 to 4000 feet of altitude will be lost during this demonstration, depending upon how long the spin is maintained.

Your instructor will also demonstrate the misuse of the controls which will cause a spin to become even more accelerated.

As the aircraft progresses into the spin, he will hold full pro-spin controls until the spin stabilizes. After the spin has stabilized, he will neutralize the rudders. He will then start moving the stick forward very slowly to demonstrate what can happen if the stick is not held full back prior to recovery or when recovery is attempted without aggressive control movements. As he moves the stick from the rear stop, the aircraft's pitch attitude will lower with resultant increase in rate of rotation. These changes are very apparent. The degree of the pitch change is easily controlled by stick movement and should not be allowed to exceed 60 degrees (nose low). The familiar pro-spin procedure followed by the aggressive anti-spin recovery technique is employed to effect the recovery from this accelerated spin. As in the previously described accelerated condition, after application of pro-spin controls and the spin has been allowed to stabilize the rate of rotation may be faster and the pitch attitude may be lower than that experienced in a normal stabilized spin. Usually 4500 to 5000 feet of altitude is lost during this demonstration.

The following are the principal objectives of accelerated spin demonstrations:

1. To acquaint you with the improper use of controls which will result in accelerated spins.

2. To acquaint you with the pitch attitudes and rotational rates that will enable you to recognize an accelerated spin, and to teach you recovery procedures.

3. To emphasize to you that the pro-spin recovery procedures are fundamental essentials to recovery from any fully-developed spin in the T–37.

4. To increase your confidence in the positive recovery characteristics of the T–37.

5. To enhance your basic knowledge and proficiency in the control of these aviation phenomena.

SPLIT S

The Split "S" is a maneuver designed to show how much altitude can be lost if recovery from inverted flight should be attempted in this manner. It is basically the same as the last half of a loop.

To enter the maneuver, the aircraft should be set up for normal cruise at 90% rpm. The area below should be cleared carefully because a great deal of altitude will be lost during this maneuver.

From straight-and-level flight with 90% rpm, lower the speed brake. Raise the nose 20-30 degrees above the horizon. When the airspeed decreases to 120 knots, raise the speed brake and simultaneously roll the aircraft to the wings-level inverted attitude. From inverted flight, start back pressure to bring the nose through the horizon. Hold maximum back pressure possible without high-speed stalling. Release back pressure when the "half loop" is completed and the aircraft resumes straight-and-level flight. As much as 2000 to 3000 feet may be lost in a properly executed Split "S."

RECOVERY FROM DIVES

Many of the maneuvers demonstrated and practiced in flying training will result in intentional or unintentional dives. The following information is given to provide you with a sound basis for a recovery technique:

Recovery from all dives should be made smoothly, without excessive airspeed or loss of altitude. All aircraft are "red lined" or have a definite maximum allowable airspeed. This is indicated by a red mark on the face of the airspeed indicator. Should this maximum be exceeded at any time, an entry should be made in the AFTO Form 781. This writeup will result in an overall inspection of the wing, tail and control surfaces.

Another factor in the recover from dives is the "G" (gravity) force. It is present any time a change of direction is made which increases wing loading of the aircraft. This in-

creased loading can be identified by the increased seat pressure present whenever back pressure is applied to the stick. In a high-speed dive, a sharp pullout may result in the wings, tail, and controls being subjected to undue stress. This may "pop" rivets, twist the fuselage, and buckle or completely collapse the wing or control surfaces. This is why you must never exceed the design G-force limits of the aircraft. Learn them from the T–37 Flight Manual.

From time to time throughout your training, you may "black out" or "gray out" (impaired vision) during a tight turn or pull out. This is a normal and momentary condition caused by the forced draining of blood from the eyes and should not alarm you. Centrifugal force opposes a normal flow, and the capillaries around your eyes and brain are starved momentarily. The stresses you are placing on your body are also being placed on the aircraft. Avoid applying these stresses when it is unnecessary.

The pullout from any dive should be made with smooth back pressure and started before the airspeed has increased to such an extent that the red-line limits will be exceeded. Any time it is apparent that the airspeed will approach the maximum allowable (red-line) limits, retard the throttles, extend the speed brake, and raise the nose of the aircraft. You should know that the airspeed does not stop increasing as you begin raising the nose. It may increase until just before level flight is attained.

RECOVERY FROM INVERTED FLIGHT

The correct recovery procedure from inverted flight is to execute a roll back to the level-flight attitude. The technique employed is the same as in executing any roll maneuver. Apply aileron pressure in the direction you want to roll. The direction of the roll depends on the attitude of the aircraft. It should be made in the direction of the shortest turning radius. For example, if the aircraft is not completely inverted and the left wing is higher than the right one, the roll should be made to the left. In a wings-level inverted attitude, the recovery roll may be executed in either direction.

The next consideration is airspeed. Since inverted flight at very low airspeeds might be inadvertently encountered, there may be insufficient control effectiveness to make an immediate roll. Therefore, it may be necessary to lower the nose slightly before or during the recovery.

Whenever possible, maintain a fairly constant pitch attitude as the recovery is made. If this cannot be done because of low airspeed, let the nose of the aircraft lower while performing the roll back to the level flight attitude. This prevents an excessive loss of altitude.

Your instructor will give you the opportunity to practice this recovery technique. He will fly the aircraft into an inverted attitude, then let you make the recovery. This will be practiced with various airspeeds. The correct recovery technique is a roll back to level flight *Do not Split "S."*

CHAPTER 15

FORCED LANDINGS

You should be prepared at all times to cope with the emergencies that will exist should you have partial or complete engine failure. From time to time, your instructor will give you simulated forced landings by retarding the throttles and calling "forced landing" over the interphone. These simulated forced landings will prepare you to act promptly and effectively under actual emergency conditions. They will develop accuracy, judgment, planning technique, and confidence. You will never know in advance when a simulated forced landing will be given, so be alert at all times. Probably at no other time in your training will your judgment be more severely tested.

The simulated forced landing outlined in the following paragraphs will simulate the actual performance of the aircraft with dead engines. A glide will be established similar to that which would be encountered in an actual forced landing. Your instructor will let you descend low enough to determine approximately where the aircraft would land under actual conditions.

SELECTING THE FIELD

An alert pilot is constantly on the lookout for suitable forced-landing fields. Naturally, the best forced-landing field is an established airfield. The next best substitute is a hard-packed, long smooth field with no high objects on the approach end.

There are many factors to consider in determining the length of a field for a forced landing. Landing into a strong wind on a level field requires much less distance than that required for landing downwind. When landing on an upslope, the aircraft will decelerate rapidly, as into a headwind. Try to select a field that is wide enough to allow correction for errors in altitude and distance. It may be necessary to vary the final turn and the point of turn onto the final approach.

If it is impossible to land into the wind because of low altitude or lack of a suitably oriented field, then land crosswind or downwind. A large field that is crosswind, or even downwind, may be better than a smaller field which is directly into the wind. Always remember that if you cannot make an established airfield, BAIL OUT unless your emergency occurs at an altitude so low that a bail-out is impracticable. This is the only time you should elect to make a forced landing on an unprepared landing surface. It is important to remember that IF IT IS NECESSARY to land on an unprepared surface, you should do so with as many landing gear down as you can get.

DETERMINING WIND DIRECTION

You should always be aware of the direction from which the wind is blowing. Wind direction can be determined in different ways. Other than the wind indicators at an established field (wind sock, tetrahedron, etc.), the best indication of wind direction is smoke. Smoke that rises slowly and then drifts off indicates a very mild wind condition. Smoke that rises and then abruptly parallels the earth in a straight line indicates a fairly strong surface wind. Grass and grain fields ripple in the direction of the wind. Dust is another excellent wind indicator. If you are unable to determine wind direction by any

of these means, use the direction of the wind at the time of take-off.

You must realize that the wind velocity at lower altitudes may vary from that at higher altitudes and may be blowing from a different direction. You must take this into consideration when planning an approach. Keep your aircraft over the selected field. Do not let the wind blow you away from your chosen field.

SIMULATED FORCED LANDINGS

Your instructor will give you practice forced landings within reach of an airfield suitable for a landing, making it imperative that you use judgment and skill in maneuvering the aircraft into a proper and safe landing approach. You may or may not touch down in these instances, depending on the extent of local flying activity. Your instructor will judge whether or not you shall touch down.

All forced landings require good judgment in selecting the field, planning the approach and maintaining a constant glide. If the approach has been properly planned, you should never need to use more than a medium bank. During all forced landing practice, your instructor will handle the throttles and will apply power at the end of the simulated forced landing.

When you are given a forced landing:

The instructor will initiate the simulated forced landing by reducing the throttles to 65%, extending the speed brake and calling "forced landing."

You should first turn toward the field, then call out, perform or simulate the procedures as pre-briefed by your instructor, i.e., engine failure during flight (two engines), restarts, and forced landing procedures.

Attempt to arrive over the field selected at the maximum possible altitude. Remember, 125 knots gives the maximum glide distance, however, 120 knots will be maintained from the time the gear is lowered until the final approach because of design limits on the gear. The gear may be lowered when over the field. Your instructor will adjust the RPM to 55% when you lower the gear. This power reduction simulates the rate of descent with two dead engines. There is no absolute pattern for a forced landing. If it is possible, maneuver the aircraft to a "high key" point over the runway at an actual altitude of 3000 to 3500 feet so that an overhead pattern can be made. In any event, a "low key" point should be established; IF THIS IS NOT POSSIBLE—BAIL OUT. The low key point is normally at 1500 to 2000 feet above the ground, but if a high key cannot be reached, the low key point may be slightly above 2000 feet. Keep the low key point in fairly close so that if the final turn is misjudged, it will be possible to angle back in and still make the field. Your approach should be planned so as to touch down at the one-third point on the runway.

Simulated forced landings will often be practiced in remote areas without any intention of touching down. This is termed a "low-go" SFO (simulated flameout). These will be terminated at or above 300 feet above the terrain. It will be your instructor's responsibility to adjust the throttles to takeoff power when the SFO is terminated. After your instructor adds the power and retracts the speed brake, you will perform a go-around procedure. However, it will not be necessary to perform clearing turns during the go-around in remote areas. Power will be reduced to 96% rpm when climbing airspeed has been attained. The first turn may be made at a minimum of 500 feet above the terrain.

The simulated forced landing normally will be given from such a position that you will be able to maneuver the aircraft to a high key position over the landing end of the runway (slightly wide of the landing end) at 3000 to 3500 feet above the ground. A 360° pattern will then be made. This pattern should proceed as follows:

1. *High Key Point:* This is normally 3000 feet above the terrain. Landing gear is lowered and checked here if not previously done during descent. Airspeed is 120 knots. A

shallow to medium-banked turn is initiated in the normal pattern direction. The instructor will secure approval of mobile control for the forced landing pattern.

NOTE: In the event of double engine failure, flaps may be inoperative due to no hydraulic pressure; flaps, therefore, normally will not be lowered.

2. *Low Key Point:* This is after the 180° turn from the high key point, at the position corresponding to the downwind leg. Altitude should be approximately 1500 to 2000 feet above the terrain at this point. The airspeed remains at 120 knots. Watch for aircraft making a normal pattern entry. The forced landing pattern is designed to be circular, but the turn may be steepened, shallowed, or even discontinued at any point to adjust the flight path for accuracy. Plan the pattern to touchdown on the one-third mark on the runway.

3. *Base Key Point:* This point follows the Low Key and is at 270° of turn. It is the position corresponding to that of a half-completed final turn. Altitude should be approximately 800 to 1000 feet above the terrain. "Play" the turn toward final approach to assure arriving at the desired point, wings level, on final.

4. *Final Approach:* Wings will be level when rolling out on final approach at not less than 300 feet above the terrain. Reduce the glide speed to 110 knots. Slip the aircraft if necessary to land at the one-third mark. If an actual touchdown is to be made, throttles may be reduced to IDLE after the roundout.

NOTE: If you are over the field and sufficient altitude is available, the gear should be lowered prior to reaching the high key point. This will enable you to better judge your glide in the pattern and will also give you more time to get the gear "down and locked" in the event of hydraulic failure. In an actual forced landing situation, if a choice of several runways exists but your altitude for reaching one into the wind is questionable and a runway with a crosswind can be more safely reached, do not hesitate to use it.

CAUTION

If an actual forced landing is being made, the canopy may be jettisoned by the canopy jettison "T" handle just prior to touchdown (pilot's discretion). However, you will be briefed on the hazards of contacting the arresting barrier with canopy off or open.

An alert pilot always plans ahead. You will be flying from only a few airfields during your flying training. You should memorize the terrain features and suitable forced-landing fields off the end of each runway. If engine failure occurs during a takeoff, you may not have time to look around for a field, but if you have selected your spot previously, you will have saved precious time. You must plan for every eventuality.

SLIPS

Slips will be demonstrated and practiced before solo. The T–37 has excellent stability in slip maneuvers as long as normal glide speed is maintained. Slips will be used whenever desired in forced landings. They will not be used in solo landings except in emergencies.

To enter a slip, apply rudder away from the desired direction of the slip, and as the nose comes up, apply opposite aileron and forward stick pressure to keep the nose down. The cross-controlled condition will keep the airspeed from increasing appreciably and no hazardous flight conditions will exist as long as the nose is held down. When slipping in a turn, always apply top rudder and slip downward in the direction of the turn. For example, in a turn to the left, apply right rudder and slip downward to the left using left aileron.

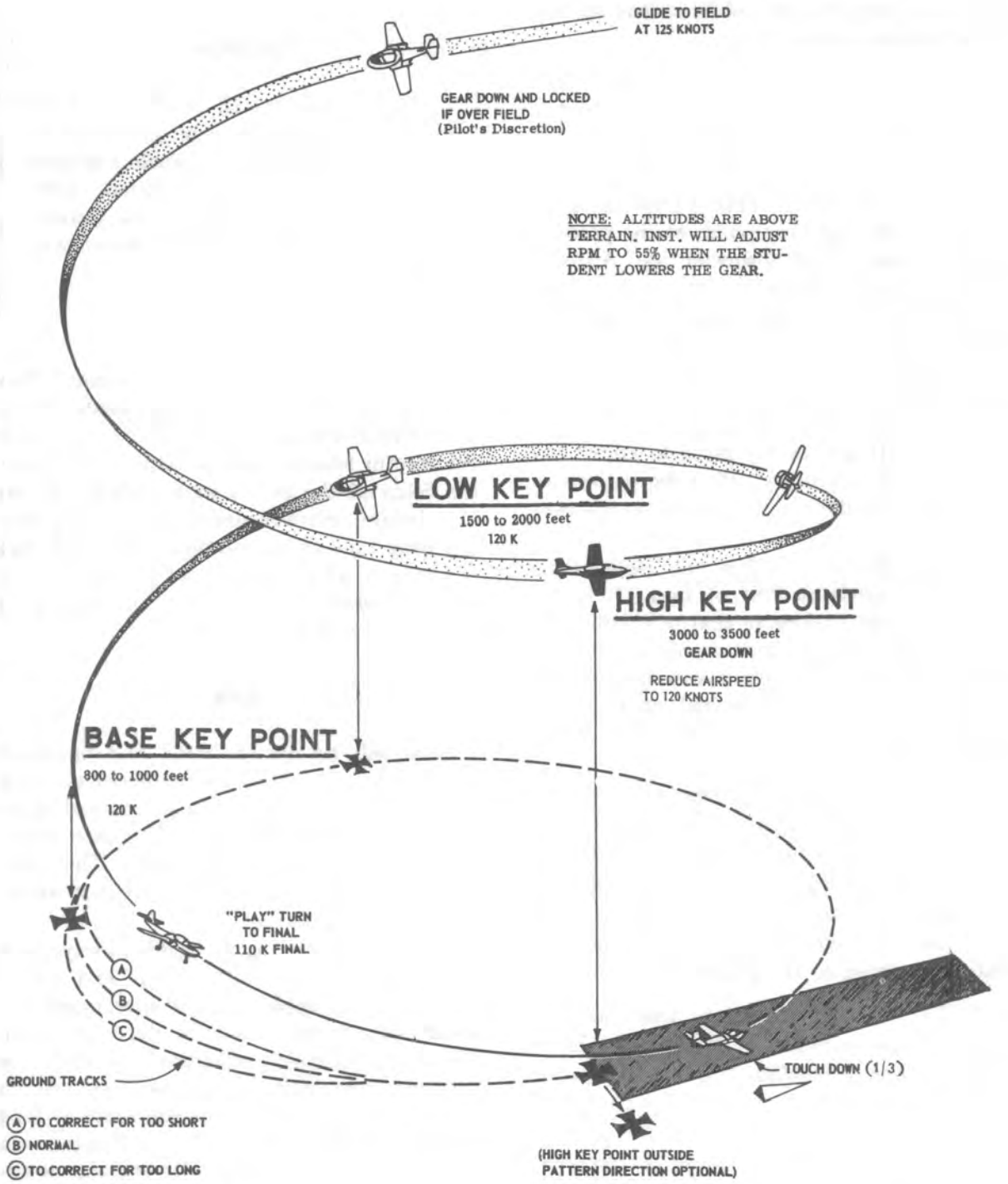


FIGURE 15–1 *360 Degree Overhead Simulated Forced Landing Pattern*

ACTUAL FORCED LANDINGS

As you may have realized by this time, all of the practice and instruction that you get in simulated forced landings are given to you for one purpose: to prepare you to make a successful forced landing if the need arises. The procedures and techniques which you learn should be second nature to you and can be readily adapted to actual forced landings. (Refer to the T–37 Flight Manual for actual forced landing procedures.)

Your chances of making a successful forced landing will be greatly improved if you remain calm. The landing can be accomplished with no damage to the aircraft and no injury to the pilot. Remember these points:

Remain calm.

Accomplish your cockpit procedure.

Select your field.

After you have selected your field, do not change to another one.

Plan your approach and follow your plan.

If time permits, attempt an air start.

All forced landings should be made with the gear extended. However, if it should become necessary to land gear up, such as in engine failure on takeoff, brace yourself forward against the shoulder harness. With gear up, the aircraft will slide for some distance on the fuselage. When it stops, abandon the aircraft and stay at least 500 feet away. Whenever you have time to get the gear down, do so. The landing gear was built to withstand shock. Tires can be replaced easily if you blow them out.

NOTE: After a forced landing is completed away from the home base, do the following:

1. Notify the home station immediately by telephone or telegraph (government collect).

2. Direct telephone calls to your Group Commander, telegrams to the Commander, _____AFB. Give this information:

Tell your exact location and type of field.

Cause of landing.

Condition of personnel.

Condition of aircraft.

Directions for contacting the pilot by telephone or telegraph.

3. Stay with the aircraft until you receive instructions or assistance.

4. If injured, enlist help to send your message and to guard the aircraft.

5. Do not leave until authorized by compentent authority to do so.

6. Do not discuss the details of the cause of your landing with civilians.

CHAPTER 16

MAXIMUM-PERFORMANCE MANEUVERS

Maximum-performance maneuvers help you develop and perfect your technique in operating an aircraft to obtain maximum flight performance. These maneuvers are maximum-performance climbing turns, chandelles, and lazy 8's.

Conscientious practice of these maneuvers will pay big dividends in providing you with knowledge of control pressures, timing and planning—all of which are necessary to precision flying.

MAXIMUM–PERFORMANCE CLIMBING TURN

This maneuver is a climbing turn beginning from straight-and-level flight and ending in a wings-level, nose-high, level-flight attitude. The maximum flight performance is demanded of the aircraft; that is, you gain the most altitude possible for a specified degree of bank and power setting without stalling the aircraft.

This maneuver is taught to develop "timing" and "feel" for maximum-performance flight, and to develop roll-out techniques at low airspeed. For these reasons, it will also prepare you for chandelles.

Since the maximum-performance climbing turn is a clearing maneuver in itself, it is unnecessary to make clearing turns before entry. Look in the direction of the turn and clear the area visually before beginning and while performing the maneuver.

Start from normal cruising, straight-and-level flight with 90% rpm; blend the rudder, aileron, and elevator pressure simultaneously to start a climbing turn.

During a normal climbing turn, the attitude is constant and the pitch-attitude corrections are relatively small. In the maximum-performance climbing turn, the pitch and bank attitudes are constantly changing. Continue the roll-in until the angle of bank reaches approximately 60°, and keep the nose rising at a constant rate. Check outside references and the Attitude Indicator for the correct angle of bank. As the bank is increased, the vertical lift component will be reduced. More back pressure must be applied to keep the nose rising steadily. This loss of vertical lift component is greatest when the bank is steepest. The greatest amount of back pressure is required at this point. If you fail to apply sufficient back pressure, the nose will not rise steadily.

When a bank of approximately 60° has been obtained, begin rolling the wings level with coordinated rudder and aileron pressures. Allow the nose to keep rising until the wings become level. Since the angle of bank is decreasing during the roll-out, the vertical lift component will increase. For this reason, you will find it necessary to release a slight amount of back pressure in order to keep the rate of climb from increasing. If you fail to release some back pressure, the nose will rise too rapidly during the roll-out.

The wings should become level just before maximum altitude is reached and as the maximum pitch attitude is obtained. When the wings are level, note the pitch attitude of the aircraft by checking outside references and the attitude indicator. Hold this pitch attitude momentarily. Crosscheck outside references to maintain your heading. Now lower the nose to level flight attitude. Check the Altimeter and if level flight has not been established,

make the necessary pitch change using outside and Attitude Indicator references.

No definite degree of turn is required in this maneuver. When a bank of approximately 60° is attained, begin the roll-out. The rate of roll-out should be the same as the rate of roll-in. If the rate of pitch increase is rapid, the roll-out, if delayed too long, will necessarily be fast in order to level the wings and return to level flight before a stall occurs. This is poor technique.

If the rate of roll-in is slow, the roll-out should be started a little early so the wings may be leveled at the same rate of roll by the time the maximum pitch attitude is attained. The nose is lowest at the beginning of the maneuver and highest when the wings again become level. The nose track should progress from the lowest to the highest point at a uniform rate. The nose should describe a straight line diagonal to the horizon as it moves up to the highest point of the maneuver.

Remember that in slow-airspeed conditions more controls are necessary to get the desired aircraft response. In the roll-out, aileron drag will create adverse yaw which must be corrected with rudder to maintain coordinated flight. Refer to the section on *Slow Flight* (Chapter 9) for more information on this subject.

These techniques must be employed in any maneuver that incorporates a slow speed roll-out, such as the chandelle.

CHANDELLE

The chandelle is a precision, 180°, steep climbing turn with a maximum gain of altitude. It is taught to develop precision, coordination and to increase your ability to remain oriented. Conscientious practice of this maneuver will improve your ability to control the aircraft through a large speed range as well as to develop a refined sense of timing and "feel" for maximum-performance flying.

Since this is a clearing maneuver itself, no clearing turns before entry are necessary. Look in the direction of the turn and clear visually before beginning and while performing the maneuver.

Adjust the throttles to 90% and enter the maneuver by executing a descending turn to line up the fuselage with a road or parallel section lines. Plan the turn and the rollout so as to align the aircraft with selected ground lines in a shallow dive of 20-30°. When the airspeed reaches 200 knots, blend rudder, aileron, and elevator pressures, simultaneously, to begin a climbing turn. This is accomplished in the same manner as the maximum-performance 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.

The nose of the aircraft should pass through the horizon between 30–45 degrees of turn, and at this time, the maximum bank angle of approximately 60 degrees should be reached. Note the amount of turn by checking outside references. Time the bank and pitch increase so that when the nose passes through the horizon, your bank attitude will be 60° (crosscheck Attitude Indicator and outside references). At this point, the vertical component of lift will decrease so that considerably more back pressure will be required to keep the nose track rising at a uniform rate.

Continue to observe the amount of turn by checking outside references.

As soon as the 135° point in the turn is reached, start the roll-out. Allow the nose track to continue to rise at a uniform rate. Since a large amount of back pressure was applied when the bank was steepest, it will be necessary to release some back pressure as the bank is decreased. By releasing some back pressure, you will keep the nose from rising abruptly in the last part of the maneuver.

Continue to observe the amount of turn remaining before reaching the 180° point by checking outside references. The roll-out should be timed so that the wings become level and the nose reaches the highest pitch attitude at the 180° point. Hold this pitch attitude momentarily. Crosscheck outside references to maintain your heading. Now lower the nose

to level-flight attitude. Check the Altimeter and if level flight has not been established, make the necessary pitch change using outside references and the Attitude Indicator.

This maneuver is similar to the maximum-performance climbing turn except that definite degree of turn must be accomplished. If the rate of climb is too fast, the aircraft will approach a stall before turning 180° and the maneuver must be discontinued. If the rate of pitch change is slow, the 180° 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.

One point must be emphasized. When starting the maneuver, the rate of roll-in is faster than the rate of pull-up; there is a greater change in bank than in pitch from the (beginning to the) completion of the maneuver. The bank will increase to 60° and then back to level. The total pitch change may only be 55° or 60°.

The nose should describe a straight line that is diagonal to the horizon from the lowest point at the beginning of the maneuver to the highest at the 180° position.

The maneuver should be timed so the nose will not have to be lowered to prevent a stall before wings are leveled. After the wings have been leveled, lower the nose to complete the maneuver before a stall occurs.

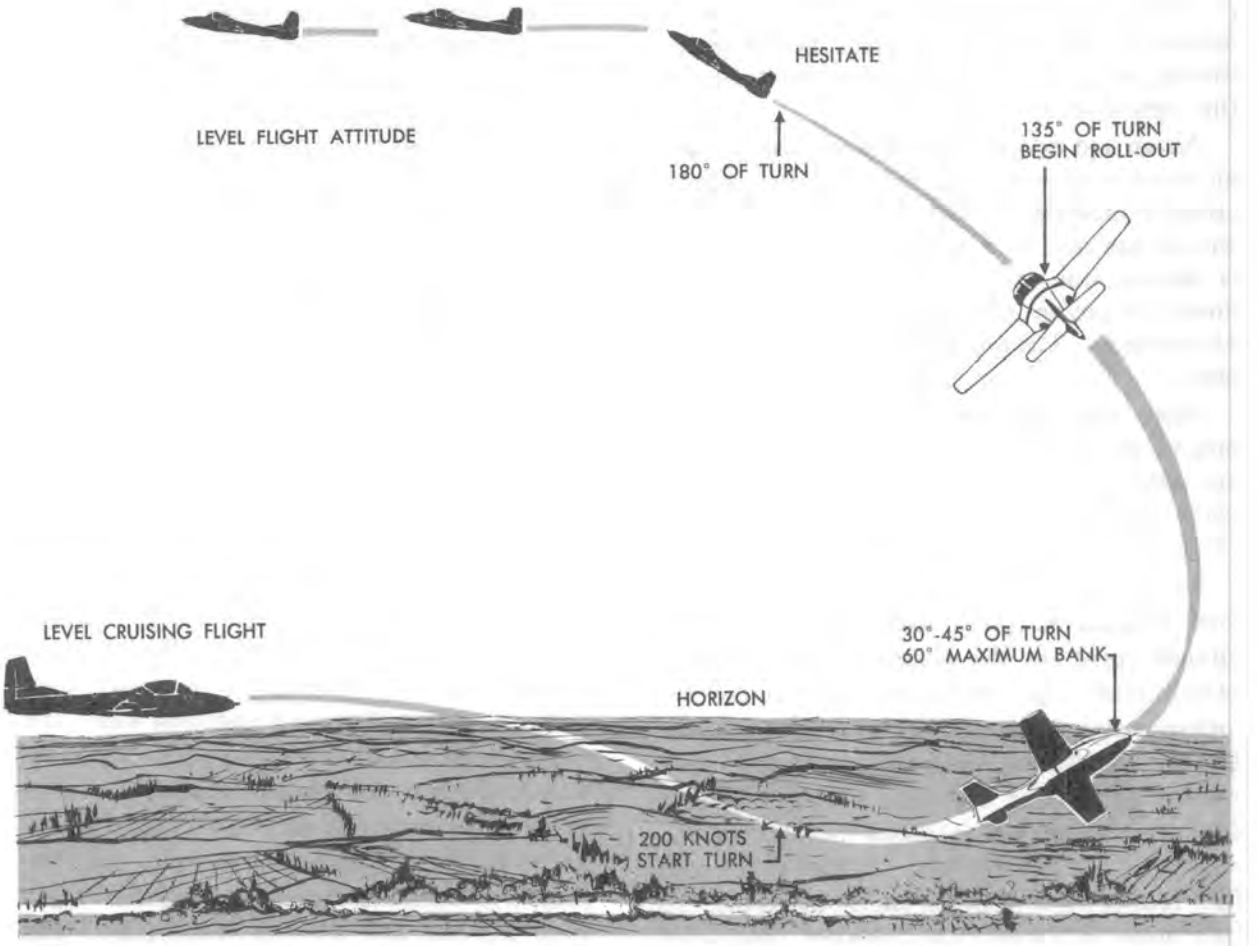


FIGURE 16–1 *The Chandelle*

LAZY 8

A lazy 8 is a slow, lazy maneuver in which 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. This maneuver utilizes a 180° change of direction and reversal and requires a continuous change of pitch and bank.

To execute the lazy 8, you will use a combination of the climb, dive and turn. This maneuver will help you develop your ability to orient yourself, your planning ability, and a "feel" for maximum-performance flying. You will use constantly changing control pressures, necessitated by changing combinations of climbs, dives and banks, which result in varying airspeeds.

The flight path across the ground is not of prime consideration. However, the maneuver should be performed with the initial turn into the wind to minimize drift.

As an aid to making symmetrical "loops" of the 8 and remaining oriented, you should select a prominent point on the horizon, preferably upwind, 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 is to perform good lazy 8's.

Since this is a clearing maneuver, it will not be necessary to make clearing turns prior to entry. Look in the direction of the turn and clear the area visually before beginning and while performing the maneuver.

In straight-and-level flight with 90% rpm and cruising airspeed, select the desired reference point on the horizon, preferably upwind. Now align the aircraft so that the reference point is directly off a wing tip. Blend aileron, rudder, and elevator pressures simultaneously to start a gradual climbing turn in the direction of the reference point. The initial bank should be very shallow to prevent the rate of turn from becoming too rapid. As the nose is raised, the airspeed decreases, causing the rate of turn to increase. Since the bank is being increased, this too will also cause the rate of turn to increase. Unless the maneuver is begun with a shallow bank, the rate of turn will become too rapid and you will overshoot the reference point.

Time the turn and pull-up so that the nose reaches the highest pitch attitude when the aircraft has turned 45° or halfway to the reference point. At this point, you should have your maximum pitch attitude above the horizon, and the angle of bank approximately 45°. Use outside references and the Attitude Indicator to crosscheck these pitch and bank attitudes. Do not hold the nose in this attitude, but lower it slowly to the horizon and toward the reference point as you continue to increase your bank to a maximum of 80-90° as the nose reaches the horizon. Crosscheck outside references and the Attitude Indicator for correct bank. The top center of the nose should reach the horizon at the 90° reference point. Keep a check on the progress of the turn by checking outside references. The lowest airspeed will be encountered just as the nose reaches the horizon and should be approximately 100 knots.

Do not stop the nose at the horizon, but fly the aircraft into a descending turn so that the nose track describes the same size "loop" below the horizon as it did above. As the nose track passes through the horizon, begin to decrease the bank gradually. When the aircraft has turned 135°, the nose should have reached its lowest attitude. The bank attitude should diminish during the descending turn at about the same rate it increased in the climbing turn.

When you have reached the 135° point, there is 45° of turn remaining before the nose track will again intersect the horizon, wings level. Continue blending sufficient stick and rudder pressure to simultaneously raise the nose and level the wings. Observe the progress of the turn and estimate the number of degrees of turn remaining to arrive at the 180° point by checking outside references. Plan your roll-out and pull-up accordingly. The wings should become level as the nose reaches level flight attitude at the 180° point. This is

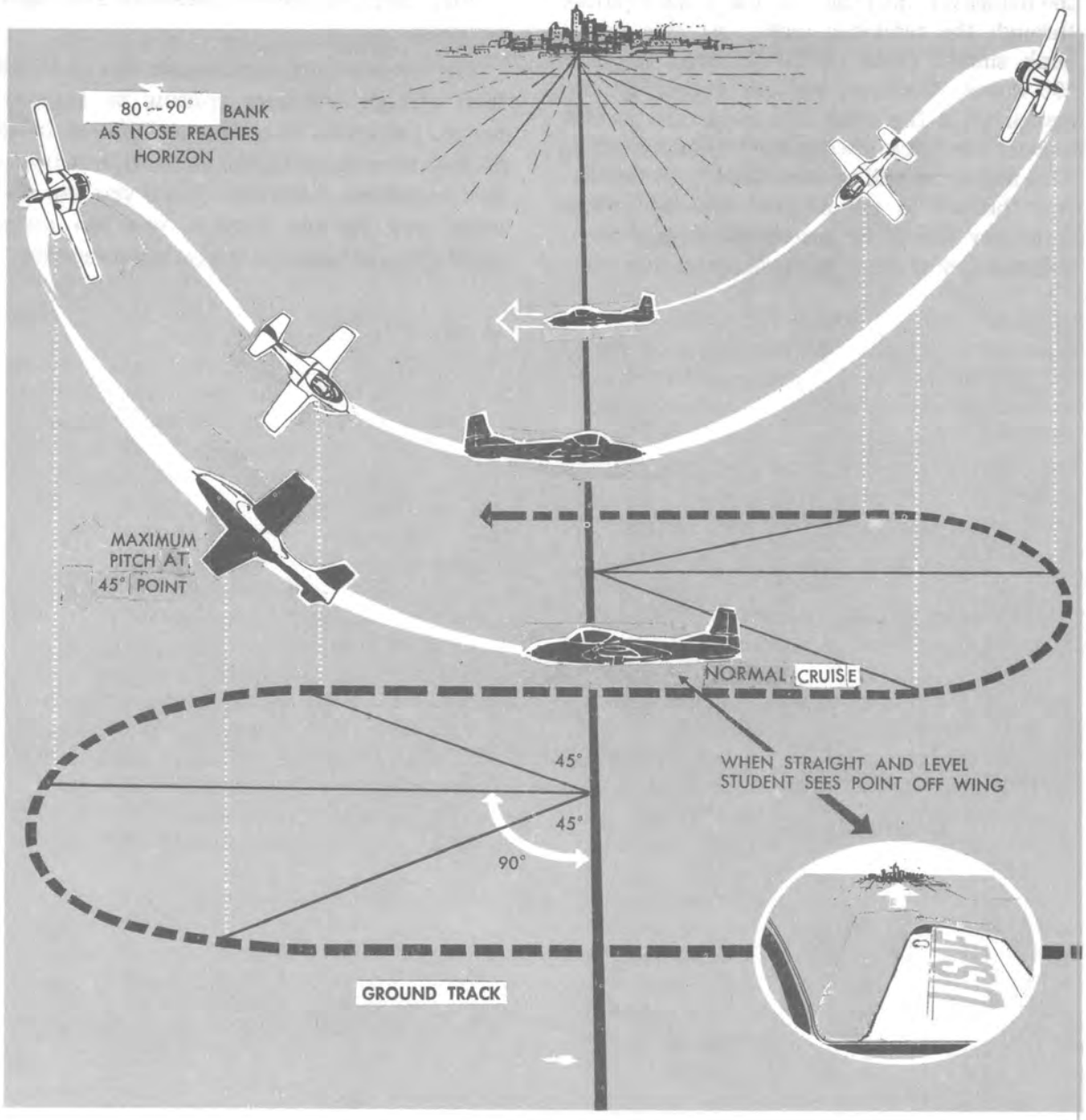


FIGURE 16–2 *The Lazy 8*

the only point in the maneuver that the wings are level other than the beginning and ending.

Having completed half the 8, the opposite wing will now be toward the reference point on the nose of the 180° point with entry airspeed regained. Do not hesitate in straight-and-level flight, but begin another climbing turn in the direction of the reference point. This turn will be opposite to the one used at the start of the maneuver. Continue through the second 180° turn as you did the first, climbing and turning to attain about 45° of bank with maximum pitch. Continue banking and decreasing pitch as in the first quarter of

the maneuver until the nose track again passes through the reference point. At this point, bank should again be 80–90° and airspeed 100 knots. Continue the last quarter of the maneuver in the same manner as the second quarter but back toward the beginning point. This maneuver will be completed with the aircraft headed in the original direction. The maneuver should be accomplished in a slow, lazy manner without hesitation and with constantly changing control pressures and flight attitudes.

The airspeed in this maneuver should range from straight-and-level cruising to approximately 100 knots. During your initial training do not concentrate on the airspeed, but try to fly the pattern correctly. When you can visualize and fly the pattern, you can make slight changes to attain the correct airspeeds.

AEROBATICS

Aerobatics are smoothly executed maneuvers which exploit the entire performance envelope of the aircraft.

The purpose of teaching you aerobatic maneuvers is to help you develop a more sensitive feel in handling the aircraft, to improve your ability to coordinate the flight controls to maintain full awareness of your orientation regardless of attitude and put the aircraft where you want it. Learning to perform aerobatics skillfully will give you more confidence in your flying ability, help you become familiar with all attitudes of flight and increase your ability to fly an aircraft throughout a wide performance range. Aerobatics will teach you to feel at ease when your body is oriented at any angle—and that you can think, plan, observe and perform as easily inverted as upright. Though having the ability to perform aerobatics is important within itself, the confidence you gain from performing these maneuvers is equally important.

Your instructor will show you how to determine the attitude of the aircraft by a combination of outside and instrument references. The Attitude Indicator will give a direct indication of all pitch and bank attitudes encountered during aerobatic maneuvers. However, the specific instrument references will be covered for each maneuver.

The aerobatic maneuvers which you will learn to perform are the loop, barrel roll, aileron roll, Immelmann, clover leaf, and Cuban 8. Although not a precision aerobatic maneuver, recovery from vertical flight attitudes will be taught preceding your introduction to the other maneuvers.

Minimum altitude during any maneuver will be 6000 feet above the ground, or higher as directed locally. Fuel will not be in excess of 1000 pounds for solo students.

Before entering an aerobatic maneuver, check safety belt and shoulder harness tight and trim the aircraft for straight-and-level flight. Do not trim the aircraft during an aerobatic maneuver. Prior to entry, clear the area visually. If your airspeed is higher than that specified for the planned maneuver, dissipate the airspeed by use of the speed brake or by climbing; then make a normal entry as prescribed.

RECOVERY FROM VERTICAL FLIGHT

This maneuver is designed to teach the best method to regain straight-and-level flight if the aircraft is maneuvered into vertical flight inadvertently. You will, however, intentionally fly through the vertical attitude many times during aerobatic practice. Suppose that you unintentionally arrive in this attitude without a predetermined plan for recovering. Unless a safe recovery is effected, you will fly into a severe stall or spin, or place undue stress on the aircraft.

The recovery technique outlined in this manual incorporates smooth, coordinated flight and is identical to the recovery used in tactical jet aircraft. Proper application with this technique will return you to level flight without negative "G" forces being applied to the aircraft.

Before entering the maneuver, adjust the throttles to 96% and clear the area. Dive to attain an entry airspeed of 250 knots. Level the wings and raise the nose smoothly to level flight.

When the nose reaches this attitude, begin applying greater back pressure to increase the pitch attitude at a more rapid rate. Use aileron and rudder pressure to keep the wings level and to maintain directional control. Use the Attitude Indicator and the Turn-and-Slip indicator to help maintain wings level and direction. Since this maneuver is accomplished with a high entry airspeed, you should use smooth pressures in flying to the vertical attitude.

When you can no longer see the horizon over the nose, look at the wing tips and keep them equidistant from the horizon. Also, refer to the two instruments mentioned above to aid in determining the exact attitude of the aircraft. To determine when you are in vertical flight refer to the wing tips and the Attitude Indicator. At approximately the vertical attitude, continue back pressure and coordinate aileron and rudder pressure to initiate a roll. If the aircraft is not perfectly vertical, this roll should be made toward the low wing; otherwise, the direction is optional.

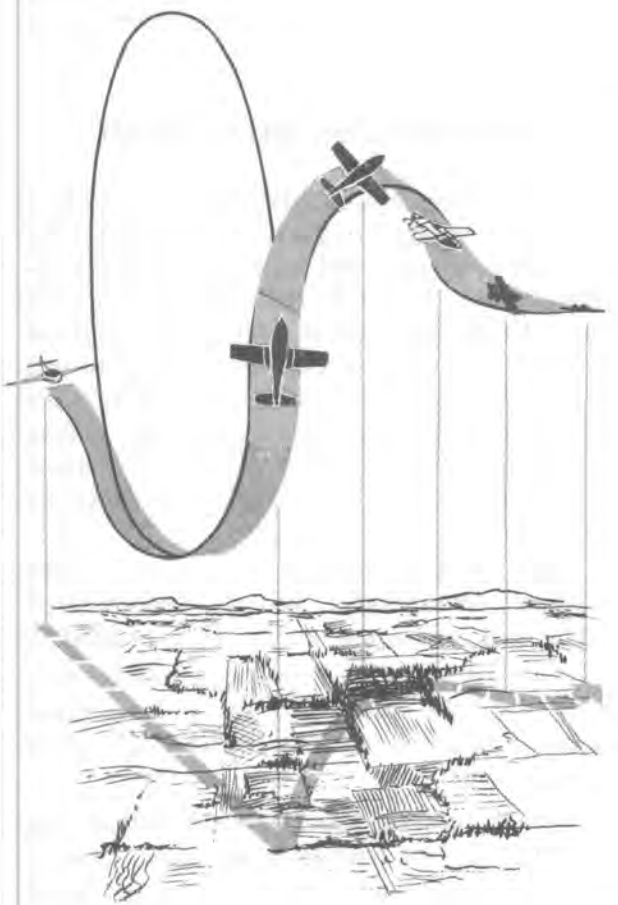


FIGURE 17–1 *Recovery from Vertical Flight*

Caution must be used to avoid a stall from excessive back pressure, but sufficient back pressure must be applied to keep the aircraft's nose coming smoothly down toward the horizon.

Continue these control pressures to execute approximately a one-quarter roll and fly the aircraft smoothly down through the horizon. As the nose of the aircraft reaches the horizon it should be inverted with wings approximately level. Again the Attitude Indicator will be the instrument reference. Continue with a coordinated roll in the same direction to return the aircraft to upright level flight. In this maneuver, the nose of the aircraft will describe an arc through, then below, the horizon, and back to level-flight attitude. Use outside references, the Altimeter and the Vertical Velocity Indicator to aid in determining level flight upon completion of the maneuver.

LOOP

The loop is a 360° turn in the vertical plane, and since it is executed in this single plane, the elevator is the basic control. The ailerons and rudder are used for coordination and directional control.

Adjust the throttles to 96% and begin the maneuver by clearing the area. Attain an entry airspeed of 250 knots by diving the aircraft while clearing.

To remain oriented, you should select a road or section line for a ground reference. Clear the area while lining the aircraft up with or parallel to this reference and keep it lined up throughout the loop. The Attitude Indicator and the Turn-and-Slip Indicator are the instrument references to use when performing the loop.

When a speed of 250 knots has been attained, raise the nose smoothly to level flight. Increase back pressure to maintain a constant rate of movement of the nose throughout the pull-up. Centrifugal force will cause you to feel a definite seat pressure. Use this seat pressure (about three "G's" on the Accelerometer) to determine the correct rate of movement of the nose. For example, if there is very little seat pressure, your rate of pull-up is too slow.

Keep the wings level and maintain direction with a combination of aileron and rudder. When you can no longer see the horizon ahead, look at the wing tips and keep them equidistant from the horizon. After passing the vertical flight position rotate your head back and watch for the horizon to appear. Use the horizon to maintain a wings-level attitude, and locate the road or section lines on the ground that you used to begin the maneuver.

As the inverted position is attained, a very small amount of back pressure should be released. However, maintain a definite seat pressure. This prevents a stall at the low airspeed encountered at the top of the loop. Use aileron pressure as needed to keep the wings level.

As the nose passes through the horizon and the aircraft re-enters a dive, you should increase back pressure to return the nose up to the level flight attitude. Throughout the last half of the maneuver, you should use the selected road or section lines for reference to follow or to parallel with the nose of the aircraft.

The elevator is the basic control used to execute the loop. The ailerons and rudder are used to maintain direction and coordination. If you pull up too fast, you will exceed the critical angle of attack and stall. If your initial pull-up is slow, you will lose too much momentum and a stall will occur before the aircraft reaches the inverted position because of too low an airspeed.

Keep the nose moving at a constant rate throughout the maneuver. Check your altitude before entering the loop and try to recover at the same altitude. The Attitude Indicator, Airspeed and Turn-and-Slip Indicators are the instrument references. The Directional Indicator may be cross-checked before and after the maneuver to determine whether direction was maintained in the vertical plane.

BARREL ROLL

A barrel roll is a coordinated roll in which the nose of the aircraft describes a circle around a point on the horizon. Definite seat pressure should be maintained throughout the roll.

The barrel roll should be practiced both to the right and to the left, and there should be little or no net loss or gain of altitude from the maneuver.

Adjust the throttles to 90% and begin the maneuver by selecting a reference point and clearing the area. The reference point should be on or near the horizon—a cloud or a landmark. Attain the entry airspeed of 200–230 knots by diving the aircraft while clearing.

The Attitude Indicator will be the main instrument reference when performing barrel rolls. To aid coordination, the Ball of the Turn-and-Slip Indicator is used.

The 200–230 knot airspeed should be attained with the nose of the aircraft below the reference point. Begin a coordinated turn in the opposite direction of the desired roll. Keep the aircraft nose below level flight until it has turned approximately 20°–30° to the side of the reference point. Then begin rolling out of the initial turn and allow the nose to rise so that the wings are level just as the aircraft fuselage passes through a level-flight attitude. At this point the radius of your circular nose track to the side of the reference point is established and should remain constant around the point throughout the barrel roll.

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 point just above the reference point. As you approach this position, relax some of the back pressure

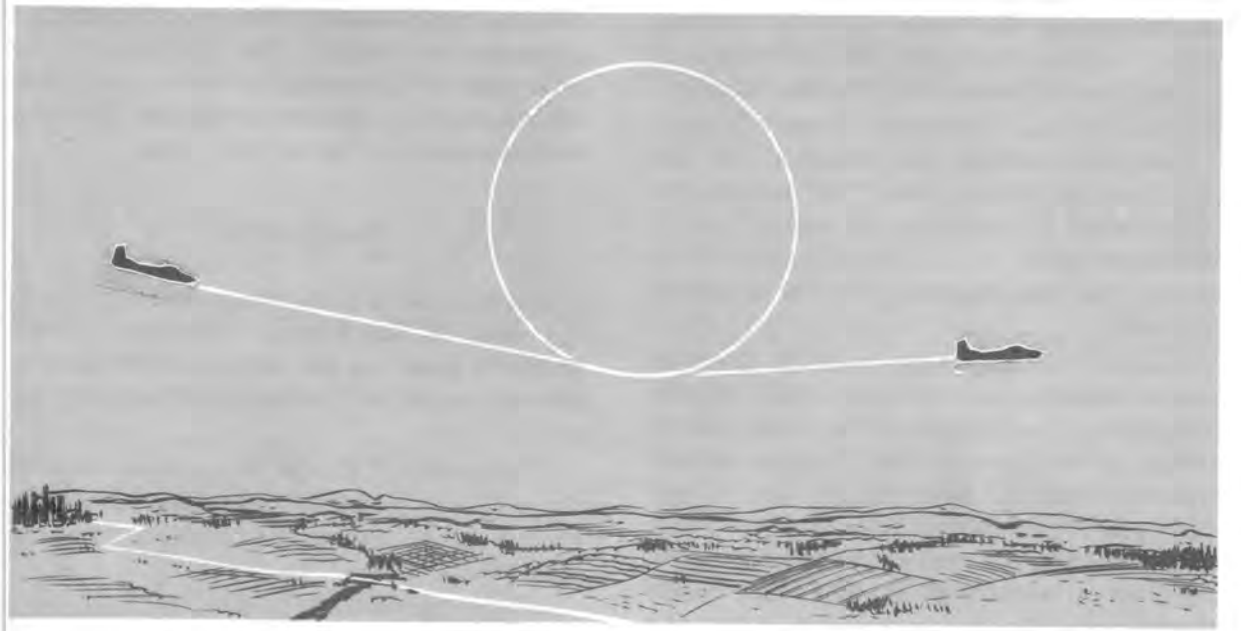


FIGURE 17–2 *The Loop*

but continue the roll by blending in more aileron pressure. Plan the roll so that the inverted wings become level just as the aircraft's longitudinal axis becomes level. 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 semi-circle about the reference point. As the aircraft passes this position, continue the roll and begin applying increased elevator pressure.

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 as its center. In this last quarter you must begin to blend in more elevator and maintain coordinated control pressures to continue the roll so that 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 vertical position in the first quarter of the roll is to maintain a constant rate of roll. Since 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 that the rate of roll will slow down unless more aileron surface is presented to the relative wind. By applying added aileron pressure the rate of roll is held constant.

In the second quarter of the roll, if you hold the same amount of back pressure as was used in the first quarter, it would pull the nose down too fast in relation to the horizon because gravity is now assisting lift (downward).

In the third and fourth quarters, the application of additional back pressure helps to coordinate the pitch with the roll to describe the proper nose track.

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 overcontrol with the rudder or elevator; they are used only to maintain coordination. Throughout the maneuver, the aircraft should remain in coordinated flight. Definite seat pressures should be maintained.

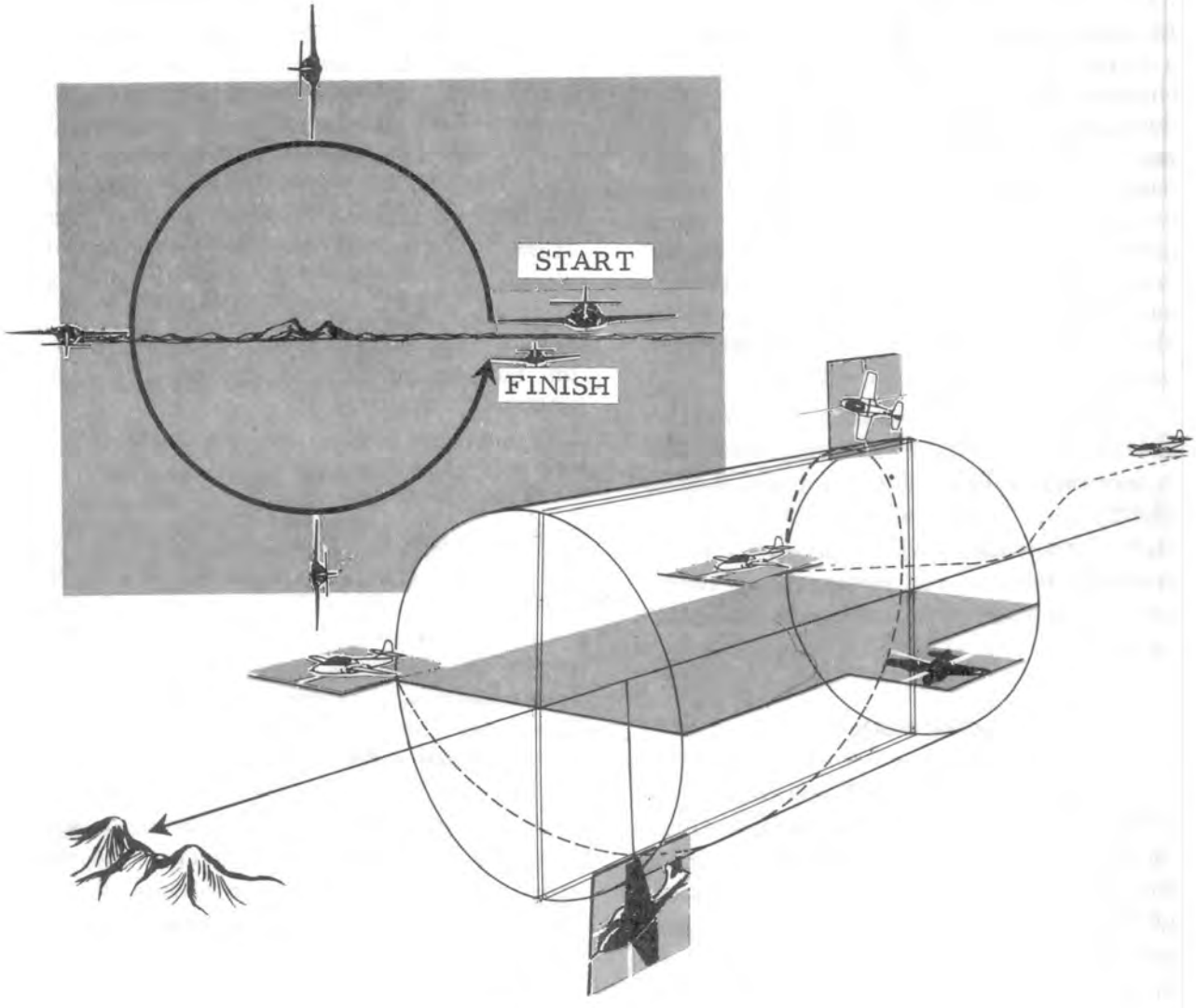


FIGURE 17–3 *The Barrel Roll*

AILERON ROLL

The aileron roll is similar to the barrel roll although much easier to execute. The greatest difference in the two maneuvers is the reduced importance of the elevator in the aileron roll. All controls are of almost equal importance in executing a smoothly coordinated barrel roll. The ailerons are of primary importance in the aileron roll, and it may be performed in either direction.

The instrument references for the aileron roll will be the Airspeed and Attitude Indicators, the Altimeter.

Adjust the throttles to 90% and begin this maneuver by clearing the area. Attain the entry airspeed of 200 to 230 knots by diving while clearing. When you have attained an airspeed of 200 to 230 knots, smoothly raise the nose to approximately a 20°–30° pitch attitude, relax back pressure and initiate the roll by briskly applying coordinated aileron and rudder pressures as in beginning a normal turn. After the aircraft begins to roll,

relax rudder pressure and steadily increase the aileron pressure. The nose pattern is like a letter "C" and is maintained almost exclusively with aileron pressure. The vertical displacement of the nose in the "C" is a natural result of the pitch that is established to begin the maneuver. The initial use of rudder will pull the nose off center, and the established lift will pull the nose down as the aircraft becomes inverted in the roll. Gravity and the diminishing airspeed contribute to this also. You must apply aileron as necessary, to obtain the desired rate of roll.

As the aircraft approaches recovery attitude, back pressure must be reapplied. This is necessary to bring the nose track back up slightly from its lowest point. Also, as level flight is approached, aileron pressure must be gradually released and corresponding rudder pressure applied to insure a smooth, coordinated return to level flight.

IMMELMANN

The Immelmann is a half loop followed by a half roll. To enter the Immelmann, adjust the throttles to 96% and select one or more ground reference lines, as explained for the LOOP. Be especially careful to clear the area behind you. While clearing, dive the aircraft to attain an entry airspeed of 270 knots. When you have attained the proper airspeed, raise the nose smoothly to the horizon as you did when entering the loop. Continue the movement of the nose by increasing the back pressure to maintain a constant rate of movement of the nose throughout the pull-up (about 3 G's on the Accelerometer). Maintain wings level with aileron. As the aircraft reaches a point about 20° above the horizon inverted, apply aileron in either direction to initiate a half roll. Rudder through the first quarter roll should be opposite to applied aileron pressure. Rudder will be reversed and coordinated in the same direction as applied aileron in the last quarter of the roll.

During the first 45° of the half roll, it will become necessary to relax some back pressure to keep the nose track in the same vertical plane. This back pressure must be increased again as the level-flight attitude is approached because with your decreased airspeed the nose will want to drop. Increase the blended rudder pressure during the last part of the roll-out to hold the nose in the vertical plane. The maneuver is complete after a momentary pause in the level flight attitude following the roll-out. The Attitude Indicator, Turn Indicator and Airspeed Indicator are the instrument references.

CLOVER LEAF

The top part of this maneuver is similar to the recovery from vertical flight. The lower part resembles a loop. It is composed of four identical maneuvers, each begun in a new direction 90° from the preceding one. It will help develop your timing and your planning. The clover leaf should be performed smoothly without rapid rates of roll or excessive "G" forces.

If possible, choose an area with ample section lines for repeated easy reference. Adjust the throttles to 90% and clear the area, diving as necessary to obtain 200 knots, and except for airspeed, enter as in the loop. Pick your first reference point 90° from the nose, as you would in a Lazy 8. Start a climb and keep checking this point as you progress through the climb.

Upon reaching a 60–70° pitch attitude, begin a coordinated roll toward the selected 90° point. Increase back-stick pressure moderately as you begin the roll, so that the maneuver will be fairly slow and lazy. Your first objective is to bring the nose through the horizon on your selected point as the wings become level in the inverted position and at a relatively low airspeed. (You should not be looking at the Airspeed Indicator but the aircraft should feel about the same as when coming through a normal loop.)

As the aircraft is brought through the 90° point, keep the wings level and pull through the bottom of the maneuver, the same as at the bottom of a loop. Plan the pull-up so that the level-flight attitude is reached with 200 knots. To avoid excessive G's at the bottom of the pull-up, apply more back pressure soon after the nose track descends below the horizon and hold it sufficiently to keep the airspeed from building up too quickly during the initial part of the pull-out. Some back pressure then may have to be eased off in order to reach 200 knots. If you have let the airspeed build up too fast you will probably exceed 200 knots and find yourself pulling high G forces in the pull-out. In starting your increased back pressure early, however, you should do it smoothly and avoid the buffet range. The buffet is not injurious to the aircraft but is poor technique.

Having completed one quarter of the maneuver, again select a point 90° from the nose and repeat the maneuver just described. Four complete "loops" make the clover leaf, and the aircraft is on the same heading used for entry. You should be proficient in clover leafs to the right and left. If the first selected 90° point is to the left, the following selections should also be to the left; or if begun to the right, continue to the right. As in all aerobatic maneuvers, clearing the area is a continuing requirement. Instrument references are the same as the loop and Immelmann.

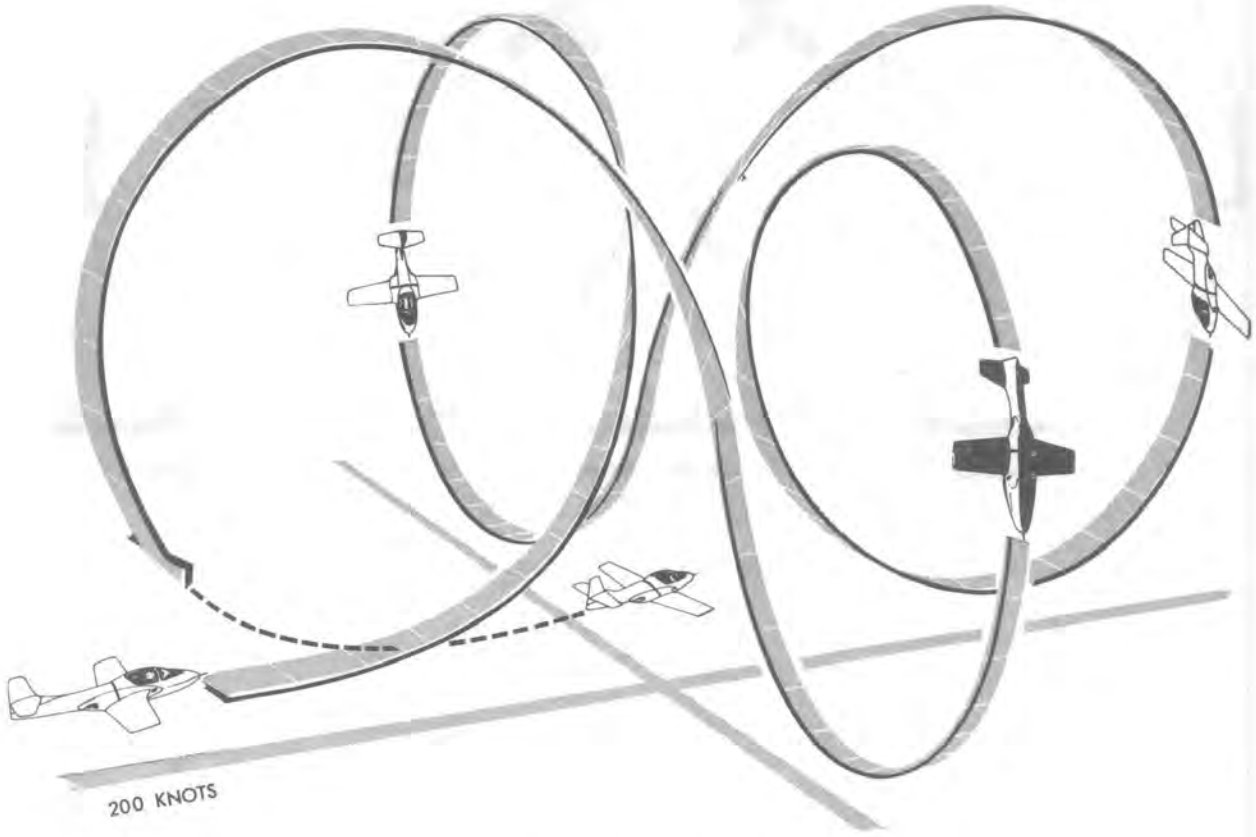


FIGURE 17–4 *The Clover Leaf*

CUBAN EIGHT

Each half of this maneuver is a slightly modified combination of the loop and the Immelmann. It is approximately the first three quarters of a loop followed by a half roll. It must then be repeated in the opposite direction.

Adjust the throttles to 96% and begin the maneuver by clearing as in a loop. Then make a normal loop entry at 250 knots. Proceed over the top and as the aircraft reaches a pitch attitude 45° below the horizon inverted, execute a half aileron roll in either direction. Use rudder pressure as in the Immelmann to hold the aircraft on the desired heading. Release the elevator pressure to keep the nose track in the same vertical plane. The nose should continue to lower during the roll.

After completing the half roll, plan a pull-up so as to attain 250 knots when passing through level flight. Continue the pull-up into another loop entry. The second half of the Cuban 8 is identical to the first except that the roll is in the opposite direction. That is, if the first roll was to the right, the second will be to the left, and vice versa. The instrument references are the same as in the loop and Immelmann.

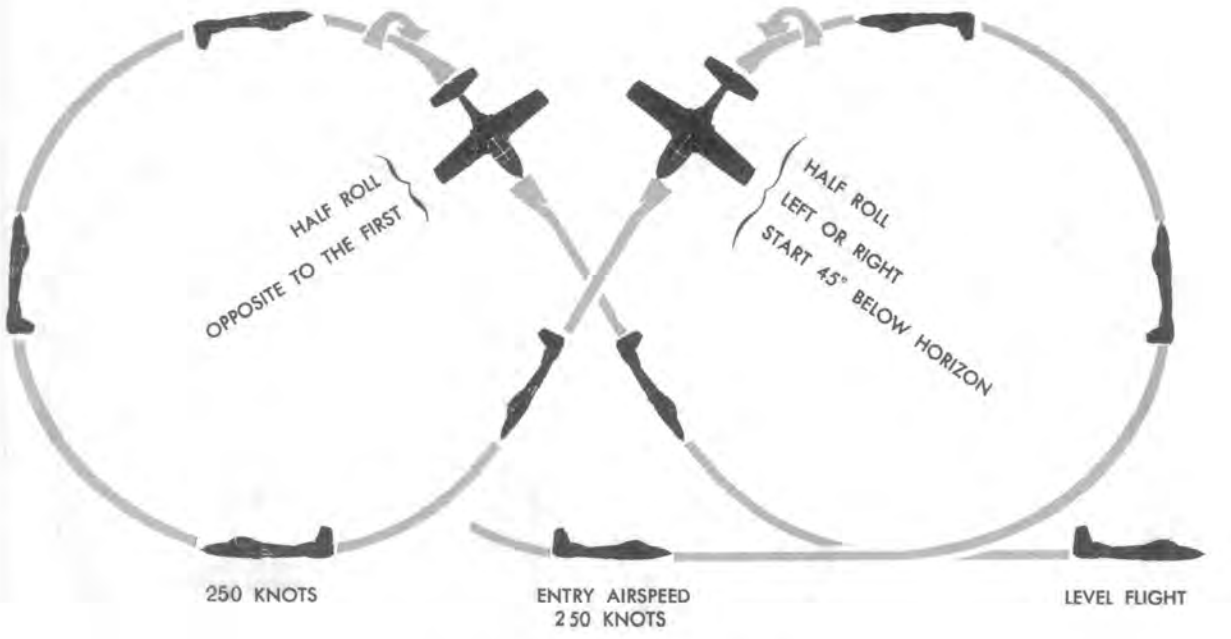


FIGURE 17–5 *The Cuban Eight*

CHAPTER 18

EMERGENCY PROCEDURES

Procedures outlined herein are intended to supplement those found in the T–37 Flight Manual. These additions may be found peculiar to a training situation. The importance of studying all emergency procedures cannot be overemphasized.

You will notify the mobile controller or the tower operator when confronted with any emergency situation if time permits. They will assist you in accomplishing a safe landing.

COMPLETE ELECTRICAL FAILURE, DAY OR NIGHT

If you should have complete electrical failure, make an initial approach over the mobile control unit, in the direction of traffic (or as directed locally) at an altitude of 300 feet above the ground and an airspeed of 200 knots. This will alert the mobile controller to your situation, and he will take action to clear the landing pattern.

Approximately halfway down the runway, make a climbing 180° turn to downwind leg. Roll out at normal traffic altitude. Continue in the landing pattern, remembering that with electrical failure your speed brake, spoilers and attenuators will be inoperative, resulting in a need for a longer final approach. There will be no gear-down-and-locked indication in the cockpit, and the trim will be inoperative.

In the daytime, mobile control personnel will be able to see your landing gear extended, but at night they cannot. At night, you can see other aircraft, but they cannot see you. You must remember to lower the gear on the downwind leg and, to assure that it is down and locked, use the emergency gear-lowering air bottle.

Without the speed brake and attenuators, the importance of establishing a proper final approach cannot be overemphasized. If a go-around is to be accomplished, initiate your go-around as early as possible.

RADIO FAILURE

Day: Use the normal traffic pattern, except that while on initial approach, rock the wings a sufficient length of time to make sure that the mobile control personnel recognize your signal. Also, turn the taxi light off after pitchout and prior to rolling out on final. This will better enable the mobile controller to see the passing light and make a more positive check of the gear. If you are cleared, make a full-stop landing.

Night: Fly a normal traffic pattern. When you are lined up on final approach, flash your taxi light twice. If you are cleared with a green light, make a full-stop landing.

RUNAWAY TRIM

Although it is not likely to occur in the T–37, it is possible for the trim mechanism to malfunction. This could result in the trim condition changing to full-forward or full-back elevator trim, or full-right or full-left aileron trim. Another possibility is an erratic fluctuation of trim condition from one extreme to the other. If the pilot is alert, he can maintain proper flight attitudes by exerting sufficient pressure on the controls to overpower the out-of-trim condition. This is easier at low airspeeds. Should the following trim malfunctions occur in flight use these procedures:

1. Travel of a trim control to an extreme condition:

a. Hold controls firmly.

b. Extend speed brake.

c. Adjust power as necessary.

d. Maintain airspeed between 110 and 150 knots. (If the nose has pitched up to a dangerous attitude, add power and roll the aircraft into a banked attitude to bring the aircraft back to level flight. CAUTION: Avoid excessive G-forces.)

e. Attempt use of trim button on the instructor's control column.

f. If trim is regained, do not use trim again unless the extreme trim condition recurs.

g. Land as soon as possible after first trim malfunction.

2. Erratic fluctuation:

a. Accomplish as much of Step 1 above as necessary.

b. Attempt to turn off battery and generator switches at a position as near neutral trim as possible.

c. After the aircraft is under control, pull trim circuit breaker and turn battery and generator switches back on.

3. Your instructor will emphasize simulated runaway trim exercises to include full elevator and aileron trim deflection. He will acquaint you with the forces necessary to control the aircraft by simulating these conditions in attitudes other than level flight. At high airspeeds, both hands will probably be required on the stick to maintain control of the aircraft.

FLAMEOUT DURING FLIGHT

Indications of a flameout are as follows:

Drop in RPM.

Drop in fuel flow.

Drop in EGT.

Drop in oil pressure.

Loss of thrust.

Fuel vapor trailing from the tailpipe.

In the event of flameout, follow emergency procedures listed in your T–37 Checklist.

If one engine flames out and a restart is impossible or is deemed unwise, return to the home field and land, using the landing pattern outlined in Chapter 13 under SINGLE ENGINE. There is no difference between a simulated single-engine pattern and an actual single-engine pattern.

A double flameout is extremely rare. However, if both engines fail in flight and a restart is impossible or is deemed unwise, follow procedures listed in Section III of the T–37 Flight Manual.

LANDING WITH STRUCTURAL DAMAGE

If structural damage occurs in flight, the pilot must decide whether to leave the aircraft or attempt a landing. If the aircraft is controllable, maintain the airspeed that you have at this time and climb at this airspeed if possible to or above the minimum safe stall recovery altitude. During the climb, notify the mobile controller or the tower operator of your situation. Upon reaching a safe stall-recovery altitude, accomplish a simulated approach. Note the airspeed at which the aircraft becomes difficult to control and do not slow the aircraft below 90 knots under any circumstances. By all means, do not permit the aircraft to stall. Recover immediately with nose down and with power when control becomes difficult, or at 90 knots, whichever occurs first. If a landing does not appear advisable, notify the mobile controller or tower operator of your intentions and position, and leave the aircraft using the prescribed Bailout Procedure. See Section III of the T–37 Flight Manual.

After determining the minimum safe controllable airspeed during the simulated landing approach, if conditions are otherwise favorable return to the airbase and make a power-on approach maintaining at least 20 knots above that minimum safe speed and never less than 110 knots until within one or two feet above the runway.

NIGHT FLYING

Night flying is a very important phase of pilot training. This phase is designed to make you as proficient at night as you are in the daytime. 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. In the first place, you will find that most of the same techniques and procedures used in day flying will apply at night. Night flying is smoother than day flying because of the reduction of thermal or convection currents. Even the engines of your aircraft will sound smoother than they do in the daytime. Generally speaking, any apprehension that you might have about night flying will result from restrictions placed on your visibility. Once you overcome the feeling of strangeness because of visual limitations, you should have very little difficulty in flying at night.

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

Prior to night flying you will be given a blindfold cockpit check to determine your knowledge of the location and various positions of all switches and controls. The ability to locate switches and controls should become second nature to you because you will have to make most changes by feel alone. Practice during the daytime in either the synthetic trainer or in a parked airplane. Determine which switches might be mistakenly or accidently actuated and whether or not such a mistake could create a problem. If so, spend extra time learning the correct switches in this area.

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 flight instruments to determine the attitude of the aircraft. Instrument lights should be adjusted to minimum brightness to avoid undue tiring of the eyes and to keep canopy reflections to a minimum. With bright instrument lights you will be unable to distinguish objects when you look out of the cockpit until your eyes become accustomed to the change. Know your cockpit procedures for taxiing as well as flying. This will eliminate confusion and the need for turning up the cockpit lights unnecessarily.

USE OF OXYGEN AT NIGHT

For night operation, you will use 100% oxygen during taxi, takeoff and climb to 5,000 feet. During the descent back to the pattern, level off at 3,000 feet above the ground and breathe 100% oxygen for one to two minutes. After this, return the oxygen selector to normal and continue your entry into the pattern. After your final landing, use 100% oxygen until you have parked your aircraft.

This will insure that you suffer no loss of vision from the inhalation of noxious fumes from other aircraft or any other source.

Although, physiologically speaking, there is no greater oxygen requirement at night, it is possible because of some minor irregularity (e. g. loose mask), to have an oxygen deficiency at the altitudes you will normally fly that would reduce your vision by 25 to 50%. The first part of the vision to be affected by loss of oxygen is the peripheral vision and, because of already reduced outside references, this loss may not be noticeable. Since you use your peripheral vision to see at night, it behooves you to follow the above procedures to insure that your night vision is at its best.

VISION AND VERTIGO AT NIGHT

A pilot is much more susceptible to vertigo and a mistaken sense of altitude in night flying than during the day. Also his depth perception at night is not completely reliable. 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 take wrong turns on taxiways, losing time and creating confusion.

Be sure you have a flashlight. If there is electrical failure, a flashlight may be the only means of checking the instruments or maps. Once the eyes are adapted to the dark, remember that even a momentary glance at bright lights destroys their adaptation. Always keep lighting in the cockpit at the minimum necessary to read the instruments. The T–37 has an excellent lighting system for the cockpit and instrument panel consisting of red lights. These can be used on the instrument panel separately or in combination. The instrument panel is illuminated by red light which can be adjusted for brilliancy. You should spend sufficient time in the cockpit before night flight to familiarize yourself with the location and operation of all the light switches. See Section IV of the T–37 Flight Manual for use and operation of lights and switches.

INSPECTIONS AND CHECKS

In addition to the normal daytime exterior check, the following checks should be made:

Exterior lights all should be operational.

Make sure all glass and plastic surfaces are clear. Scratches and dirt cause reflection. Ask the ground crewman to wipe off any grease spots in the cockpit and on the instrument panel. Keep the cockpit lights turned down as low as possible when taxiing or flying. This includes tell-tale lights such as the trim light and three gear down lights which give non-critical information. Bulb covers which glow under emergency conditions should not be twisted for dimming. They will not glow so long as conditions are normal, and when abnormal conditions exist the bright indication light cannot be overlooked.

Know the location of all important switches by touch to avoid operation of the wrong one in a dim or dark cockpit. The same applies to the position of all control levers. The flap lever and landing light are items which are usually required at a critical time in the landing pattern. You should know their locations by touch. Also, you should know the location of the flap indicator without searching for it. Clip your flashlight in a readily accessible place.

INSTRUMENT PRECAUTIONS

Perform a complete instrument cockpit check before takeoff. Allow sufficient time for gyros to reach operating speed. Check the Directional Indicator while taxiing to see if it is indicating turns properly. Compare it with the Standby Magnetic Compass to be sure it returns to the proper heading. Be sure the Attitude Indicator is adjusted as for an instrument takeoff (See Chapter 22, Instrument Flying); otherwise, on takeoff it gives a false reading that may cause a dangerous situation.

Set the correct altimeter setting and always reset before landing, particularly at night. Obviously, this is the best safeguard against fly-

ing into the ground or obstructions in the flight path. You should also know the height of obstructions in your area.

NIGHT TAXIING

Judgment of speed and depth is poorer by night than by day. Allow for this fact. Follow the daytime procedures with extra care. Always taxi more slowly at night. Taxi with the taxi light on. Remember, there probably are other aircraft around, too. Watch out for them. Get tower guidance for night taxiing whenever needed. Get a radio clearance from the tower for crossing runways. If taxiing toward a landing runway, use caution with the taxi light to keep from blinding the pilots of landing aircraft. Radio procedures for night flying will be as directed locally.

NIGHT TAKEOFF

Concentrate on proper alignment of the aircraft with the runway. Look far down the runway, not out to one side at the runway lights. Turn the taxi light off after the aircraft is aligned with the runway. Be sure to set the Directional Indicator the same as for an instrument takeoff.

On takeoff, do not hurriedly retract the gear at night. There may be a tendency to fly the aircraft back into the runway. If you become disoriented, resort immediately to instrument flight. Use the instrument takeoff procedures previously taught. (See Chapter 21.) If you resume outside visual reference to determine flight attitude after takeoff it should be accomplished with extreme caution because of deception and broken continuity in unlighted areas. You needn't be alarmed by loss of references on takeoff if you go confidently on instruments and maintain a positive rate of climb on the Attitude Indicator and Vertical Velocity Indicator.

NIGHT LANDINGS

The importance of utilizing the "Before Landing" checklist on night landings and making sure by every means possible that the gear is down and locked before turning final cannot be stressed too strongly. Line up with runway lights when the turn to final is completed, then concentrate on the descent. Aim ahead of the green threshold lights at the end of the runway. *Keep the eyes roving; don't stare at any bright lights on the ground.* It is easy to confuse a moving light with a stationary one. Turn the landing lights on after completing the turn to the final approach and after you have received clearance to land.

SUSPENSION OF FLYING

If night flying should be suspended for any reason, a blanket broadcast will be made on all active radio channels instructing you of the nature of the suspension.

EMERGENCY PROCEDURES

Radio Failure. If the radio goes out, determine the direction of the traffic by watching other aircraft, enter with caution, and comply with local directives. Make a full stop landing. Be alert for a red light or flare from mobile or the tower. They may be trying to warn you of some unseen hazard.

Electrical Failure. In the event of complete electrical failure, approach the field with caution at an altitude specified by local directives. Fly in the direction of traffic, (or as directed locally), observe other aircraft in the pattern and remain clear of them. You can see them but they can't see you. Remain clear of the normal traffic pattern and descend to 300 feet above the ground adjacent to mobile control. After passing mobile control, fly an electrical emergency pattern and land. Aircraft will be controlled by lights from mobile control. (Refer to Chapter 18, *Emergency Procedures*).

Emergency on Runway

In the event of an emergency on the airfield such as an accident on the runway or

failure of the airfield lighting system, a broadcast call will be made instructing all aircraft to hold clear of traffic. If appropriate, the call will include instructions to use cruise control or loiter procedures. If you are low on fuel, contact mobile for permission to land on the parallel runway or at a suggested airfield.

Gear Malfunction. If gear malfunction is suspected, the pilot should turn the landing lights on, make a low approach (100–200 feet above the runway) at 120 knots and request that gear be inspected by the mobile controller.

CHECK–OUT

Your instructor 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. After you are comfortably adjusted to night flying, you will be asked to lower your head or close your eyes, and the instructor will place the aircraft in a spiral. You will then be required to recover from the spiral and return the aircraft to the level-flight attitude using flight instruments only. Should you become disoriented while flying solo, you must trust your flight instruments to aid in controlling the attitude of the aircraft. Therefore, a satisfactory spiral recovery will be required before you are allowed to fly solo.

Your instructor will demonstrate the first landing to you. You will then execute landings until your instructor releases you for solo. Dual landings with and without landing lights will be required. At least one practice go-around will be required, using the same techniques and procedures that you have previously learned with the addition of landing lights. Generally, traffic at night will be controlled by light signals from the mobile control officer, and you will be required to have a thorough knowledge of all light signals. These light signals will be covered in the local flying directives. You will receive a thorough briefing prior to night flying.

SOLO

Turn your radio volume up before taking off. Adjust your instrument lights as low as practicable. When you are cleared for takeoff, insure that the canopy is down and locked; then acknowledge the clearance with the call "694 canopy down and locked, light out". Line the aircraft up with the runway, check your directional indicator against the known runway heading, complete the Before-Takeoff check and make your takeoff assisted by reference points.

When flying in the traffic pattern or other congested areas, be especially vigilant for other aircraft. Look around constantly for aircraft identification lights.

CHAPTER 20

CRUISE CONTROL, NAVIGATION, AND FLIGHT PLANNING

Aerial navigation is the art of flying an aircraft from one point to another and determining its position along the route. Up to this point you have devoted all of your time in training to practicing maneuvers which developed your ability to control the aircraft in all flight attitudes. In developing this skill, you have had little chance to appreciate the aircraft as a means of transportation. Since flying from one place to another is an important part of almost any mission you will accomplish later on, the cross-country flying that you will do in flying training will be valuable and will give you the fundamentals of aerial navigation. You will have the opportunity to work practical problems in navigation and to apply the knowledge you have acquired in the classroom.

Prior to both your first day and night navigation flights, you will be given a dual navigation familiarization ride. The day familiarization flight will come first. During the ride your instructor will show you how to identify check points, compute ground speed, and make off-course corrections. He will also give you a chance to navigate in order to check your proficiency prior to your first solo navigation flight. The purpose of the night familiarization flight will be to show you the difference in appearance of the check points during the day and night and to demonstrate the different techniques employed.

PREPARATION FOR A NAVIGATION FLIGHT

There are many factors to consider in preparation for a navigation flight. These factors will vary with the conditions under which the flight is to be conducted. For instance, you have to prepare differently for a day navigation flight than you do for a night navigation flight. The weather, terrain, landing and fueling facilities, and availability of check points along the proposed route will also influence your preparation.

Your first navigation flight will be in the daytime and under favorable weather conditions. Much of your preflight planning will be done for you. Later on, you will do all of the planning and preparation yourself; but for your first navigation flight, you will have only a few necessary fundamental considerations. They are chart, route survey, and flight log preparation.

PUBLICATIONS PERTINENT TO NAVIGATION

It is your duty to acquaint yourself with all publications pertinent to navigation. You will be expected to use them during your training and after graduation. Briefly, the following information pertinent to navigation missions may be found in the listed publications:

En route Supplement—United States

Aerodrome Facility Listing
Adiz Procedures
UHF and VHF/DF Stations
Lost or Distress Procedures
Radar
ILS
Position-report Procedures
Special Notices
Channelization of VHF and UHF Radios

Flight Information Publication—Planning

Airspace Reservations
Aerodrome Facility Directory
Continental Control Area
Course Separation System
Civil Air Regulations
Positive Control Airways
Hand Taxi Signals
Air Force Regulation 60–16

Terminal High Altitude—Northeast, Southeast, Northwest and Southwest United States

Instrument Approach Charts
Procedures for Radio Failure
Landing Charts
Position Reports

Flight Information Publication, En route High Altitude

Four charts covering United States—NE, NW, SE and SW.

VHF Airways

CRUISE CONTROL

General

Cruise control as applied to jet flying is not a matter of flying at minimum power settings to conserve fuel. It is the process of flying the aircraft so that you will arrive at your destination as expeditiously as possible consistent with economical expenditure of fuel.

The duration of flight in jet training aircraft is not long but, due to the high speeds attained, fairly long distances may be covered. During the course of a flight, varying types of weather will be encountered, and with this you will have changes in wind velocities. The first step in planning the cruise-control phase of your mission will, therefore, necessitate a thorough weather briefing. This briefing will take into account the weather at take-off, en route (clouds, visibilities, and wind velocities), and destination (ceiling, visibility, clouds, freezing level). It is during the climb to cruising altitude that you may make or break the mission. Jet aircraft burn huge quantities of fuel during takeoff and climb, and during flight at low altitudes. On a long flight, it is your responsibility to get to altitude in the most efficient manner. Using proper techniques, it is possible to figure your fuel to within 10 gallons (65 lbs.) and time to within two minutes. Appendix I of the T–37 Flight Manual has a complete set of charts which will enable you to plan your mission properly. The charts in the manual will be used to plan navigation missions during this course of training.

Climb

Approximately 26 gallons (170 lbs.) of fuel are consumed in a normal start, taxi, and takeoff. After starting, get the aircraft off the ground without delay. Each minute on the ground uses approximately one gallon (6½ lbs.) of fuel.

The important factor affecting the time and fuel for the climb is the temperature of the air. The higher the temperature, the slower the rate of climb. This increases the time, distance traveled, and amount of fuel used in the climb. The true airspeed and wind velocities will also affect the distance covered while climbing. It has been found that by computing an average true airspeed and ground speed for the climb, satisfactory results will be obtained. This is done by consulting the "Climb Chart", Appendix I of the Flight Manual, and applying distance against time on the computer. This will give you an average *No-Wind Ground Speed for the Climb.* A no-wind ground speed is nothing more than a TAS. The wind at the ⅔ climb altitude is used as the average climb wind and is applied on the computer for climb calculations to obtain the ground speed for the climb. The ⅔ point in the climb is used because the rate of climb is greater at low altitudes and you will have reached the ⅔ point in your climb when approximately half of your climb time has elapsed.

Cruising

The recommended cruise information for your flight at a given level should be obtained from the "AIR NAUTICAL MILES PER POUND OF FUEL" charts in Appendix 1 of the Flight Manual. The use of this chart is explained in Appendix 1 of the Flight Manual.

Other charts useful to cruise control are presented and explained in Appendix 1 of the Flight Manual and should be used as conditions warrant. As fuel and time is critical in jet aircraft, it is imperative that you understand cruise control. Learn the power settings that will give maximum range and maximum endurance. This will be valuable information to you in case of emergency.

Descents

The "DESCENT CHART" Appendix 1, Flight Manual, gives the letdown distances, times, airspeeds and fuel consumed to provide the best range to fuel ratio. Under IFR condition never descend below 20,000 feet unless you are sure of landing. You may not have enough fuel to climb back to altitude and reach your alternate. Know your landing conditions before letting down.

NAVIGATION AND FLIGHT PLANNING

During the primary phase of training you will encounter three types of navigational mission; low altitude which will be below 10,000 feet; high altitude, which will be above 10,000 feet; and night missions, which will be at either altitude. The knowledge gained here will be used on most navigational missions.

The secret of successful navigation is thorough and adequate preparation. You should thoroughly familiarize yourself with all details of the mission before takeoff. Having all data of the flight well in mind, together with strict adherence to the plan throughout the flight, will insure a successful mission. You should keep well in mind the speed of the T–37. A short lapse in observance of check points and other details of navigation during the flight will quickly result in getting many miles off course before you realize your situation. You should always know approximately how many miles per minute your aircraft travels in order that you can make quick mental calculations to verify your progress with respect to landmarks you observe which may not have been used in your original flight plan but which are easily checked on the map.

After you have been notified of your intended course and type of flight, the first job is to secure and prepare the maps. The log will be prepared immediately prior to the mission when the altitude, winds, and temperatures are known. Neat and accurate work on maps and log can mean the difference between success or failure of the mission.

Briefing

You will be briefed for each navigation flight by your flight commander or flight instructor immediately before the flight. Important instructions on lost procedures, cruise control, and voice reports to the navigational patrol aircraft will be reviewed with you. Your altitude will be assigned and you will be given the winds and weather for each leg of the flight. Much other important information will be given you at this time. Attentive following of briefing instructions will insure successful completion of the mission.

Plan the Flight

The procedures for planning your cross-country flight are as follows:

Secure the necessary maps to cover your proposed flight and make sure they are current.

Draw course lines on your map from your point of departure and between subsequent check points to represent your path of flight.

Be sure your course lines do not cross any restricted or warning areas.

Mark the lines off in 25-nautical-mile intervals and label on the right side of the course lines each 50 nautical miles.

On the right side of your course line make an arrow pointing in the direction of flight and label with the MC (Magnetic Course) and the total distance.

Circle emergency fields within 50 miles either side of your course line. These should include active airfields along your route which may be used as alternates. Select and circle major check points along the route. These should be about 10 to 15 minutes flying time apart and easily seen and identified from the planned flight path.

Flight Log (Air Force Form 21a)

List your check points on your log with the distances between them.

After checking the winds, figure out your time and fuel for each check point. When airborne, keep a running record for time, fuel, and distance on your log. This will show whether time and fuel consumption are on schedule and whether your subsequent schedule needs revision.

Plainly mark all radio aids to navigation which can be used on the flight and underline those with a usable airport where an immediate landing can be made in case of an emergency. Navigation aids adjacent to the flight path may be needed to ascertain position in the event of disorientation. These aids include OMNI ranges, TVOR stations, DF (direction finding) stations, Radar facilities, and other types of navigational and emergency radio and radar installations. They should be a part of your log and contain frequencies and identification letters. There is little time to look for them once an emergency arises, so keep the map and log readily accessible during flight. You should occasionally practice taking a "line of position" bearing on these stations during the mission to thoroughly learn this means of checking your progress and develop confidence in your ability to use it.

It is smart planning to have an adequate fuel reserve (15 to 25% extra) in case of error. Normally you will fly VFR flights of approximately 1:30 duration. If you learn to set safe time and fuel limits for yourself, chances are that Air Rescue Service will never have to look for you. Other unforeseen factors which can deplete extra fuel are taxi and take-off delays, unpredicted adverse winds, single-engine operation (loss of an engine), and landing delays at destination.

Flight Planning in the Air

Frequently, you may encounter stronger winds than you have planned on. Consequently, your time and fuel begin to exceed the figures on your log. Here it becomes necessary to refigure your flight log.

The procedures are as follows:

Get an accurate check on your groundspeed.

Determine the remaining distance you have to fly and how long it will take you.

Get an accurate check on your fuel consumption and determine how long you can remain airborne with the amount of fuel you have left.

Determine if the amount of fuel you have left will get you to your destination with 10% reserve fuel. This is done in comparing the number of minutes you have yet to fly against the number of minutes fuel remaining. If you can still make your destination with 10% reserve fuel, refigure your check points along your flight log. If you cannot safely reach your destination, immediately proceed to a closer alternate.

NIGHT NAVIGATION

In many respects it is easier to navigate at night than during the day because distracting details are obscured. Extremely valuable aids such as airport beacons and large towns are visible for many miles. Sun glare is absent. Haze and dust frequently subside at night.

Figure all courses accurately. Then fly *accurate compass headings* and airspeeds. Compare the Directional Indicator with the Standby Magnetic Compass frequently to determine if any difference exists. Remember, a malfunction of the slaved gyro can cause it

to indicate errors up to 180° without warning. When this happens, the CDI will provide accurate homer headings to the selected VOR station, but the Standby Magnetic Compass is the *only* reliable compass in the aircraft on which you can fly these headings.

Night vision, of course, is of primary importance. Try to keep out of bright lights and avoid excessive smoking before flying. Check oxygen supply frequently as oxygen deficiency will quickly affect vision.

On all night flights, be sure to take a flashlight, matches, maps and flight log. Complete the inspection, giving special attention to the interior and exterior lighting equipment and location of lighting switches. Know how to use your map light (with extension cord), and learn to keep the brightness of interior lights as low as practicable. Find a handy location for your flashlight where the clip will hold it in place and where you can locate it in the dark. Check your oxygen system thoroughly before takeoff.

On reaching cruising altitude, trim the aircraft, and set it up for cruise control. Fly out the first leg, completing the flight log as you go.

At each turning point, make an entry on your flight log and *then* make a normal position report as briefed. If you make the position report first, you may forget the exact time and fuel readings that existed over the check point.

HOMING PROCEDURES

Information on UHF and VHF/DF homing facilities is contained in the En route Supplement. Practice steers normally are obtained on channel "14" UHF. "Guard" channel UHF is also available for emergency steers. Navy or Air Force towers either possess or will alert D/F facilities and can provide information on frequencies and status of equipment.

The D/F homing provides a "steer" or *magnetic course* to reach the station giving the homing. The words "steer" and "home" is the procedure whereby the pilot follows a succession of "steers" from the D/F homer. Station passage using D/F is obtained only by frequent transmissions until a reciprocal indication is received by the D/F operator. No accurate station passage is possible. When you have passed the station, the steer will change by 180°. The D/F homing apparatus is located on or very near the base for which it is named.

NAVIGATIONAL EMERGENCY PROCEDURES

Probably the foremost thought in your mind on a navigational flight is the possibility of getting lost. This is a very real possibility if you are careless in maintaining your heading or in keeping accurate log data. Even the most conscientious and skillful pilot will, at one time or another, become temporarily confused or lost. Whether a pilot becomes confused depends on whether or not he has a definite plan to follow. The greatest hazard to the pilot when he fails to arrive at a given check point at a particular time is panic. The natural reaction is to fly where you think the check point is. After the proper elapsed time and not finding the check point, the inexperienced pilot may be tempted to fly in another direction for a given time. As a result of several of these wanderings, the pilot will have no idea where he is. The fact remains that if the pilot flies basic dead reckoning until his ETA runs out, he is going to be within a reasonable distance of his check point.

The chief cause of becoming lost is "assuming a wrong position." If, after having flown out your ETA, your check point is not visible, it is a good idea to continue flying for an additional period of time in the event the wind has changed and decreased your ground speed. This additional amount of time will be determined by the distance from your last check point. In the early phase of flying training these points will be so close together that three minutes will be sufficient time to fly past your ETA.

Rule number one, then, is this: If you believe you are lost, maintain your heading and fly the ETA plus three minutes. If at the end

of this time you are still uncertain of your position, you should immediately call the closest ground control or air patrol. The instructors flying these patrol aircraft will then give you instructions as to what to do.

In the event that you are unable to contact either the ground control or the air patrol or anyone else who could give you help, it will be necessary for you to use your own initiative and good judgment. Since every situation will be different, it is impossible to set down a list to apply to every situation. One possible course of action, however, is to set course for the next checkpoint and watch for landmarks which will either verify the planned position or provide you the means for accurate orientation. There are several other things which you can do, however, to orient yourself:

1. Locate some prominent landmark on the ground and try to identify this landmark on your chart. Every technique used to recognize check points can be employed to identify this unknown landmark. You should, however, read from the ground to the chart, because nearby points you can see on the ground are unquestionably in the vicinity of your aircraft, but assumed positions on the map may not be.

2. If you are on your first leg, a 180° turn will take you back into the local area with which you are familiar and where you undoubtedly will recognize some familiar landmark.

3. Throughout the United States there are UHF/DF (ultra high frequency) direction finding stations. Those that are located near your base or course should be listed on the back of your flight log. If you should become lost do not hesitate to use this equipment.

The important thing to remember is this: Do not fly aimlessly about the area trying to find your check point. Be calm and follow whatever plan good judgment dictates. If, after trying to identify your position by every known means, you still do not know where you are, plan to land before you run out of fuel. It is desirable, when lost, to land at the first suitable airport. Otherwise you may fly past good landing facilities hoping to regain orientation and in the meantime run out of fuel before another suitable facility is found. If you make a decision to land, call your home base collect by phone as soon as you are on the ground. DO not take off again. If no airport is available and fuel is low, trim the aircraft in a nose-low attitude, heading it toward an unpopulated area, and bail out. Never attempt a landing on any unlighted strange field at night. Even on moonlight nights, it is extremely difficult to judge height, and many pilots have been killed trying to do so.

VHF Navigation Equipment (OMNI)

Know how to operate this equipment, and bear in mind that it is relatively static-free and reception ranges increase as altitude increases.

UHF D/F

Know the location and frequencies of available D/F stations and the procedure to use when using the D/F homer.

GCI Surveillance Radar

The Air Defense Command operates Ground Controlled Intercept (GCI) radar stations throughout the United States. These stations monitor the flight of all aircraft within range of their equipment. You will be briefed as to proper call signs and voice procedures. If you do not know the proper call sign or the GCI frequency, call "Star Gazer" on "Guard" channel. Once contact is made, follow the instructions of the GCI operator. If you do not understand the terminology used by the operator, request clarification. Tell him you are a student pilot on a training flight. He will give you every assistance.

NOTE: Keep in mind that effective ranges of OMNI, VHF, (or UHF/DF), and GCI control are increased as the altitude is increased.

HINTS TO NAVIGATION TRAINING

Make neat and accurate maps and logs.
Mark maps plainly. Do not use red pencil

for night flying. It doesn't show up under red cockpit lights.

Use maps and logs throughout the flight.

Keep them in a safe, readily-accessible place.

Have instructor check the maps and logs before and after each mission.

Have in mind closest airfields and radio aids along the route in case of emergency.

Check the Directional Indicator and the Standby Magnetic Compass against the known runway heading when lined up for takeoff.

Check the Directional Indicator against the Standby Magnetic Compass frequently during flight to insure accuracy.

Make positive identification of check points.

Do not change course indiscriminately. Make any necessary off-course correction over a known position and mark the change on your map.

Check fuel consumption at specified intervals and compare with planned consumption. If a deviation exists, recompute your reserve fuel.

Check oxygen equipment frequently during flight, especially at higher altitudes.

Don't hesitate to call for help if you think you need it.

CHAPTER 21

INSTRUMENT FLYING

GENERAL

All AFM 51–37 references in this text refer to the 1960 edition of AFM 51–37 which is based on the USAF's latest concept of instrument flying. This concept places added importance on the Attitude Indicator, while rate turns, timed turns and the Standby Magnetic Compass have been relegated to a standby, emergency status.

In order to understand the basis for present-day instrument flying, a careful study should be made of the techniques and procedures in AFM 51–37, the T–37 Flight Manual, and this text. AFM 51–37 establishes the standard instrument flying techniques and procedures. These are general and apply to fixed wing aircraft. The All Weather Procedures (Section IX) of the T–37 Flight Manual contains specific procedures for the T–37. However, the only maneuvers given in Section IX are those required to go from point A to point B under actual instrument conditions. This text contains specific techniques and procedures (for the T–37) utilized in the undergraduate pilot training program. The maneuvers in this program were designed to prepare a pilot for the situations that may be encountered during an instrument flight.

Instrument flying is a series of basic maneuvers. The sequence in which these maneuvers are performed is governed by pilot and aircraft considerations and the need for a safe and orderly flow of air traffic. A penetration and a low approach contain many of the same maneuvers but the sequence for making the turns, descents, level-offs, etc., is not the same. Instrument flying is more simple to understand if it is considered as nothing more than a series of basic instrument maneuvers. A few of the maneuvers, such as the confidence maneuvers and the vertical "S" A–B–C–D, are practiced only to increase confidence and proficiency in the maneuvers required in everyday instrument flying.

References are made in this supplement to AFM 51–37 and the T–37 Flight Manual so that duplication of contents is held to a minimum. Therefore, it is necessary to use all three of these publications to get a complete understanding of instrument flying techniques and procedures for the T–37.

Instrument Flying

Instrument flying is attitude control of an aircraft by reference to the flight instruments for the visual cues necessary to judge and establish attitude.

Instrument flying is similar to visual flying since reference points are used in both methods to determine the attitude of the aircraft. Interpretation of instruments shows the attitude of the aircraft as readily as the attitude is determined in clear weather by observing the relationship of the nose and the wings of the aircraft to outside references.

The same control techniques are used while flying instruments as are used in visual flying.

During instrument flight all of the aircraft's instruments must be cross-checked. Cross-checking is the visual and mental process of instrument observation and interpretation necessary to determine the attitude of the aircraft.

The flight instruments are broken down into 3 main groups according to their functions. This grouping presents the information in such a way that a good cross-check technique can be developed. The 3 groups are: (1) Control instruments (Attitude Indicator and Tachom-

eter), (2) Performance instruments (Altimeter, Vertical Velocity Indicator, Airspeed or Mach Indicator, Turn-and-Slip Indicator and Directional Indicator; (3) Navigational instruments (VOR equipment and radio compass).

During the early phase of instrument training, the navigation instruments will not often be used. Later on they will be used to determine aircraft location.

Performance and control instruments are interpreted to establish or maintain the aircraft attitude. This is accomplished by cross-checking the instruments and making adjustments when needed. Lack of precision in instrument flying can be traced to a slow and inaccurate cross-check. Proficiency is attained by practice and experience. There is no set order of cross-checking. The order of cross-checking depends upon the type of maneuver being flown.

An understanding of the construction and principles of operation of the flight instruments is an aid in developing a good cross-check technique.

Aircraft Attitude Control

Through a proper cross-check, good aircraft attitude control should result. The control of pitch, bank and power simultaneously provides the basis for good attitude control.

Two points that cannot be overemphasized when flying instruments are: (1) Initiate corrective action to maintain the desired aircraft attitude the moment such a need is detected; (2) All corrections should be smooth but positive (a definite amount).

THE COCKPIT CHECK

Make the cockpit check of instruments and equipment as indicated in the abbreviated check list. This will be done on all flights.

The check of flight instruments will be given over the interphone to the instructor.

All equipment must be carefully checked prior to takeoff in order to insure that each instrument is working properly and that navigational publications are available if required. When checking the condition of the instruments, the remarks about each instrument should be specific. For example, "The Turn Needle indicates the proper turns" (while the aircraft is taxiing in a turn). The use of statements such as "The Turn Needle is o.k." does not tell the instructor whether the student is checking closely or is going hurriedly through the instrument check.

Additional instructions for certain instruments and equipment are indicated below:

Publications—Check that appropriate publications are in the aircraft and up-to-date.

Pitot Heater—If the flight is to be made in clouds or precipitation, turn on the battery switch and pitot heat and feel the pitot head for heat.

Clock—Check to see that it is running and set for the correct time.

Inverters—Check both main and spare inverters.

Vertical Velocity Indicator—With the aircraft on the ground, the indicator should indicate zero. If it is above or below zero, gently tap the panel. If the needle does not return to zero, adjust it by using a small screwdriver to turn the screw in the lower left corner of the instrument. While making this adjustment, gently tap the panel to release any friction. If you cannot adjust the indicator to zero, you must remember its ground indication and use it as the zero position in flight.

Loadmeters—Check to see that they show approximately equal load.

Road Equipment—Check all radio equipment for proper operation of the transmitter and receivers.

Airspeed Indicator—The Airspeed Indicator Needle should indicate zero and the window reading should be 30 to 40 knots.

Directional Indicator—Make certain the Directional Indicator is checked against the Standby Magnetic Compass. Check the Directional Indicator against a known heading such as the runway, to make certain it is

not out of phase. If it is, turn off the inverter, turn the aircraft 180° and then turn the inverter on.

Standby Magnetic Compass—Check to see if the Standby Magnetic Compass has sufficient fluid. Determine its accuracy by comparing its indications with a known heading while the aircraft is taxiing straight.

Attitude Indicator (J–8)—After turning on the inverter, adjust the Miniature Aircraft so that it is level with the 90° indices on the sides of the case. This will approximate level-flight attitude at normal cruising airspeed. Due to the sequence of items on the check list, thirty seconds will generally elapse from the time inverters are turned on until the Attitude Indicator is caged. After allowing thirty seconds for gyro rotors to attain operating speed, pull the "pull to cage" knob on the lower right corner of the Attitude Indicator, then release it. This eliminates the long period of time necessary for self-erection of the Attitude Indicator. If the Horizon Bar erects quickly to the horizontal position and remains at the correct position for the attitude of the aircraft, or if it begins to vibrate after this attitude is reached and then slowly stops vibrating altogether, the instrument is operating properly. If the Horizon Bar fails to remain in the horizontal position while you are taxiing straight, the instrument is unreliable. If the Horizon Bar tips in excess of 5° during a taxi turn, an unbalanced condition is indicated, probably caused by low rotor speed or clogged erection mechanism.

Attitude Indicator (MM–3)—Erection of the MM–3 requires approximately one minute and should not take longer than one and one-half minutes after power has been applied. When the "OFF" flag disappears, the gyro is erected. Adjust the sphere so the Horizon Bar will coincide with the Miniature Aircraft.

Altimeter—Set the Altimeter to the station altimeter setting. Check to determine if the Altimeter indicates the known altitude of the field. If there is a difference between the actual field elevation and the indication on the Altimeter, either the altimeter setting is incorrect or there is a scale error in the instrument. If there is an instrument error of 75 ft. or more, the instrument should be replaced. If the deviation is less than 75 feet, set the Altimeter at field elevation and note the difference between the tower altimeter setting and the reading in the Kollsman window. Apply this algebraic difference to all subsequent altimeter settings received. For example, the altimeter setting given by the tower is 30.01. The Kollsman window reads 29.99 when the Altimeter is set on field elevation. This means that your Altimeter reads .02 lower than the correct altimeter setting. Apply this minus .02 correction to all altimeter settings received in flight.

Turn-and-Slip Indicator—Turn the aircraft to the right and left while taxiing and note the reaction of the Turn Needle. If its indications are not positive, or if the needle is sluggish and does not return promptly to the center when the turn is stopped, the instrument is not operating properly.

Engine Instruments—Check all engine instruments for proper operation and allowable indications at 100% RPM prior to takeoff.

Throttles—Check the throttles for proper friction.

PITCH CONTROL

A knowledge of the similarity between visual and instrument flying is necessary when the attitude of the aircraft cannot be determined by visual reference to the ground. By reference to various instruments the attitude of the aircraft can be maintained for any condition of flight.

The Attitude Indicator, Altimeter, Vertical Velocity Indicator and Airspeed Indicator give indications of the pitch attitude or the pitch trend of the aircraft. Small, timely corrections of pitch attitude and an accurate cross-check are essential to developing good pitch control technique.

Proper use of elevator trim is an integral part of pitch control. Good instrument flying

technique is very difficult without it. Accurate and timely cross-checking between the instruments used to control pitch is necessary.

Attitude Indicator

While unhooded fly the aircraft straight-and-level and adjust the Attitude Indicator so that the wings of the miniature aircraft are superimposed on the Horizon Bar. Observe the similarity between the Horizon Bar and the natural horizon of the earth as you place the nose of the aircraft first above, and then below the natural horizon. Note how this relationship on the instrument corresponds to the actual movement of the nose of the aircraft as it appears on the natural horizon. The natural horizon and the Horizon Bar give a corresponding indication of attitude.

The J-8 Attitude Indicator should not be caged and uncaged in flight except in cases where in-flight errors have been induced in the instrument. Consult AFM 51-37, Chapter 3, Gyroscopic Instruments and the T-37 Flight Manual, Section I, for information on the construction and limitations of the J-8 and MM-3 Attitude Indicators. During in-flight practice, you will change the pitch attitude so that the miniature aircraft indicates a climb of one bar width. (All references in this text to "bar width" are to the width of the Horizon Bar above or below the wings of the miniature aircraft silhouette in the Attitude Indicator.) 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 will note that you maintain level flight by keeping the wings of the Miniature Aircraft centered exactly on the Horizon Bar and that adequate changes in pitch attitude are normally made with not more than one-half a bar width.

Your instructor will occasionally place the aircraft in a steep climb or dive and have you return it to level flight. This is to give you practice for special maneuvers which will come later.

Application of smooth control pressure and avoidance of overcontrolling are necessary for good pitch control.

Altimeter

Fly the aircraft straight-and-level with a fixed power setting. Note that to maintain a constant altitude with the throttle set, the pitch attitude must also remain constant.

Raise the nose of the aircraft until the Altimeter indicates a climb. Observe the change in pitch attitude. When altitude is being gained, the nose of the aircraft is high and should be lowered for level flight. When altitude is being lost, the nose is low and should be raised.

Raise the nose of the aircraft until the miniature aircraft of the Attitude Indicator is well above the Horizon Bar. Observe that the Altimeter changes rapidly with any substantial change in pitch attitude shown on the Attitude Indicator.

Make a small change in pitch attitude. Observe the correspondingly slow change in altitude as indicated by the Altimeter.

When you make an abrupt change in the pitch attitude, observe the momentary lag in the Altimeter. You will note that a lag is not 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 it can be considered as giving an immediate indication of a change in pitch attitude.

From this demonstration you should see that the approximate change in pitch attitude of the aircraft can be determined by the rate of change in altitude indicated by the Altimeter.

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. You should not rely solely on the Attitude Indicator because a change in power setting will require it to be reset for level flight. With only two instruments at this

stage of instruction the cross-check consists of merely looking from one instrument to the other. During level flight the Attitude Indicator should receive more attention than the Altimeter, but the Altimeter should be cross-checked to make sure that you are keeping the altitude constant.

Practice holding the altitude constant by use of the Attitude Indicator and the Altimeter. Correct for a deviation of 100 feet from the desired altitude by changing the pitch attitude not more than one-half a bar width. Corrections in altitude are made by these small changes in pitch attitude.

Vertical Velocity Indicator

While the Vertical Velocity Indicator gives an immediate indication of a change in pitch attitude, a short time elapses before it settles down and indicates the actual rate. This time element is commonly referred to as "lag." The lag is directly proportional to the speed and magnitude of the pitch change. The Vertical Velocity Indicator is a *trend* instrument and it should not be "chased." Make small corrections and then wait for the instrument to settle down.

To learn the function of the Vertical Velocity Indicator and its relationship to other pitch instruments you will do a few simple exercises:

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

During your practice, raise the nose of the aircraft so that the Attitude Indicator indicates a climb of one-half a bar width. A change in pitch of this magnitude indicates a vertical velocity of about 400 fpm. This relationship between the Attitude Indicator and the Vertical Velocity Indicator is for low-speed flight. At higher speeds a one-half bar width movement of the Horizon Bar might indicate a climb of as much as 2,000 fpm.

Altitude corrections should be such that the pitch attitude change will result in a vertical velocity in feet per minute that is about double the error in feet of altitude. For example: if 100 feet off your altitude, a rate of correction of approximately 200 feet per minute is generally suitable.

In level flight, cross-check the three pitch instruments to detect a deviation in altitude. The Vertical Velocity Indicator is added to the sequence of the pitch attitude cross-check previously described, and any deviation of the Vertical Velocity Needle from the zero indication shows the need for a change in pitch attitude.

Next, establish a climb or descent of about 100 fpm. Note that the Vertical Velocity Indicator shows the change in pitch attitude earlier than the Altimeter, and its movement is easier to detect than that of the Attitude Indicator.

Descend now to 100 feet below the desired altitude and establish a climb to return to the original altitude. To accomplish this, a small pitch change is made on the Attitude Indicator and the vertical velocity is cross-checked to ensure that the pitch change was not too small or too large (approximately 200 fpm). The Altimeter is cross-checked to determine when the level-off should be started (10% of vertical velocity indication). This cross-check must be done rapidly during the few seconds required to change the altitude 100 feet.

You should practice using the Vertical Velocity Indicator as a trend instrument to prevent overcontrolling. Practice maintaining level flight, cross-checking the Attitude Indicator, Vertical Velocity Indicator and Altimeter. Emphasis should be placed on precision.

Airspeed Indicator

Observe that the airspeed remains constant when straight-and-level flight and a constant power setting are maintained. Note that 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 has been changed. However, there is no appreciable lag in the correct indication of this instrument.

The Airspeed Indicator is brought into the cross-check in the same way as the Attitude Indicator, the Altimeter, and the Vertical Velocity Indicator. As each instrument is added to the cross-check, the speed of cross-checking must be increased.

During practice you will be required to hold the airspeed constant in level flight using just the Airspeed Indicator (constant power setting) and the Turn-and-Slip Indicator. You will be allowed to practice the same maneuver using all available pitch instruments.

Elevator Trim

Your instructor will have you fly the aircraft in level flight with the elevators out of trim. Note that 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. Relieve this pressure with elevator trim. The importance of keeping the aircraft trimmed cannot be overstressed.

From level flight, you will be required to make various power changes and practice the use of elevator trim with all available pitch instruments.

Summary

A rapid cross-check is essential for precision instrument flying. The earlier a deviation can be noted, the smaller the amount of control pressure necessary to counteract the deviation.

The Attitude Indicator is the most informative instrument referred to for pitch attitude control in level flight. But the Altimeter and vertical velocity must be cross-checked with the Attitude Indicator to ensure that the altitude remains constant.

As soon as proficiency is attained in one maneuver you will proceed to another maneuver referring to another combination of instruments for good control. Success in instrument flying depends upon proficiency in all combinations of instruments before advancing to another lesson.

If necessary, each maneuver may be practiced "open hood."

BANK CONTROL

Accurate and timely cross-check between bank and pitch instruments is necessary.

The Attitude Indicator gives direct information as to the banking attitude of the aircraft. The Directional Indicator and Turn Indicator provide turning information. Errors in banking attitude should be noted quickly so that corrections will be small.

Proper use of rudder and aileron trim is essential to good bank control.

When in straight-and-level flight, the desired attitude is maintained with reference to the Attitude Indicator. The performance instruments are used to assist you in maintaining a constant heading and altitude. The cross-check should always be made as rapidly and accurately as possible, even in simple maneuvers. This allows more time to direct attention to other matters in the advanced phases.

Attitude Indicator

Observe the similarity between the Horizon Bar and the natural horizon as the aircraft is banked. The natural horizon and the Horizon Bar give the same indication of attitude. The Horizon Bar, through gyroscopic stabilization, always stays parallel to the actual horizon, and any attitude of the real aircraft is dupli-

cated 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 is also proper control of the actual aircraft.

Two indications on the J–8 Attitude Indicator can be used to determine whether the aircraft is inverted or right side up. The Horizon Bar has two small "stubs," or projections, from the bottom side which can be thought of as the two main landing gears. The two little projections (or stubs) on the Horizon Bar will always extend downward, and the bank index at the top of the instrument will be adjacent to the reference marks on the case whenever the aircraft is right-side-up. If inverted, the stubs (or landing gears) on the Horizon Bar will be extended up and the Bank Index will be on the opposite side of the case from the reference marks. The Bank Index can be thought of as a sky pointer, because it always points straight up. Regardless of aircraft attitude the stubs will always point to the ground. Therefore, when the Miniature Aircraft is upside down the landing gear appears to be extended upward.

Two indications on the MM–3 Attitude Indicator can be used to determine if the aircraft is inverted. As in the J–8, if the Bank Index (or sky 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.

Your instructor will make a steep turn of 180° to demonstrate the precession error. The maximum precession error usually occurs after 180° of turn. When the aircraft returns to straight-and-level flight the Miniature Aircraft will still show a slight bank because of the precession of the Attitude Indicator in the turn. Errors in pitch and bank up to 5° on the J–8 may be noted after rolling out. Errors on the MM–3 should be less than 5°. The steep turn will make the error more apparent than after a normal turn.

The bank and pitch attitudes are shown on the Attitude Indicator. When the Attitude Indicator is cross-checked, both pitch and bank attitude should be checked at the same time.

You will be required to practice pitch and bank control using the Attitude Indicator to produce straight-and-level flight.

Directional Indicator

The Directional Indicator gives an indirect indication of bank. As you roll the aircraft into a very shallow bank note that the Directional Indicator moves slowly in the direction of bank. When you increase the bank, note the corresponding increase in the movement or rate of turn on the Directional Indicator.

When correcting to a heading do not use a bank exceeding the number of degrees to be turned. However, the bank should never exceed 30°. This is a good rule to prevent overcontrolling on instruments.

After becoming proficient add the Directional Indicator to the cross-check with the other instruments used to maintain straight-and-level flight.

When flying on a fixed heading for a period of time it is good technique to place that heading under the top index.

Turn-and-Slip Indicator

This instrument is composed of two major elements which will be referred to separately as the Turn Indicator and the Ball. The importance of the Turn-and-Slip Indicator has been de-emphasized in recent years because of the improved reliability of Attitude Indicators and improved instrument flight procedures which have relegated the Turn-and-Slip Indicator to a minor role. It is still used when trimming the aircraft and for emergency bank indications if the Attitude Indicator fails. Should such a failure occur, the Turn-and-Slip Indicator assumes major importance for it is the only remaining instrument which will reliably enable you to keep the aircraft upright. It is less likely to

fail than the Attitude Indicator because it is less complicated and runs on DC current whereas the Attitude Indicator needs AC and will fail if the inverters fail.

Your instructor will demonstrate how the Turn Indicator gives an indirect indication of bank. Observe that when the aircraft is banked it is also turning. The Turn Indicator is sometimes referred to as the "Turn Needle," and these terms are used interchangeably.

When the Turn Indicator is exactly centered the aircraft is in straight flight.

Your instructor will place the aircraft in a very shallow bank (approximately 2°) by reference to the Attitude Indicator. Notice the small deflection of the Turn Indicator and the correspondingly small movement of the Directional Indicator.

Your instructor will have you add the turn indicator to the cross-check used to maintain straight-and-level flight and practice bank control using the Turn Indicator, Attitude Indicator and Directional Indicator.

The Slip Indicator is used to determine whether the ailerons and rudder trim are set correctly. The aircraft is improperly trimmed when the wings are level and the ball is not centered. Hold the wings level with aileron pressure, and center the Ball with rudder. Relieve all pressures by adjusting appropriate trim.

It is of prime importance to keep the aircraft trimmed properly at all times. Practice trimming the aircraft in straight-and-level flight.

If you have a tendency to use rudder when you should not, or to use the improper amount of rudder to compensate for adverse yaw when rolling into or out of a turn, your instructor will have you observe the Ball out of center—a certain indication that you are making these errors.

Particular emphasis should be placed on trim and cross-check. Control is not difficult if the aircraft is trimmed and the instruments are cross-checked properly. An accurate and timely cross-check between bank and pitch instruments is a necessity for good instrument flying techniques.

POWER CONTROL

Correct power settings and standard procedures for changing airspeeds are essential to proper power control.

The cross-checking method used for pitch and bank is also applicable to power control. The speed of the entire cross-check must be increased when power changes are made. Power changes that result in airspeed changes will affect the attitude of the aircraft. These changes will require elevator control pressure to prevent any undesired change in the pitch attitude. This pressure is then relieved by proper application of elevator trim.

Power Corrections

When you increase power, the aircraft has a tendency to go into a nose-high attitude as the airspeed increases. Forward pressure on the elevator control is necessary to maintain constant altitude. Use elevator trim as necessary. With a decrease in power, the nose has a tendency to drop as the airspeed decreases. Back pressure and then elevator trim must be used to maintain a constant altitude.

Your instructor will have you make large changes in power and practice elevator trim control in straight-and-level flight as the airspeed changes.

To fly straight-and-level at a desired airspeed, there is a specific power setting which will hold this airspeed at the altitude you choose. If you want, say, 200 knots at 10,000 feet, level off at 10,000 feet and set the power on the Tachometer at the rpm you think should hold 200 knots. Keep the aircraft at 10,000 feet with elevator control and watch the Airspeed Indicator. If it stabilizes at more than 200 knots, you must reduce rpm; if it stabilizes at less than 200 knots 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 and airspeed is maintained with power control. The need for a power or pitch change is indicated by a cross-check between the airspeed indicator and the altimeter. When the altitude is correct and the airspeed is not, a power change is needed to regain the desired airspeed. When both the altitude and the airspeed are incorrect, use the elevator control to correct the altitude, and power to adjust the airspeed. If you are below desired altitude with a high airspeed it may be feasible to kill off the excess airspeed with a pitch correction that will return you to the desired altitude. Similarly, if you are above desired altitude with a low airspeed, you may be able to regain your desired airspeed with the required pitch correction to bring you back down to 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 pitch and bank instruments with the instruments that control power in order to maintain straight-and-level flight. During power corrections the speed of cross-check must be increased so that control corrections can be timely and small.

Airspeed Changes

During all airspeed changes, use the Attitude Indicator to hold a constant altitude as well as to make pitch and bank corrections when the performance instruments indicate a deviation.

Change of Airspeed: 25 Knots or More

To decrease the airspeed 25 knots or more, decrease power to the approximate rpm setting for the desired airspeed and simultaneously extend the speed brake. Hold a constant pitch attitude on the Attitude Indicator when the speed brake is extended. Hold the heading constant on the Directional Indicator. The throttles should be moved smoothly during all power changes. The Tachometers should be brought into the cross-check after the throttles have been moved to the approximate desired position. The Tachometers are then checked for the approximate rpm. Use trim to aid in maintaining the desired pitch attitude. The pitch attitude must be raised to hold a constant altitude as the airspeed decreases. As the airspeed approaches approximately 2 to 3 knots above the desired airspeed, retract the speed brake. Cross-check the airspeed to see if the power setting is correct. Reset the Miniature Aircraft on the Horizon Bar of the Attitude Indicator.

To increase the airspeed 25 knots or more, increase power to 100% rpm. Approximately 2 or 3 knots below the desired airspeed, decrease power to the rpm required to maintain that airspeed. Adjust pitch attitude as necessary to hold level flight. Cross-check the Vertical Velocity Indicator and Altimeter to maintain altitude. Reset the Attitude Indicator with the Miniature Aircraft on the Horizon Bar when the desired airspeed is established.

Change of Airspeed: Less Than 25 Knots

To reduce the airspeed less than 25 knots, decrease power below the approximate rpm setting for the desired airspeed. The amount of reduction will depend on the amount of airspeed to be lost. Approximately 2 or 3 knots above the desired airspeed, increase power to the rpm required to maintain that airspeed. Adjust pitch for level flight throughout. Reset power if necessary to stabilize the airspeed desired.

To increase the airspeed less than 25 knots, increase rpm above that required for the desired airspeed. Approximately 2 or 3 knots below the desired airspeed, decrease power to the rpm required to maintain that airspeed. Adjust pitch and airspeed as necessary.

In changes of airspeed by less than 25 knots, a 3 to 5% decrease or increase above or below the approximate power setting for the desired airspeed will generally be sufficient; you will quickly learn to judge this and vary it as necessary.

Airspeed changes require a rapid cross-check and good pitch attitude control. Referring to the Attitude Indicator, Altimeter, Vertical Velocity Indicator, and the use of trim during these changes will aid in controlling the aircraft attitude.

INSTRUMENT TAKEOFF

The instrument takeoff is taught so that you will attain proficiency in takeoff without reference outside the cockpit when operational requirements dictate, and to be able to smoothly and safely transition from visual references to instruments if restricted visibility is encountered during, and shortly after takeoff.

Although ITO's are practiced throughout pilot training, it is rarely necessary to make one during instrument conditions. Even during low visibility conditions visual references such as runway lights, centerline, or edge of runways are usually visible. During an actual ITO the visual reference used would become a part of the instrument cross-check.

There are many procedures to accomplish in executing an instrument takeoff and they must be accomplished in a definite sequence. The procedures should be learned well prior to making an instrument takeoff so that more attention can be devoted to the cross-check and aircraft control.

Your instructor will taxi the aircraft into the takeoff position and align the aircraft with the runway. He will make certain that the nose wheel is straight. Rotate the Directional Indicator so that the pointer is under the index at the top of the instrument. You should also reset the Miniature Aircraft of the Attitude Indicator opposite the 90° bank indices, the position for level flight. Hold the aircraft with the brakes while instruments are checked at 100% rpm.

When directed by your instructor, release the brakes and begin the takeoff roll. During the takeoff roll, hold the heading on the Directional Indicator. Hold this heading constant by use of nose wheel steering until rudder becomes effective (approximately 60 knots). Any deviation in heading must be corrected immediately. When the elevator control becomes effective (approximately 65 knots), establish takeoff attitude on the Attitude Indicator by raising the pitch attitude to approximately two bar widths (5 degrees on the MM–3). Hold the heading constant on the Directional Indicator.

When the aircraft leaves the ground, control the pitch and bank attitude by reference to the Attitude Indicator until the Vertical Velocity and the Altimeter show a climb. At this time, call for gear up (instructor raises gear). Maintain a pitch attitude of between 500 to 1000 fpm on the Vertical Velocity Indicator which will result in a continuous climb and a smooth increase in airspeed. Raise the flaps when a safe altitude and an airspeed of 110 knots has been attained. When the flaps are retracted, adjust the pitch attitude to compensate for the loss of lift. Climb at 100% rpm and 200 knots.

Since trim tabs are properly set prior to takeoff, this setting should not be changed until the aircraft is definitely airborne. After becoming safely airborne the control pressures should be relieved with trim as necessary.

Make the first turn at 500 feet above the terrain (or higher as directed locally) using 30° of bank. This will be a 90° turn and in the direction of traffic.

For the purpose of student training, a starting airspeed of 200 knots will be used for the climb. Otherwise, the climb is accomplished exactly as a technical order climb. Calibrate the Turn Indicator as soon as possible in the climb to insure that it does not contain a large error. (See subsection, Calibration of the Turn Needle, this chapter, under RATE AND TIMED TURNS.) Normal turns will be used for basic instrument climbs when possible. Your instructor will brief you thoroughly on the exceptions to this rule.

Level-off from climbing airspeed should be made at 190 knots at or above 5000 feet. When a level-off is required below 5,000 feet, it will be made at 200 knots.

CONFIDENCE MANEUVERS

Confidence maneuvers are taught to show that an aircraft can be flown through extreme unusual attitudes safely by reference to instruments. The Attitude Indicator is the most useful instrument in extreme pitch and bank attitudes, and you should study the various attitudes of this instrument as shown pictorially in your other reference books. Training aids will also be useful.

Aileron Roll

With power at 90%, lower the nose to obtain approximately a 3000 fpm descent. Attain an airspeed of 200–230 knots.

On the MM–3 Attitude Indicator bring the nose up smoothly with a wings-level attitude until the nose is 25° above the horizon. On the J–8 this places the Horizon Bar about ¼-inch from the bottom of the instrument. Relax the back pressure momentarily to maintain 25° pitch.

Start a roll in either direction. Adjust the rate of roll so the wings will be level in the inverted position as the nose passes through the horizon. Continue the roll and recover in a wings-level attitude, nose low. Sufficient back pressure on the stick should be maintained to keep the pilot in the seat at all times.

The Attitude Indicator is used to determine pitch and bank attitude until the recovery is started. The aircraft is returned to level flight using the Attitude Indicator and cross referencing the performance instruments.

Wingover

With power at 90%, lower the nose to obtain approximately a 3000-fpm descent. Attain an airspeed of 200–230 knots.

Bring the nose up smoothly to the horizon maintaining a wings-level attitude.

Begin the maneuver by starting a climbing turn in either direction. Hold the wing tip of the Miniature Aircraft on the Horizon Bar until reaching the 60° bank position. While continuing to increase the bank to 90°, allow the nose of the aircraft to start down. As the nose of the Miniature Aircraft reaches the Horizon Bar, begin decreasing the angle of bank so that the other wing tip reaches the Horizon Bar as 60° of bank is attained. Recover to level flight by decreasing the bank to 0° and holding the wing tip of the Miniature Aircraft on the Horizon Bar.

The rate of roll for entry and recovery should be the same.

The Attitude Indicator is used to determine both pitch and bank attitude throughout the maneuver.

Loop

With power at 100% lower the nose to obtain approximately a 4,000 fpm descent. Attain an airspeed of 250 knots.

Ease the nose up to the horizon with wings level. Apply back pressure of 3 to 4 "Gs" using the Accelerometer as your reference. Keep the wings level by keeping the Bank Index of the Attitude Indicator at zero degrees of bank.

As the aircraft approaches the inverted attitude, reduce the back pressure (approximately 2 Gs to prevent a shudder) until the nose is well below the horizon.

As the airspeed increases reduce power to approximately 65% and increase the back pressure to 3 to 4 "Gs" for recovery.

Refer to the Miniature Aircraft of the Attitude Indicator to keep a zero bank attitude throughout the maneuver.

Present-day weapon delivery methods employed by tactical aircraft require extreme pitch and bank attitudes. The all-weather concept demands that flight patterns such as the confidence maneuvers be flown safely by reference to instruments.

UNUSUAL ATTITUDES

An unusual attitude is any attitude not required for normal instrument flight. Some possible causes of unusual attitudes are: a slow cross-check, vertigo, turbulence, transition

from VFR to IFR, and extreme attitudes resulting from combat tactics.

Due to the reliability of the non-tumbling type of Attitude Indicator, it should be used as the main recovery instrument. The interpretation of the Attitude Indicator has been practiced in the confidence maneuvers. Now this skill will be further utilized in recoveries from unusual attitudes in which your instructor will intentionally place the aircraft in order to give you practice.

Bank interpretation and control response are most important in recovering from unusual attitudes. In high-performance aircraft a diving inverted attitude is the most critical situation. Proper bank correction to return to right-side up is mandatory; it must be initiated prior to pitch correction. This situation is the one that could most quickly lead to disaster.

From inverted (beyond 90 degrees of bank) diving attitudes the aircraft must be first rolled right-side-up (less than 90° of bank) to avoid excessive loss of altitude or exceeding design limits.

From steep climbing attitudes the aircraft must recover in a 90° banked attitude to allow the nose to slice smoothly to the horizon to avoid stalling or negative Gs. By entering the 90° bank attitude the nose will fall naturally to the horizon, and enough back pressure can be held to hold you comfortably in your seat.

The initial recovery is made by referring to the Attitude Indicator. Consider the Bank Index as a sky pointer. The Bank Index Pointer will always point straight up. If the Pointer is in the lower half of the instrument case, the aircraft is inverted (over 90° of bank), because the instrument case remains rigid with respect to the aircraft and will be inverted whenever the aircraft is inverted.

On the J–8 when the Bank Index Pointer and the Horizon Bar are close together at the top of the instrument case and are not separated by the Miniature Aircraft, the aircraft is in a dive. When the Bank Index and the Horizon Bar are far apart (opposite one another in the case) and separated by the Miniature Aircraft, the aircraft is in a climb.

As long as the Horizon Bar is visible on the MM–3, similar indications of attitude can be observed. However, in extreme pitch attitudes the Horizon Bar goes out of sight. It then becomes necessary to read the words "climb" or "dive" on the Attitude Indicator to determine the pitch attitude of the aircraft.

The Airspeed Indicator, Altimeter, and the Vertical Velocity can also be cross-checked to determine if the aircraft is climbing or diving.

If the aircraft is diving, reduce power to idle, extend speed brake, and roll (or continue the roll) to a wings-level attitude. The extension of the speed brake in the T–37 causes a slight nose-low pitch change. This pitch change has no adverse effect and is easily controlled. Therefore, the use of speed brake in unusual attitudes in the T–37 is not restricted as in some other aircraft.

Until the Bank Index Pointer is in the upper half of case, back pressure will only aggravate loss of altitude. Therefore, until the Pointer is in the upper half of the case hold only enough back pressure to keep well seated.

If the aircraft is climbing, add full power and roll (or continue to roll) to bring the Bank Index Pointer toward the nearest 90 degree bank index mark. Maintain the bank and enough back pressure to remain well seated. As the Horizon Bar and fuselage dot of the Miniature Aircraft come together, establish a wings-level, slightly nose-low attitude. In some cases recovery can be made before reaching a 90 degree bank. This recovery is similar to the wingover maneuver.

Recovery from unusual attitudes on partial panel (without the attitude indicator) is an emergency procedure. Refer to AFM 51–37, *Instrument Flying,* Chapter 9 for this procedure.

TURNS AND TURNS TO HEADINGS

In jet aircraft it is possible but impractical to maintain a constant rate of turn using the

Turn Indicator. This is especially true at higher altitudes and under instrument conditions when even light turbulence is encountered. Moreover, the flight director systems presently undergoing tests and programmed for use in the near future are designed so that the pilot maintains a constant angle of bank rather than a specific rate of turn. This is also true in the automatic flight control systems. The Turn Indicator has rightfully been deemphasized and relegated to standby status.

The Attitude Indicator is used as the bank control instrument in all normal turns (30° of bank). A normal turn utilizes the maximum angle of bank normally used in instrument flying—namely 30°.

Normal Turns

Enter a turn by applying a steady, coordinated pressure on the aileron and rudder in the desired direction of the turn. As you apply pressure, the Attitude Indicator becomes the bank-control instrument. In level turns maintain a constant altitude and airspeed by cross-checking the Attitude Indicator and performance instruments. The pitch attitude must be changed to maintain a constant altitude due to the loss of vertical lift when the aircraft is in a bank. Corrective pressures should be applied only when the flight instruments indicate a deviation from the desired conditions of flight. The method of cross-checking is basically the same as that used for straight-and-level flight. When the desired angle of bank is reached, it may be necessary to exert a slight pressure on the aileron in the opposite direction. This prevents the bank from increasing beyond the desired amount. Maintain an exact angle of bank. Adjust the power to hold a constant airspeed. After the bank is established a small increase in power will usually be required. The Attitude Indicator is the bank control instrument used to return to straight-and-level flight. As the Miniature Aircraft approaches a wings-level attitude, resume a normal level-flight cross-check. Return the power to the rpm required for straight-and-level flight.

Turns to Headings

Procedures for turns to headings are the same as in normal turns except that you establish a lead point on the directional indicator for roll-out.

Enter a normal turn with smooth and coordinated control pressures. The roll-out must be started before reaching the desired heading since the aircraft will continue to turn as long as the wings are banked. The lead point on the Directional Indicator is governed by the technique of the pilot. As a starting point and guide, use one-third the angle of bank as the number of degrees to lead the desired roll-out heading. A consistent rate of roll-in and roll-out should be developed. No attempt should be made to play the roll-out. If the desired heading is not attained after roll-out, change the lead point on subsequent roll-outs until the proper amount of lead is determined.

If the number of degrees to be turned is less than 30°, the angle of bank should not exceed the number of degrees to be turned. If the number of degrees to be turned exceeds 30°, use a 30° bank.

Precision in making turns and rolling out on desired headings is required in actual instrument flight. The success of a low altitude approach or a radar approach may depend on maintaining or turning to specified headings.

CONSTANT-AIRSPEED CLIMBS AND DESCENTS

Learn the proper procedures for entering climbs and descents from various airspeeds. Know the difference between a constant airspeed climb and a technical order climb. A technical order climb is similar to a constant airspeed climb except that in a technical order climb the indicated airspeed is decreased 10 knots for each 5000 feet gain of altitude. A

technical order climb will be accomplished to the level-off altitude on all instrument flights.

For practice purposes, after level off at working altitude, climbs and descents will be performed at 160 knots. Under actual instrument flight conditions it may be necessary to climb or descend at other than this speed; however, the procedures involved are the same.

Constant-Airspeed Climb from Higher-than-Climbing Airspeed

During the entry increase the power to 100% (this power setting will be used for all constant airspeed climbs). Only a slight amount of back pressure is necessary to complete the change from level to climbing attitude. Establish the climb on the Attitude Indicator at the time power is applied to 100%. As the diminishing airspeed approaches 160 knots make pitch changes on the Attitude Indicator to maintain that airspeed. The use of trim is important with pitch and airspeed changes.

By changing the pitch attitude so that the airspeed is two to five knots below 160 knots you will note a definite change on the Vertical Velocity Indicator. Use this knowledge as an aid to maintain a constant airspeed. To regain two knots adjust the attitude on the Attitude Indicator to change the vertical velocity by 100 fpm—or by 200 fpm to regain five knots. In climbs, as in level flight, the Vertical Velocity Indicator is used as an aid in pitch control.

To make a level-off at a predetermined altitude at higher than normal cruise airspeed, refer to the Altimeter for a lead point to initiate the level-off. A rule of thumb for the amount of lead to be used on all level-offs (climbs and descents) is ten percent of the vertical velocity indication. As the level-off is started, reduce pitch with elevator control by reference to the Attitude Indicator. To attain level-flight attitude cross-check the Altimeter and Vertical Velocity Indicator to determine if the established pitch attitude is approximately correct for level flight. Leave the power at 100% until the airspeed approaches 190 knots; then reduce power to maintain airspeed and adjust the pitch attitude to maintain altitude. Reset the Miniature Aircraft on the Horizon Bar for level flight. Resume a level-flight cross-check. It must be remembered that trim adjustments will be frequent throughout the level-off, since pitch attitude and airspeed will be continually changing.

Constant-Airspeed Climb from Normal-Cruise Airspeed

Increase the power to 100% and adjust the pitch on the Attitude Indicator so that 160 knots is maintained. Cross-check the vertical velocity and airspeed for pitch control.

To level off at a predetermined altitude maintaining climbing airspeed, refer to the Altimeter for a lead point before you coordinate the change of pitch and reduction of power. This level-off is the same as a level-off at higher-than-normal-cruise airspeed with the exception that power is reduced when the level-off is initiated since desired cruise airspeed is already achieved. In this level-off you reduce the power to maintain 160 knots in level flight. Frequent trim adjustments will also be necessary in this level-off.

Constant-Airspeed Climb from Lower-than-Normal-Cruise Airspeed

Increase the power to 100% and maintain altitude. As the airspeed approaches 160 knots, leave power at 100% and enter climb as described in "Constant-Airspeed Climb from Normal-Cruise Airspeed."

If level-off at low-cruise airspeed is desired, use the same procedures as during level-off at climbing airspeed with the exception that the power is reduced to maintain 140 knots in level flight.

Descent from Higher than Normal-Cruise-Airspeed

Reduce the power to 65% and maintain a constant altitude (use of the speed brake is optional during this airspeed change). As the diminishing airspeed approaches 160 knots,

adjust the pitch attitude on the Attitude Indicator to establish the descent. Maintain 160 knots during entry. The Vertical Velocity Indicator is used as an aid in maintaining the desired airspeed as previously outlined in climbs.

To level off on the desired altitude at descending airspeed or lower, smoothly adjust the power to the approximate setting necessary to maintain level flight at the desired airspeed and simultaneously adjust the pitch attitude. This should be done when you reach the lead point for the level-off. Reset the power and pitch for level flight utilizing the Altimeter and Vertical Velocity Indicator. When established, reset the Miniature Aircraft on the Horizon Bar. Resume a cross-check for straight-and-level flight.

Descent from Normal-Cruise Airspeed

Simultaneously decrease the power to 65% and adjust the pitch on the Attitude Indicator to maintain 160 knots. Cross-check the Vertical Velocity and Airspeed Indicators during the descent. The Vertical Velocity Indicator is used as an aid to maintain the desired airspeed as previously outlined in climbs.

Constant Airspeed Climbing and Descending Turns

The technique used to establish the bank for a level turn and the technique used to establish the pitch for a straight climb or descent are used simultaneously during the entry to a constant-airspeed climbing or descending turn. Begin the climb or descent and the turn simultaneously. During normal climbing or descending turns with a constant power setting, the nose must be slightly lower than in straight climbs or descents to maintain the same speed. To level off from this maneuver you may: (1) stop the turn, then level off; (2) level off, then stop the turn; or (3) stop the turn and level off simultaneously.

Constant airspeed climbs and descents are required in executing many actual instrument flight procedures. For example, a jet penetration is a constant-airspeed descent. The penetration enables high performance aircraft to descend from a high altitude to a lower altitude in a minimum amount of time in a designated airspace, thereby conserving fuel and airspace. The penetration also positions the aircraft for a radar or low altitude approach to the field.

RATE CLIMBS AND DESCENTS

All rate climbs and descents are entered from level flight, maintaining an airspeed of 160 knots and a vertical velocity of 1000 fpm. If a change of airspeed is necessary, make the change before starting the maneuver.

Rate Climbs

To enter the climb make a power adjustment to the approximate climb-power setting. At the same time, adjust pitch for the proper attitude on the Attitude Indicator during the transition into the climb to maintain the airspeed at 160 knots. When the vertical velocity approaches 1000 fpm, readjust your pitch on the Attitude Indicator, as necessary, to maintain the desired vertical velocity. At the same time that you start maintaining the vertical velocity, adjust the rpm on the Tachometers, as necessary, to maintain 160 knots. Maintain the heading on the Directional Indicator. Any deviation from the desired rate of climb on the Vertical Velocity Indicator indicates a need for a change in the pitch attitude. Pitch and power corrections must be coordinated closely. For example, if the vertical velocity is correct but the airspeed is high, reduce the power. As power is decreased, pitch must be increased slightly to avoid a decrease of vertical velocity. Level-off from a rate climb is accomplished in the same manner as level-off from constant-airspeed climbs.

Rate Descents

The technique and cross-check used for descents are exactly the same as those used

for climbs. The only differences are the pitch attitude and power setting.

Level-off from a rate descent is accomplished in the same manner as from constant-airspeed descents.

Rate climbs and descents have many practical applications in actual instrument flight procedures. Radar approaches and instrument landing systems (ILS) require rate descents during the final approach. The proficiency with which a rate descent is accomplished could mean the difference between breaking out of a low ceiling or making a missed approach.

Rate climbs and descents should also be practiced at other rates that simulate actual maneuvers such as 500 fpm for radar approaches, 2000 fpm for level-off from a penetration, etc.

VERTICAL "S" A–B–C–D

These maneuvers are designed to improve your proficiency in the instrument cross-check and in pitch, bank, and power control. Procedures for maintaining the descent or climb are exactly the same as those for climbs and descents at a constant rate. All four types of vertical "S" begin with a descent.

The Vertical "S" A–B–C–D

The Vertical "S" —A maneuver consists of a series of alternating rate descents and climbs to accomplish a change of altitude of 1000 feet in each reversal of vertical direction. Establish a descent at a rate of 1000 fpm and descend 1000 feet. Then start a climb back to the original altitude. Proper coordination of pitch and power is essential. The lead associated with a descent or climb level-off is used as a starting point for the reversal in vertical direction after each 1000 foot change of altitude. The instant the power is changed, refer to the Airspeed Indicator and maintain 160 knots during the transition to the climb or descent. The use of trim increases the ease of aircraft control. A rapid cross-check is necessary during the changes in vertical direction. You must anticipate the need for a power change before the 1000 foot point is reached because the vertical velocity cannot be stopped in an instant.

The Vertical "S" —B is identical with the Vertical "S" —A except that a normal turn is entered in either direction as the descent is initiated and is continued in this same direction throughout the maneuver.

The Vertical "S" —C is the same as the Vertical "S" —B except that at the beginning of each descent the direction of turn is reversed.

The Vertical "S" —D is identical to the Vertical "S" —C except that with each change of vertical direction there is also a simultaneous change in the direction of turn.

Although these maneuvers have no practical use in actual instrument flight procedures the benefits derived from improved aircraft control and cross-check technique will be evident in nearly all of your instrument maneuvers.

RATE AND TIMED TURNS

Today, the importance of rate and timed turns is reduced. This is due to the increasing reliability of the Attitude Indicator for supplying bank information and the modern improved instrument-flight procedures. The reason they are learned is to enable you to do smooth turns using the Turn Needle in the event of AC failure in the electrical system. "Turn Needle" is another name for the Turn Indicator.

The Turn-and Slip Indicator's principal function is to provide bank and turn information in case of failure of the Attitude Indicator. Also, in case of Directional Indicator failure, timed turns are possible using rate turns for predetermined time periods as a means of changing the aircraft's heading efficiently. In this case, a timed turn is made, the aircraft leveled and the accuracy of the timed turn checked against the Standby Magnetic Compass. Final adjustments to the selected heading can then be made.

The inverters supply alternating current that operates the Attitude and Directional Indicators. The Turn-and-Slip Indicator operates on direct current and therefore would not be affected by failure of both inverters.

A standard rate turn is one which registers a deflection of two needle widths of the Turn Needle and is a turn at a rate of 3° per second. A one-half standard-rate turn registers a one-needle-width deflection and is a turn at a rate of 1½° per second. The true airspeed determines the angle of bank necessary to maintain a standard rate turn. The bank will have to be increased to maintain the same rate of turn when the airspeed is increased. The opposite is true with a reduction of airspeed. The following table shows approximate angles of bank for various airspeeds at 15,000 feet:

A/S Knots		Bank	
IAS	– True	Standard	½ Standard
140	180	30°	15°
160	205	32°	16°
190	245	40°	20°

Rate Turns

Roll into a turn using the Attitude Indicator and the Turn-and-Slip Indicator to establish a standard (or half-standard) rate turn. With the four-minute turn needle, use a two-needle-width deflection for a standard rate turn or a one-needle-width deflection for a one-half standard rate turn. Develop a consistent rate of roll-in and roll-out. A four-minute turn needle is simply one that requires four minutes to complete a 360° turn at the rate of one and one-half degrees per second (one needle-width). In other words, 60 seconds is required for each 90° of turn using one needle width.

Although the number of failures of Attitude and Directional Indicators is decreasing with technical improvements, they still do occur. For this reason, rate turns are used in "gyro out" radar approaches. The gyro referred to is in the Attitude Indicator. Therefore rate and timed turns are still important and should be practiced often enough so that proficiency is maintained.

Calibration of the Turn Needle (Turn Indicator)

Roll into a one-half standard-rate turn using the Attitude Indicator and Turn Needle. After the rate turn is established, note the second hand of the clock as the Directional Indicator passes a numbered point. The aircraft should turn 30° in 20 seconds or 45° in 30 seconds. A change in heading of more or less than 30° in 20 seconds indicates that a smaller or larger deflection of the Turn Needle is necessary. The degree of heading change in 20 seconds should be multiplied by 3 to compute the corrected turn rate in degrees per minute. For example, in a left turn, a needle that turned you 33° in 20 seconds using one needle-width would indicate a turning rate of 99° per minute to the left. This is a 10% increase in the normal turn rate. In subsequent timed turns to the left, you should remember to reduce estimated turning duration by 10%. Errors in the Turn Needle of less than 10% will be considered negligible. Calibrate the Turn Needle to the right and to the left. Note the corrections, if significant, and use these during all timed turns.

Timed Turn: Directional Indicator and Attitude Indicator Inoperative

Enter a one-half standard rate turn when the second hand is on a cardinal position. Timing is very important. The time is started when pressure is applied to roll into the turn and is stopped when pressure is exerted to roll out.

The method of cross-checking is similar to that used in turns to headings except that the clock is now added while the Directional Indicator and the Attitude Indicator are excluded from the cross-check. Reference instruments for pitch are the Vertical Velocity Indicator and the Altimeter.

The rate of roll-in and roll-out must be the same. Maintain a constant indication on the

Turn Needle throughout the turn. Start the roll-out when the time has elapsed. When the wings are leveled, allow time for the Standby Magnetic Compass to settle down, then check it to see that desired heading has been attained. By holding the desired rate of turn for the proper number of seconds, changes of headings of desired amounts are accomplished. For small changes in headings the selected rate of turn will depend on the number of degrees to turn. For changes in headings of 30° or more, make the heading change at 1½° per second (one-half standard rate turn). For changes in heading of less than 30° make a 1° per second turn (two-thirds needle width deflection).

THE STANDBY MAGNETIC COMPASS

Since failure of the Directional Indicator and the Radio Magnetic Indicator can occur, use of the Standby Magnetic Compass on instrument flights in the T–37 is a useful emergency procedure. The reliability and presentation of the Directional Indicator have placed the Magnetic Compass in a standby status; however, the Standby Magnetic Compass should be referred to periodically to check the Directional Indicator for possible errors. When checking the Directional Indicator against the Standby Magnetic Compass the aircraft must be in straight-and-level flight with a constant airspeed in order for the Standby Magnetic Compass to give a reliable indication. This is because it is an instrument of simple design, subject to frictional errors when tilted and acceleration (or deceleration) errors when airspeed is changing; but the simplicity of the instrument is an asset inasmuch as it is virtually foolproof under straight-and-level, unaccelerated flight conditions.

Furthermore, it requires no electrical power and is therefore equally reliable with complete electrical failure. It is not uncommon for the Directional Indicator to be up to 180° "out of slave"—or out of phase with the mechanism that senses the earth's magnetic field. Periodic checks of this instrument against the Standby Compass would instantly reveal this. If the two are in disagreement under level flight, unaccelerated conditions, you can be certain the Directional Indicator has malfunctioned. Learn this well, for it may someday prevent you from becoming lost.

Turns to Headings Using the Standby Magnetic Compass

Turns can be made to headings in VFR conditions using only the Standby Magnetic Compass as a reference. The Standby Magnetic Compass swings ahead of your actual turn in a turn to North and lags behind in a turn to South. Turns to East and West have no appreciable error.

The lead to use for roll-out in turns to a heading of North is approximately the number of degrees of latitude plus the number of degrees required to roll out of the bank. The rate of roll-out is the same as taught previously. For turns to South you must overturn the heading of South the approximate number of degrees latitude minus the number of degrees required to roll-out the bank.

Obviously, you must know the latitude of the geographic region of your flight to make these turns. In turns to East and West the turn error is small when approaching these headings. Therefore, use your normal amount of lead required to roll-out the bank. You should also remember to use no more than 15° of bank when making turns with the Standby Magnetic Compass, due to its unreliability while banking steeply.

If the Directional Indicator fails, headings will have to be maintained using the Standby Magnetic Compass, and all turns should normally be timed turns. Turns to headings accomplished by reference to the Standby Magnetic Compass to determine lead point for roll-out may be used as an alternate method.

STEEP TURNS

Steep turns will be practiced at 45° or 60° of bank at both normal and high-cruise airspeed.

Steep turns should be accomplished with a constant angle of bank. Altitude corrections are made by adjusting the pitch attitude. However, if excessive altitude is being lost or gained, a corresponding decrease or increase in bank may be made to help correct the pitch attitude. With practice you will learn to do steep turns without varying the bank. The need for a bank change shows a lack of technique. When this becomes excessive, roll out of the turn and begin again.

Enter a steep turn by applying steady, coordinated control pressures in the desired direction of the turn. As pressure is applied the Attitude Indicator is the bank control instrument and remains the bank control instrument throughout the turn. Maintain altitude and airspeed by referring to the Attitude Indicator and the performance instruments.

It is more difficult to control the pitch attitude in steep turns because of the greater loss in vertical lift with the increased angle of bank. Precession and G forces on the gyro in some Attitude Indicators in a steep turn add to the difficulty of maintaining the desired attitude. The G forces can be minimized if you do not allow the vertical velocity to go below zero. The maximum precession usually occurs after 180° of turn. There is a tendency to lose altitude in steep turns. Therefore, take immediate corrective action as soon as the necessity is indicated on the flight instruments. Do not arbitrarily put in a correction before the necessity arises. Since any back-stick correction involves an increase in the angle of attack, the drag increases and the airspeed decreases. Adjust the power as necessary to maintain a constant airspeed.

Refer to the Attitude Indicator when making all pitch and bank corrections even though the precession of the instrument is apparent. Note the need for a correction on the Vertical Velocity Indicator and the altimeter. Then check the attitude on the Attitude Indicator and make a change from this indication. Remember that the fuselage of the miniature Aircraft must be kept slightly above the position it takes for straight-and-level flight. After making the attitude change, check the Altimeter and Vertical Velocity Indicator to determine whether the correction was adequate.

If the Attitude Indicator is not available, refer to the Vertical Velocity Indicator and Altimeter for corrections. Initiate the corrective action before deviations become large. Observe the Altimeter and Vertical Velocity Indicator closely to determine whether or not the correction was adequate.

The recovery should be made smoothly and with a normal rate of roll-out. Use the one-third-the-angle-of-bank rule for lead. The vertical lift will increase during the roll-out and the aircraft will tend to climb. Make the necessary pitch corrections as soon as they are needed. Readjust the power to maintain the desired airspeed.

You will be allowed to practice coordination exercises using steep turns. Start with 30° of bank and increase the bank 5° on each reversal of direction until 60° of bank is reached. Your instructor may then have you reverse the procedure until 30° of bank is reached.

Any turn with an angle of bank greater than 30° is considered a steep turn. This type of turn is seldom necessary or advisable in instrument navigation flight. In tactical operations steep turns are routine and must be accomplished with precision. A steep turn is also a good maneuver to improve your skill in reacting quickly and smoothly to rapid changes of attitude.

Power control to maintain a constant airspeed is much more critical in a steep turn than a normal turn. Due to the back-pressure required to counteract the loss of vertical lift while in the turn, the airspeed will dissipate more rapidly than normal as a steep turn is entered and will build more rapidly as the roll-out is accomplished. Therefore, a faster application and a greater amount of power will be needed as the turn is entered and a faster reduction of power will be needed as soon as the roll-out is initiated.

CHANGE OF AIRSPEED IN TURNS

The procedures for making a change of airspeed in turns are the same as for airspeed changes in straight-and-level flight. The use of trim is important during airspeed changes and will aid in maintaining altitude.

Normal turns (30 degrees of bank) will be used for training purposes.

Change of Airspeed After Turn Is Established

After the bank has been established, change the power setting to increase or decrease the airspeed. As the airspeed changes, adjust the pitch attitude to maintain altitude. Cross-check control and performance instruments. Roll out on the desired headings.

Simultaneous Turn and Change of Airspeed

Simultaneously initiate a turn and make a power change estimated to attain the desired airspeed. Adjust the pitch attitude to maintain altitude and adjust the trim as necessary during the turn. Cross-check control and performance instruments and readjust power if necessary. Roll out on the desired heading.

Changes of airspeed in turns are taught to increase the speed of the cross-check and to improve technique of aircraft control. Your instructor will vary the amount of turn to give you practice in rolling out before, after, and as airspeed is attained. If you must roll out before desired airspeed is attained, continue to change the airspeed to the desired setting after leveling the aircraft.

VOR ORIENTATION

In VOR all information except station identification is presented visually. This eliminates the necessity of consciously listening to and interpreting aural signals after station identification. The high VOR frequencies are not normally affected by static or other irregularities generally associated with low frequency radio facilities.

The Collins 101 VOR receiver is installed in the T–37 aircraft. It utilizes the Course Indicator (1D–249) and Radio Magnetic Indicator (1D–250). It is necessary to be thoroughly familiar with this set and its operation.

Information for operation of the equipment may be found in Section IV of the T–37 Flight Manual. Procedures for time-and-distance check, homing, course interception, maintaining course, station passage and holding are given in AFM 51–37, Instrument Flying.

Previously, most of your instrument flying has been basic instrument maneuvers. They have been 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 the planned sequence. The maneuvers and procedures in this chapter are used to arrive at a definite fix and, if necessary, hold at a fix until the controlling agency can clear you for a low altitude approach.

JET PENETRATIONS AND APPROACHES

A FLIP Terminal (High Altitude) plate, or a similar locally-reproduced plate, should be used when making the penetration, low altitude approach and missed approach.

Entry airspeed for the penetration will depend on whether the entry is made upon initial station passage or from a holding pattern. If cleared for an immediate penetration after initial station passage, cruising airspeed at that time is the entry airspeed. If the penetration is made from a holding pattern, entry airspeed is 160 knots.

Today, low altitude maneuvering for jet aircraft on actual instrument flights is being held to a minimum. Where possible, low altitude approaches requiring procedure turns are being eliminated. At some locations, however, it is impossible or impractical to do away with procedure turns. The tear drop procedure turn is generally replacing the other types since it is more simple and requires less maneuvering.

Your instructor will require voice procedures throughout all phases of the penetration.

The Penetration

At high station (usually 20,000 feet) reduce the power to 65% rpm and simultaneously lower the nose of the aircraft by reference to the Attitude Indicator (Horizon Bar at the 60° bank indices on the J–8, 10° nose low on the MM3). This pitch attitude is maintained on the Attitude Indicator until the airspeed approaches 200 knots. As the airspeed approaches 200 knots, extend the speed brake. Trim the aircraft to relieve pressure during this procedure. Your vertical velocity will be about 5,000 fpm.

The descent is made at 200 knots, 65% rpm and speed brake extended. If a penetration turn is to be made, use 30° of bank. Your letdown plate will show whether the penetration contains a penetration turn or whether it is a straight-in descent.

At approximately 1000 feet above level-off altitude, raise the speed brake and decrease the pitch attitude on the Attitude Indicator by about ½ (e. g., if the Attitude Indicator shows a four bar nose low attitude, decrease the pitch attitude to a two bar nose low attitude). When approximately 200 feet above the desired altitude, smoothly adjust the pitch to a level-flight attitude and return to the station at minimum penetration altitude. During the level-off the airspeed is allowed to build above 200 knots. Adjust power when necessary to maintain at least 140 knots (65% rpm minimum). Refer to AFM 51–37 for information on proper procedures for intercepting inbound course.

When the level-off is started, the use of the speed brake depends on what aircraft configuration is desired for the low altitude approach. The following paragraph on *Low Altitude Approach* explains the reasons for using different configurations.

Low Altitude Approach

Low altitude approach aircraft configurations depend on many factors such as: whether the low altitude approach is straight-in or a procedure turn is required; whether the low altitude approach is lined up with the landing runway or a circling approach is necessary; whether the time from the radio fix to the field is 2 minutes or more; and the existing weather at destination.

Straight-In

If the airfield is located less than two minutes at approach airspeed from the radio fix, the gear should be lowered and 120 knots attained prior to reaching the fix.

If the airfield is located two minutes or more at approach airspeed from the radio fix, the gear should be lowered and 120 knots established over the fix.

Utilizing a Procedure Turn

When over the fix at minimum-pentration altitude, extend the speed brake and descend at 140 knots IAS to procedure-turn altitude. (The procedure turn may be started while descending to minimum procedure-turn altitude.) Retract the speed brake and level off at procedure turn altitude. Maintain 140 knots during the procedure turn.

After completion of the procedure turn, extend the speed brake and descend to the published altitude. Retract the speed brake and level off at the published altitude. Apply power as needed to maintain the desired IAS and proceed inbound to the fix. Lower the gear and reduce the airspeed to 120 knots in accordance with paragraphs under *Straight-In* described above.

When over low station, immediately start descent to minimum altitude. The rate of descent should be commensurate with safe flight. The speed brake may be utilized, as needed, to control the airspeed and descent. The speed brake should be raised upon reaching the minimum altitude unless needed to control airspeed.

The speed brake and full flaps will be lowered for the landing after visual contact is established (Straight-In or Procedure-Turn

type approach). When a circling approach is required, extend the speed brake and wing flaps on base leg or final approach as desired.

Missed Approach

The missed approach is similar to the ITO. Advance the throttles to 100% rpm and retract the speed brake. Establish a two-bar width climbing attitude on the Attitude Indicator. Check the Vertical Velocity Indicator, and when definitely climbing, raise the gear and flaps. When the airspeed reaches 140 knots reduce power to 85% rpm and maintain a constant-airspeed climb until reaching the missed approach altitude. Cross-check all instruments to insure that the proper heading and climb are maintained. Level off and maintain 140 knots. Follow instructions given by approach control, ATC, or your instructor.

RADAR APPROACH

A radar approach usually begins with the aircraft arriving over a radio fix (radio range station, radio beacon, VOR, etc.). The type of radar approach pattern is determined by the physical setup of the field and the instructions given by the controller. Follow the controller's instructions. Read back all headings, altitudes, and altimeter settings, and acknowledge all other transmissions until on the final approach. The final controller will say, "You need not acknowledge any further transmission" when on the final approach. All changes of headings in the initial-approach phase should be made by establishing an angle of bank on the Attitude Indicator that will approximate a standard rate turn for the TAS being flown (not to exceed 30 degrees of bank). For turns during the final-approach phase use an angle of bank equal to the number of degrees to be turned (not to exceed ½ standard rate).

Airspeeds, power settings, and procedures are as follows:

Downwind leg will be flown with clean configuration and 140 knots airspeed (minimum power setting 65% rpm). Its location will be determined by the instructions from the controller and is further from the airfield than the downwind leg of a normal landing pattern. The initial cockpit check will be performed here except for lowering of landing gear. Use the speed brake if descending.

Lower the landing gear on the base leg and allow the airspeed to decrease to 120 knots. The base leg is that leg of the radar pattern which brings you from downwind leg to final approach and makes a 90° angle with both. Adjust the power setting to maintain 120 knots on base leg (approximately 73% rpm) and perform the final cockpit check. Oftentimes a radar controller will turn you from a base leg to a 45° dogleg to final. This can be considered a part of the base leg and is flown at the same airspeed. Its purpose is to reduce the magnitude of your turn to final approach and allows greater precision in the final turn.

When on the final approach heading, extend the speed brake, lower 50% flaps and allow the airspeed to decrease to 110 knots. Make small power adjustments to maintain 110 knots (approximately 80% rpm). Altitude and heading should remain constant.

When entering the glide slope, lower full flaps. Maintain 110 knots (approximately 83% rpm). The glide slope airspeed is normally 30 knots above stalling speed in the landing configuration. However, in the T–37 use an airspeed of 110 knots. The reasons for the faster airspeed of 110 knots are: this is a safe single-engine speed, the aircraft handles better, and a more normal rate of descent can be maintained on the glide slope. The technique for entering the glide slope is the same as the entry to a rate descent. No change in configuration should be made after glide slope interception.

Half flaps are used on final approach when visual reference to the runway will be impaired for any reason during the landing phase. This configuration gives a pitch attitude that would allow the aircraft to touch down on the main gear first. With full flaps, the pitch attitude is steeper and the nose wheel would hit first, creating a dangerous situation.

Procedures for making a missed approach from a radar approach are the same as those from a low altitude approach. Follow the missed approach instructions given by the controller.

During the ground briefing your instructor will go through a typical radar pattern stating instructions that would normally be received and the way you should acknowledge them. Know where and how to change airspeed, perform the cockpit checks, lower speed brake, lower the landing gear, lower flaps, and enter the glide slope. Know the procedures for corrections of heading and altitude while on the glide slope.

Your instructor will have you perform a radar approach without the hood. He will then have you practice a simulated radar approach using the hood.

In practice, if a radar approach unit is not available, the instructor will act as the radar approach controller and you will be the aircraft pilot.

Surveillance and gyro-out approaches are two variations of the radar approach. They are both explained in AFM 51–37, Instrument Flying.

Acknowledge all heading and attitude changes and altimeter settings by repeating them. All other instructions may be acknowledged by "Roger" or "Wilco".

Radar approaches are increasing in importance at major air terminals as well as Air Force installations. Radar approaches greatly increase the effectiveness of the Air Force's all weather concept. Published low altitude approach minimums are lowered when radar is available. In the forseeable future, with the acceptance of a new type approach and runway lighting installation coupled with a radar approach, field minimums will be reduced even more. This would enable the Air Force to have a true all weather capability.

VOR INSTRUMENT NAVIGATION FLIGHT

The instrument navigational flight will be conducted with as much realism as possible. It will include filling out a DD Form 175, copying a simulated ATC clearance, and making position reports.

Where local conditions permit, you will file a DD Form 175 with Flight Service. If this is not practical, a local simulated handling of all the procedures will be used.

INSTRUMENT–APPROACH PATTERNS

The practice instrument-approach patterns found in this section are designed to provide maneuvers or portions of maneuvers used in accomplishing an actual instrument flight. An instrument flight is composed of a series of maneuvers that are determined by such circumstances as weather, terrain, type of aircraft, radio and radar facilities, etc. The types of practice patterns included herein contain the typical features included in many actual published instrument approaches for specific airports.

Instrument approach patterns will help build your confidence in handling the aircraft under hooded conditions while in close proximity to the ground and in rough air.

Voice procedures are an integral part of instrument flying, and their importance cannot be overstressed. Making prompt and correct position reports while controlling the aircraft and planning ahead requires practice. Voice procedure will be practiced throughout the instrument-approach patterns.

The use of radio navigation aids with these patterns offers the best training situation. If this is impossible or impractical, your instructor will impart as much realism into the patterns as possible.

It is not intended that the patterns be memorized. These patterns will be flown by reference to approach plates similar to the FLIP Terminal (High Altitude) Charts. Thorough briefings prior to executing a particular pattern should eliminate the necessity for a demonstration.

One of your instrument missions will include a simulated ATC clearance, ITO, instru-

ment departure and climb, holding, penetration, low altitude approach, and missed approach.

Pattern I (Simulated Penetration)

The first pattern has a dual purpose. It is a maneuver that can be used to lose considerable altitude, and it contains the procedures used in a jet penetration. Your instructor may give this maneuver to terminate the flight after practicing instruments at high altitude. It may also be used to get the aircraft down lower for practice in rough air.

You should start this pattern at a specific fix or time. Variations will be made in starting the pattern. For example, you will not approach the fix (or starting point) from the same heading each time. This eliminates the same turn to get on the out-bound course. Another variation that is practical is delaying the descent to simulate overflying an airway. It may be necessary to fly several miles after passing the fix to clear an airway.

The voice procedures used for this pattern should include, but not be limited to, all compulsory radio calls. Optional calls such as "passing through every 5,000 feet" or "call completion of penetration turn" will be used as your proficiency permits.

At first you will make the penetration straight ahead. As proficiency increases, penetration turns using 30° of bank will be made. The altitude at which the penetration turn is usually started can be determined by adding the minimum-penetration altitude to the initial-penetration altitude and dividing by two. This is an estimate for determining when the penetration turn should be started since the initial penetration altitude will quite often vary.

Refer to JET PENETRATIONS AND APPROACHES, this chapter, for the penetration procedures used with the T–37.

Pattern II (Holding)

This pattern simulates entering a holding pattern. Three minutes from the fix (or starting point) 160 knots airspeed should be established. Initially, the entry into the holding pattern should be made on the inbound heading. Later, your instructor will vary the entry to include entry angles of less than, and more than 45°. Standard and nonstandard holding patterns will be flown. Descents may also be added to make this pattern more realistic.

To descend in the holding pattern when holding at high altitude, reduce power to 65% rpm and maintain holding pattern airspeed (160 knots). To level off use the normal rule (10% of vertical velocity indication) for lead, and adjust power to maintain 160 knots. To descend when holding at low altitude (10,000 feet or below), extend the speed brake and maintain the holding pattern airspeed. Normally, no power reduction will be necessary. To level off retract the speed brake when the lead point for level-off is reached. Adjust power to maintain 160 knots.

You will be required to vary the inbound and outbound headings of the pattern as your proficiency permits. This will familiarize you with holding patterns in general. Radio voice procedures will be used between instructor and student. Terminology and sequence will be made as realistic as possible. The instructor may ask for time estimates from the fix (or holding point), arriving and departing the fix, arriving or departing an altitude, etc.

Procedures for entering, holding, descending, and leaving the holding pattern should be accomplished as described in AFM 51–37, Instrument Flying.

Pattern III (Low Altitude Approach)

This pattern simulates the low altitude approach to the airport. It starts at the radio fix at initial approach altitude and terminates after flying the specified time and/or distance outbound from the fix (or starting point).

There are many different low altitude approaches in use today. Though only one is shown, the individual base or instructor may

wish to use others. For instance, if the base has a published let-down procedure, this can be used. It is important to be aware of the complexities of instrument approaches; therefore, your instructor will have you practice more than one pattern. A good way to accomplish this is to look at FLIP Terminal Charts and discuss them with your instructor.

Radio voice procedures will be stressed. Your instructor may also require other than compulsory radio calls.

Procedures for executing the low altitude approach patterns will be accomplished as described under JET PENETRATIONS AND APPROACHES of this text and AFM 51–37, Instrument Flying.

A circling approach may have to be made following a low altitude approach. This would occur when a turn of more than 30° is necessary to align the aircraft with the landing runway. Many variables exist in executing a circling approach, and no definite pattern can be established. Circling approaches should be flown under contact flight conditions. Procedures for executing a circling approach are described in AFM 51–37, Instrument Flying.

Pattern IV (Radar Approach)

This pattern will simulate an actual radar approach. Your instructor will act as the ground controller and determine, depending upon local conditions, what type of pattern will be flown. If your proficiency warrants, and time and availability permit, an actual radar approach will be flown. This pattern requires correct and timely voice procedures. They are an integral part of any radar approach.

As in previous patterns, your instructor will vary headings, altitudes and turns. Other variations such as straight-in approaches and dog-legs to final will be taught. The more realism your instructor puts into this pattern, the more benefit you will derive.

Procedures for executing the radar approach patterns should be accomplished as described under RADAR APPROACH of this text and AFM 51–37, Instrument Flying.

Pattern V (Missed Approach and Instrument Departures)

There are many different types of missed approaches. The main objective is to follow definite procedures for reorientation in the event a landing cannot be made.

The complexity of this pattern may be increased as your proficiency permits. A straight-ahead climb is one pattern. A climbing turn to a specific heading and altitude, leveling off, and reversing course is another type pattern that may be given. Procedures for executing missed approaches are described in this text and AFM 51–37, Instrument Flying.

Another type of pattern is the instrument departure. Today, more than ever, these departures are becoming more complicated. The local traffic conditions and areas as well as the desired direction of departure will decide what type of departure is flown. This is another pattern that your instructor will stress. These patterns will vary at the individual bases.

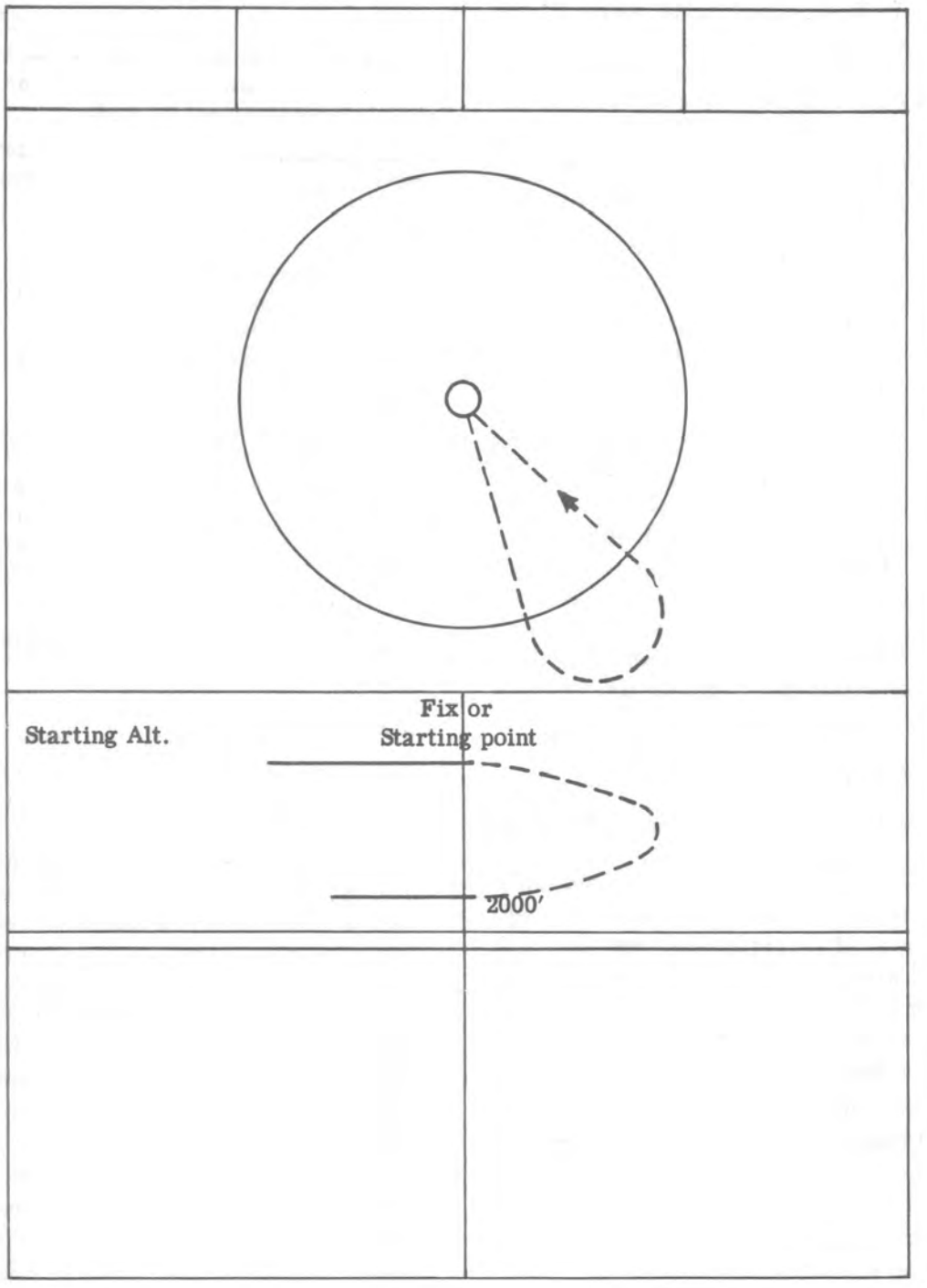
Conclusion

This chapter should tie together the reasons for all of the previous basic instrument maneuvers. Actual instrument flying is nothing but a series of basic instrument maneuvers flown in a sequence depending on the route flown, weather, air-traffic congestion, etc.

You should be able to make an ITO, technical order climb to altitude and navigate from one omni fix to another by use of VOR equipment. Upon arriving at the destination, you should be able to hold or, when cleared, penetrate and make a low altitude approach to the airport.

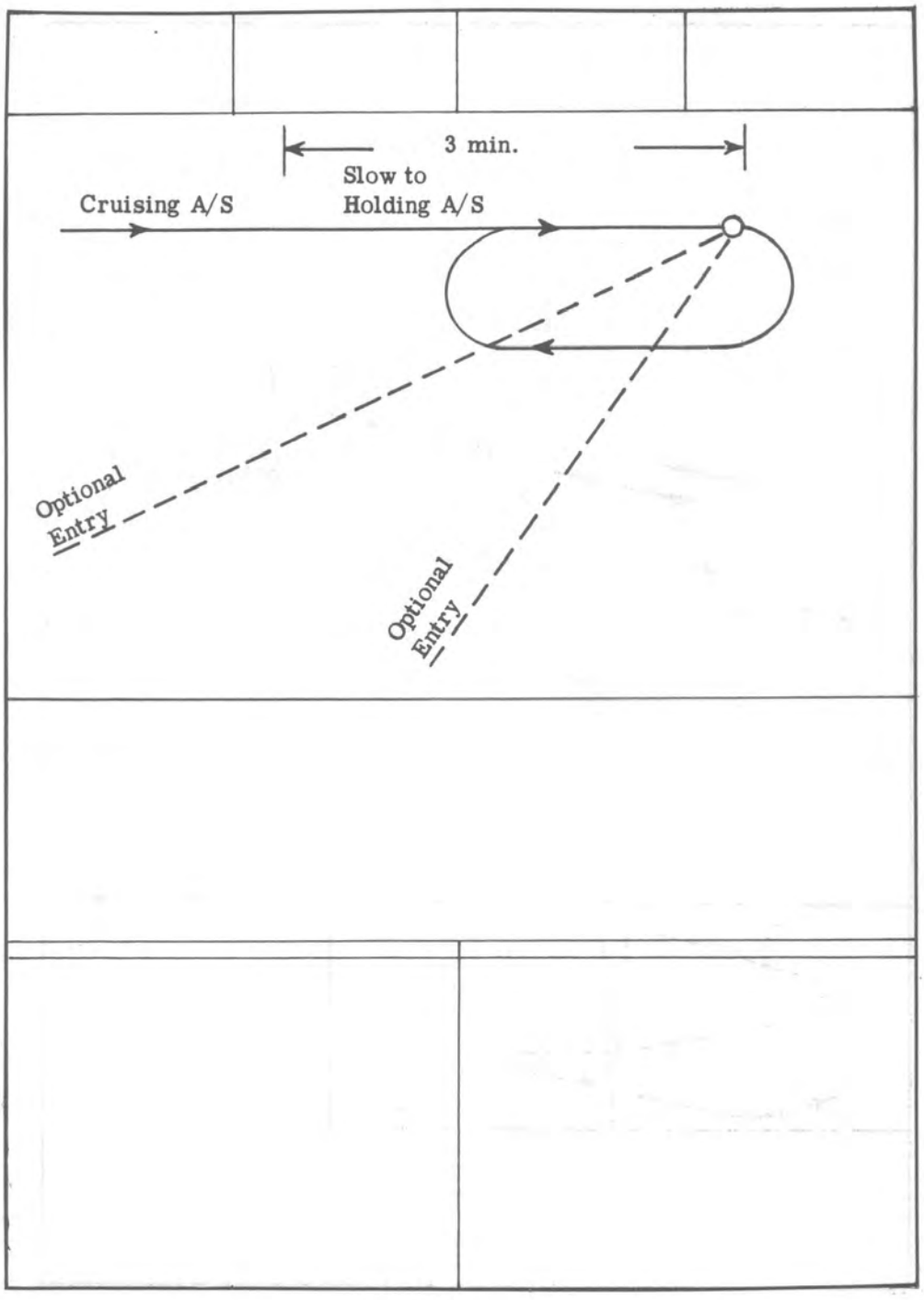
The reason for practicing the fundamental types of instrument approach patterns is to send a better-educated, more-experienced student pilot to the Basic Phase of Pilot Training. The benefits from the patterns are unlimited. Variations and added emphasis imparted with realism greatly increase their value.

PATTERN I (PENETRATION – T–37 AIRCRAFT ONLY)

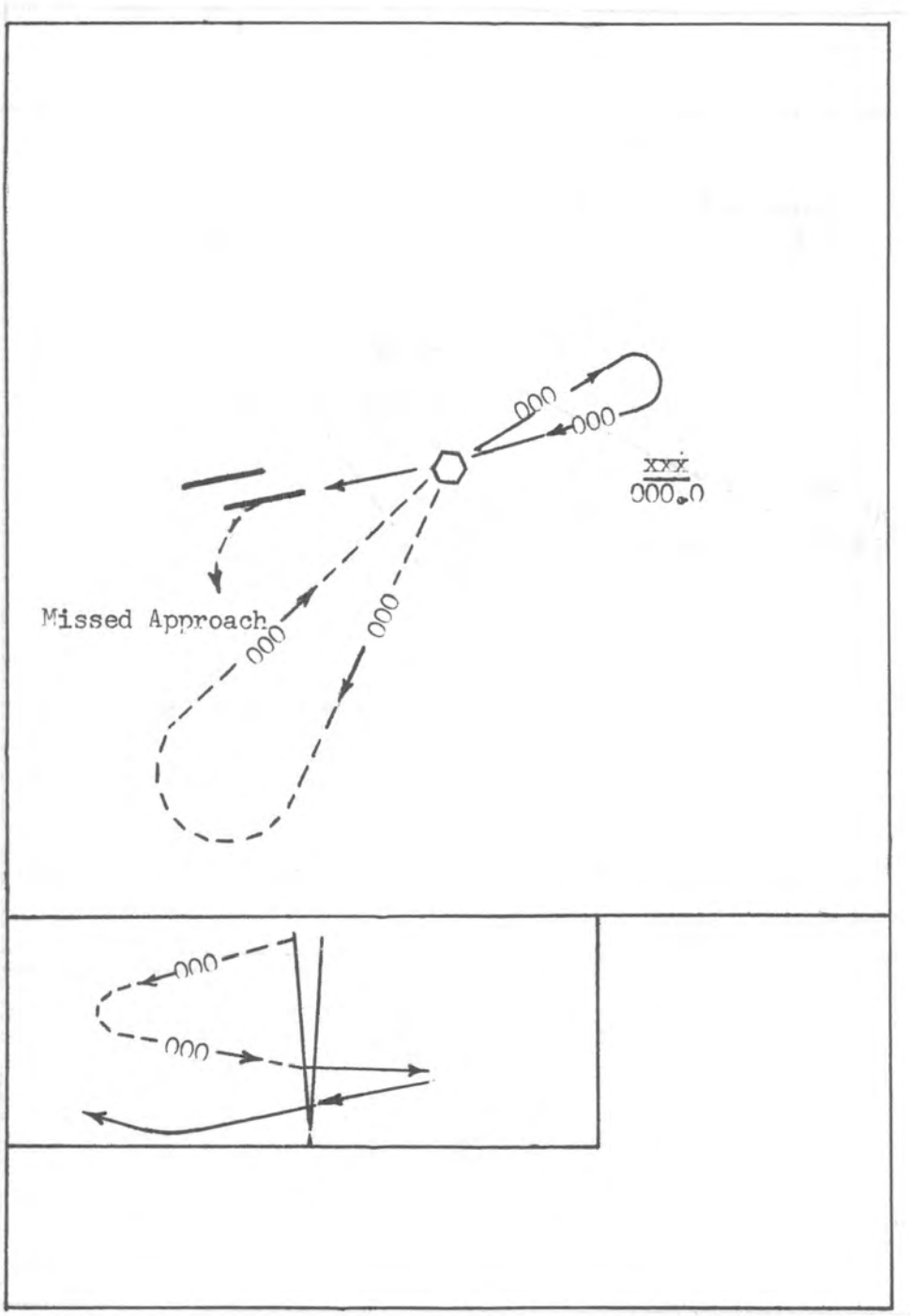


NOTE: For added authenticity, fill in all blank spaces. As an example, if no radar approach is available at the field – No Radar – should appear. This will apply to all patterns.

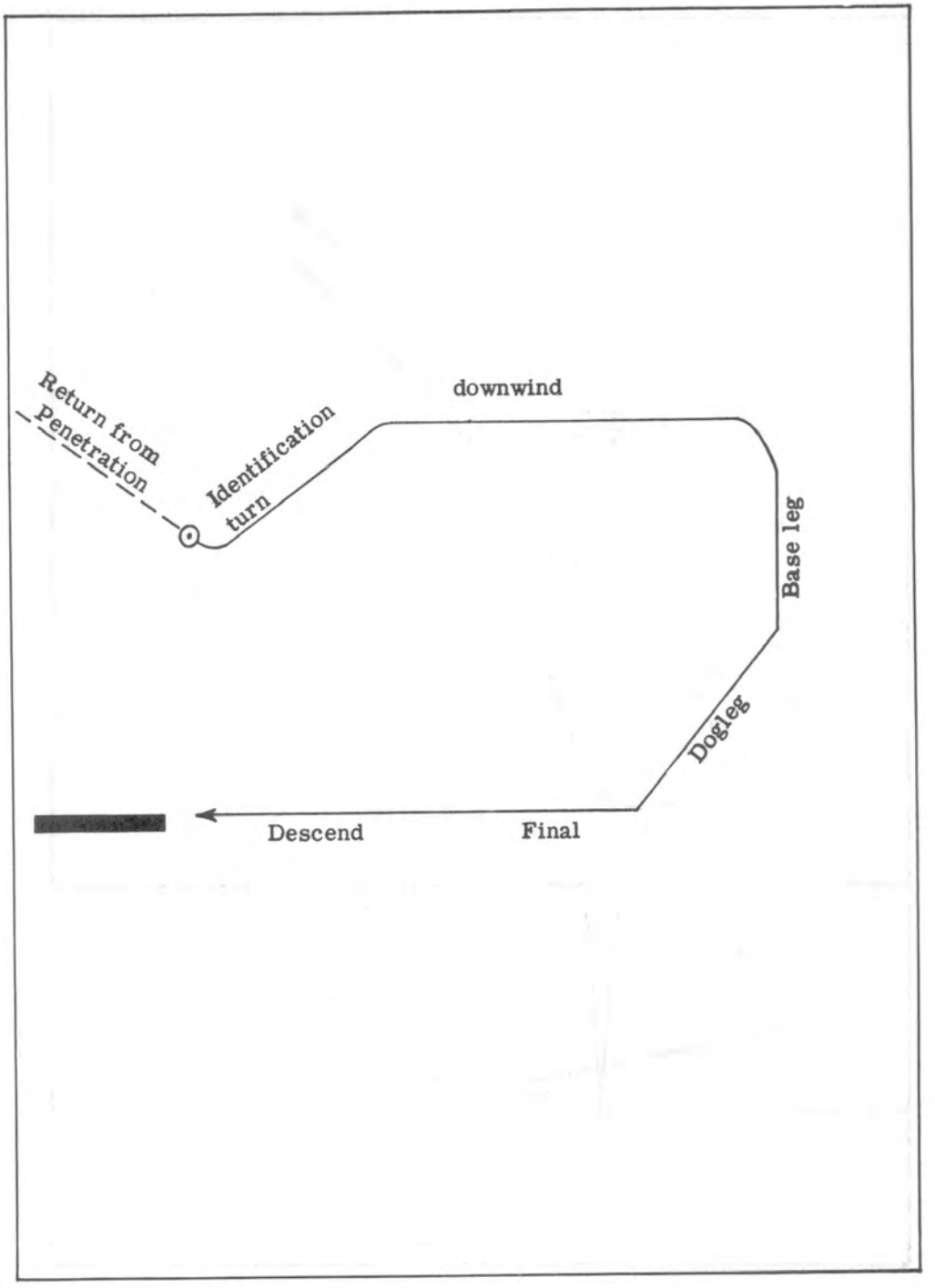
PATTERN II (HOLDING)



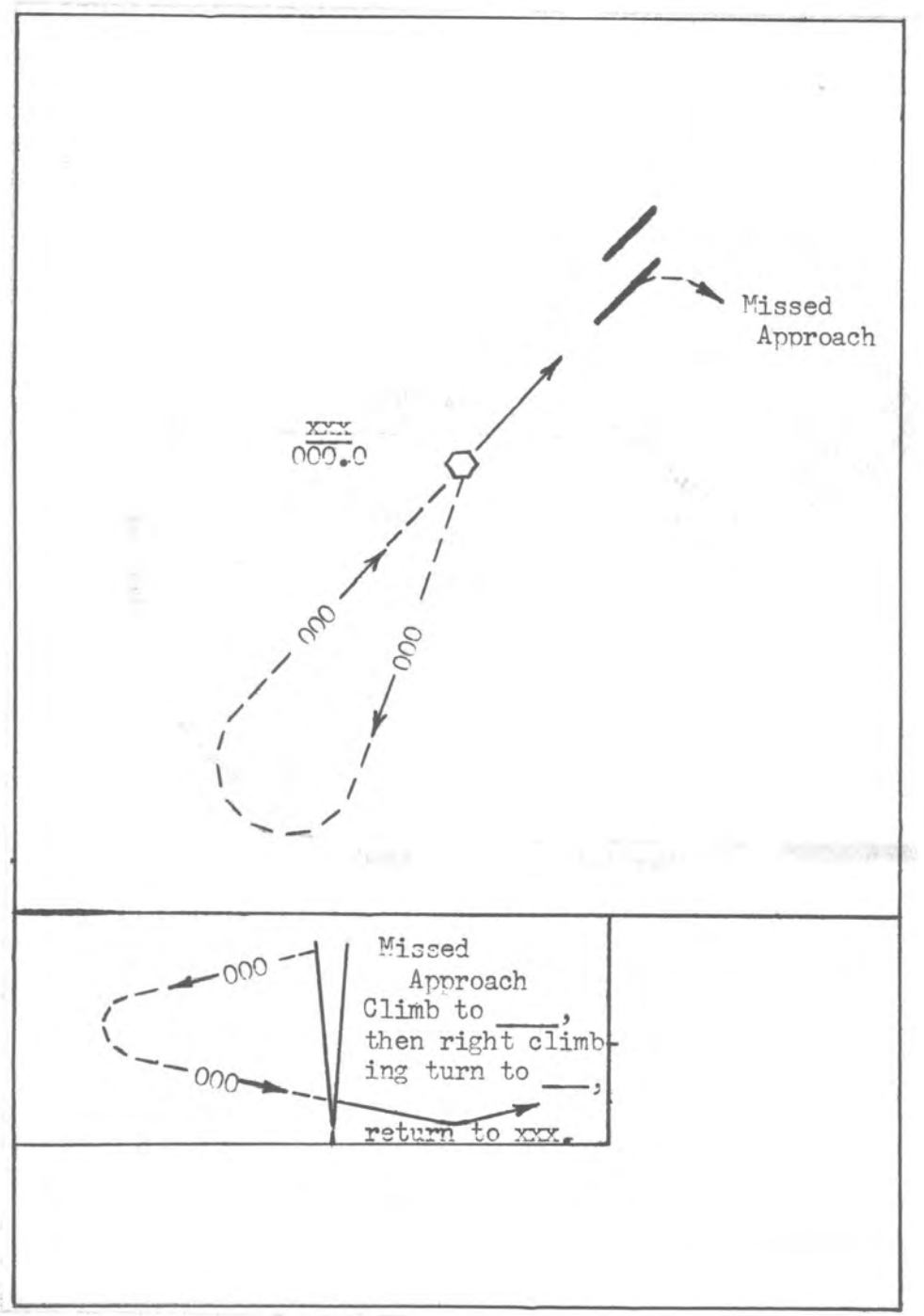
PATTERN III (LOW ALTITUDE APPROACH)



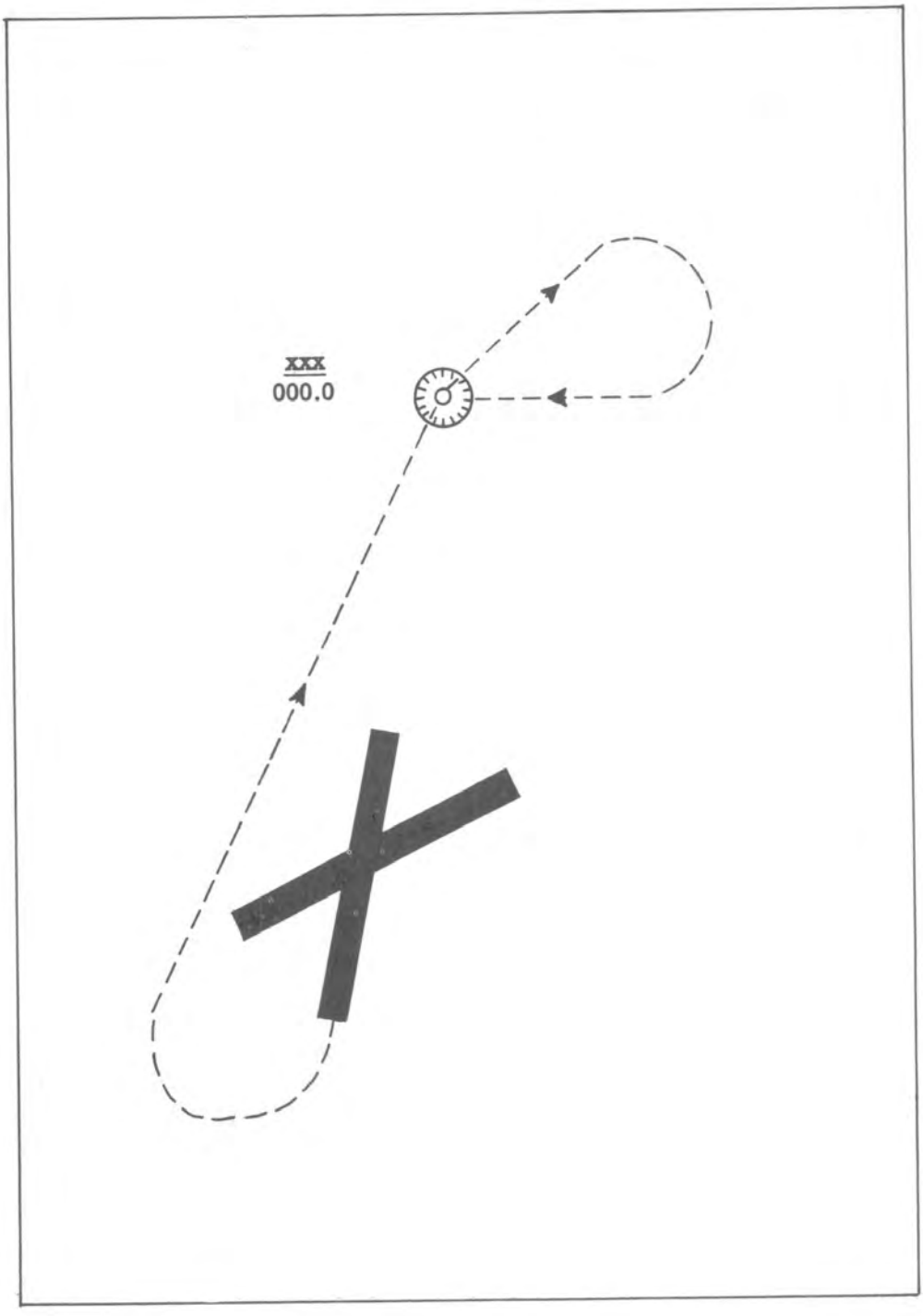
PATTERN IV (RADAR APPROACH)



PATTERN V (MISSED APPROACH)



PATTERN V (INSTRUMENT DEPARTURE)



Keystone Departure: *After takeoff, right climbing turn to_____. Proceed direct to_____VOR at_____. Make good an outbound track of_____° until reaching_____altitude. Reverse course so as to return over_____VOR at _____altitude. Proceed on course or as directed by ATC.*

T-37 AIRSPEEDS AND POWER SETTINGS

Conditions of Flight	Airspeed (Knots)	Approx. RPM %	Configuration
Takeoff		100%	50% Flaps, gear
Climb	T.O. Climb	100%	Clean
Fast Cruise, 15,000 ft.	190	87%	Clean
Normal Cruise, 15,000 ft.	160	81%	Clean
Slow Cruise, 15,000 ft.	140	78%	Clean
1000'/min climb, 15,000 ft.	160	90%	Clean
1000'/min descent, 15,000 ft.	160	57%	Clean
Penetration	200	65%	Speed brake extended
VOR final (level flight)	120	73%	Gear
Radar downwind	140	65%	Clean
Radar base	120	73%	Gear
Radar final (level flight)	110	80%	Gear, speed brake, 50% flaps
Radar final (500/ descent)	110	75%	Gear, speed brake, full flaps
Radar final (500/ descent)	110	70%	Gear, speed brake, 50% flaps
Missed approach	140	85%	Clean

NOTE: The above power settings are only an approximation and are to be used as a guide. They will vary with fuel load, temperature changes, and different aircraft.

Some aircraft may not be able to reduce to low rpm when at high altitude because of the barometric restriction in the fuel control.

CHAPTER 22

FORMATION FLYING

GENERAL

As a student, you will realize that the type of formation flown in tactical units will vary according to assigned mission, different weapon systems, etc., but the fundamental concepts of air discipline and essentials of aircraft control used in formation seldom change. Training in these essentials will enable you to become proficient in formation tactics with a minimum of instruction and standardization in Basic Pilot Training and later in an operational unit.

FORMATION FLYING RESPONSIBILITIES

Every pilot in a formation has well-defined responsibilities. A leader must know and consider the capabilities of his wingman, planning and executing each maneuver with this factor in mind. The wingman must be considerate of others in the formation, and must be capable of reacting to any circumstance precisely and surely. He must trust his leader and maintain perfect self-discipline. The combination of good leadership and capable wingman creates teamwork and good formation. To fly good formation, you must relax and discipline yourself never to be satisfied with anything less than perfect position. With this habit, you will find you seldom need to make large corrections which cause your wingman to yo-yo and lose respect for your flying ability. These factors of habit are interdependent. The prime prerequisites for good formation technique are planning, relaxation and diligence.

FORMATION BRIEFING PROCEDURES

A briefing guide will be used, and the instructor will brief on the following before each flight:

a. Engine starting.

b. Call signs and position of both flight members.

c. Maneuvers and checks to be accomplished.

d. Method of leaving and rejoining formation if this is necessitated.

e. Instructions if takeoff is delayed.

f. Additional information considered desirable for the flight.

Ask questions. The student who takes to the air with any doubts about his formation duties is a potential hazard to the formation.

TAXI, DELAYED START, AND TAKEOFF

Start and Taxi

If both aircraft of the formation are parked together, engines will be started on a visual signal; if not parked together, you will be given a starting time. After starting, the leader will contact the tower for a radio check. Immediately after the tower answers, the wingman will check in: Example: "Red 2". The formation will then taxi out, assuming proper position on pulling out of the parking area. All taxiing will be done in trail with adequate clearances. If another pilot attempts to taxi his aircraft between you and the formation leader, ask him to hold. The formation has the right-of-way. Follow the leader in position, and take the runway with him.

Delayed Start

If delayed in reaching your aircraft, do not omit items on preflight or attempt to rush starting procedures beyond your ability. Your flight leader will assign a rendezvous point and altitude. If unable to join the leader for takeoff, you will advise him of your difficulty. If it is quickly corrected, take off and proceed to the rendezvous, notifying your flight leader on the air-to-air channel when airborne. If the flight leader's aircraft is delayed, you will either proceed on an alternate mission or wait for the flight leader as previously briefed.

Line-up on Runway

Formation takeoffs in the T–37 will be made with the wingman on the right side. This is necessary so that the instructor in the lead aircraft can see the number 2 man and number 2 student pilot can see the lead. Taking off on the left wing, would result in restricted visibility for the pilot of the number 2 aircraft because of his left position in side-by-side seating. Follow the formation leader onto the runway, positioning your aircraft so that you have tail and nose clearance as well as wingtip clearance with the leader. Since all takeoffs will be made with the number 2 man on the right wing, the wingman will be on the inside when the first traffic exit turn is to the right. Conversely, the number 2 man will be on the outside of the exit turn when there is left hand traffic.

Takeoff

Your formation flights will be in a two-aircraft formation. For takeoff in wing position, the leader will look at you and give the run-up signal. At this time, pump up the brakes and advance the throttle to 100% rpm. Perform your Before-Takeoff check, and signal to the leader when you are ready. The leader will adjust his throttle to 98% rpm prior to giving the release-brake signal. Your 2% margin will allow you the flexibility you need to hold position. Both of you will release brakes on the signal. Use power as required to hold position on the takeoff roll. Use the same techniques that are employed in aerial formation, and do not attempt to divide your attention to watch the runway ahead. The leader will allow space and clearance for you.

When airborne, retract the gear; if you are overrunning the leader when breaking ground, delay retracting your gear; if you are falling back, start your gear up as soon as the leader does, provided you are safely off the ground. In no case will you raise your gear before the leader's gear starts up. When a safe altitude and 110 knots airspeed has been reached, the leader will signal to raise flaps. Raise your flaps at the same time. The leader will maintain the normal after-takeoff attitude, allowing airspeed to increase to 200 knots, then reduce power to 96% rpm. Traffic exit will be made using a maximum of 30 degrees of bank. If the leader aborts his takeoff after takeoff roll is started, the wingman will normally continue his takeoff, each keeping to his own side of the runway. For this reason, it is important to maintain normal formation wingtip clearance when lining up on the runway and throughout the takeoff.

If either the leader or wingman is compelled to abort the takeoff while rolling on the runway, he must call immediately on the radio and make known his intentions. Example: "Red 2 aborting takeoff". The reason the wingman continues when the leader aborts should be obvious. If one aircraft develops trouble when breaking ground and decides to take the abort, there is no need for both aircraft to do so.

Technique During Takeoff

Nose wheel steering should be used [redacted] for maintaining directional control. After becoming airborne, maintain a level position on the lead aircraft until the landing gear and wing flaps are retracted, then stack down in normal formation position. (See Figure 22–1)

Power Settings

a. Takeoff—Formation leader 98%; wingman, as needed.

b. Climb—Formation leader 96%, wingman, as needed.

FIVE–THOUSAND–FOOT CHECK, CLIMBING

At approximately 5,000 feet above the terrain, the leader will make a radio call and yaw his aircraft alternately left and right as a signal for the 5,000-foot check. Example for the radio call: "Red flight 5,000-foot check, go 10". "Go 10" means switch to channel 10 and make your report to leader on that channel after the check is completed. This 5000-foot check will be made during straight flight and no turns will be made until the 5,000-foot check has been completed. When this signal and radio call are given, the wingman will loosen formation two aircraft widths so he may devote partial attention to the cockpit. Normally, radio channels will be changed during the 5,000-foot check. Radio channels will never be changed, however, unless called by the flight leader. The 5,000-foot climbing check will be performed as follows:

a. Switch radio channel (if so directed).

b. One-and-zero lanyard—Unhook and stow.

c. Oxygen system—Check.

NOTE: This check is most important AT THIS TIME, since your attention will soon be taken up with watching the lead aircraft intently without the opportunity for checking your oxygen. Check blinker, quantity, and connections.

d. Fuel quantity—Check.

e. Acknowledge completion of 5000-foot check with flight call sign. Example: "Red 2".

f. Resume normal formation position on rejoin signal from leader.

LEVELOFF

When cruising altitude is reached, the leader will give the level-off signal. After attaining cruising airspeed and power setting (normally 90%), the leader will yaw the aircraft to loosen the formation, then call for the level-off check:

a. Acknowledge flight leader's call as follows: "Red 2, blinker working, 370 pounds". (Give pounds of oxygen pressure showing on your gage. He will be able to determine from this whether you have accidentally left your oxygen setting on *100%* —with danger of depletion).

b. Resume normal formation position after the rejoin signal is given by the leader.

COCKPIT CHECK PRECAUTIONS

The flight leader will not make turns or initiate climbs or descents during any of the oxygen or fuel checks in formation.

Except during scheduled checks, any checking of instruments within the cockpit must be done with one quick glance for each instrument. If further scrutiny appears necessary, advise the leader that you are leaving the formation, and pull off slightly to the side. Request and receive permission to rejoin before rejoining. The leader must always know when he is being joined in order that he will not maneuver accidentally into the joining aircraft at a critical moment.

NORMAL FORMATION

Normal. This type of formation will form a basis for your formation flying, Figure 22–1. The lead aircraft is responsible for keeping the formation clear of other aircraft and for the navigation work.

Position

At the beginning of formation training, the wingman flies in level flight about 45° to the rear of the leader, so there is a small amount of clearance between his nose and the leader's tail, between his wingtip and the leader's wingtip, and between the level of his canopy and the leader's lower fuselage.

As the flight becomes able to hold the formation described above, the instructor will, at his discretion, permit the wingman to move

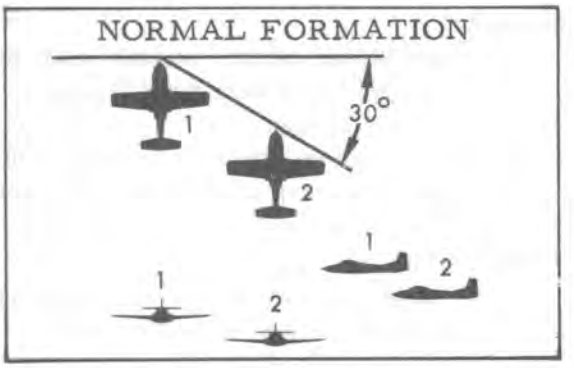


Figure 22-1

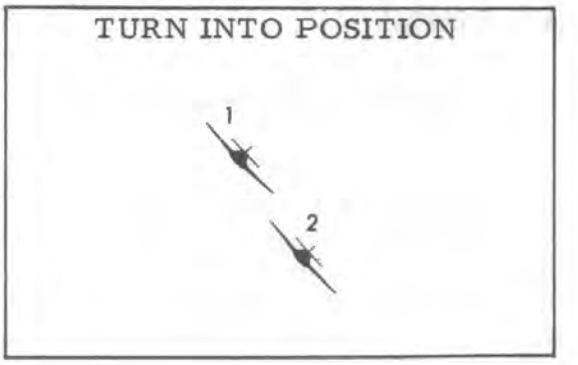


Figure 22-2

forward so that his angle back from the leader is about 30°. In this position only wingtip and canopy clearances are observed. Although the 45° position is "normal" for beginning, the 30° position will be the one you will use most. (See Figure 22–1)

Technique

Good formation is the result of anticipation and planning and the application of *small* corrections. Detect shifts in position promptly and stay in position; do not always be "getting back" into formation. Remember that in turns away from you, you will have to carry more power because you have farther to go than the leader. Conversely, reduce power slightly on turns into you. As the turn continues, it probably will be necessary to reapply some of the power reduction to maintain your position. Always keep the aircraft trimmed and coordinated. Your wings should always be parallel with the corresponding wings of the leader. This is one of the most important fundamentals of good formation flying.

Bear in mind that the wings of the aircraft have dihedral and that in formation you can only see opposite wings of each plane. When these opposite wings are parallel, you are actually banked toward the leader. In turns into the wingman, the wingman will maintain the same relative position as in level flight with respect to the leader. (See Figure 22–2) In turns away from the wingman, the wingman will roll in place and keep the leader's lower fuselage on the horizon. (See Figure 22–3)

CROSS UNDERS

Change from right wing to left wing in flight will require crossing from one side of the leader to the other. (See Figure 22–4) The leader signals for position changes by dipping a wing in the desired direction of change. When this is done, proceed as follows:

a. Throttle back slightly, and as airspeed is reduced move a few feet lower than normal position.

b. Move a few feet behind normal nose to tail clearance, then increase power slightly to maintain this spacing.

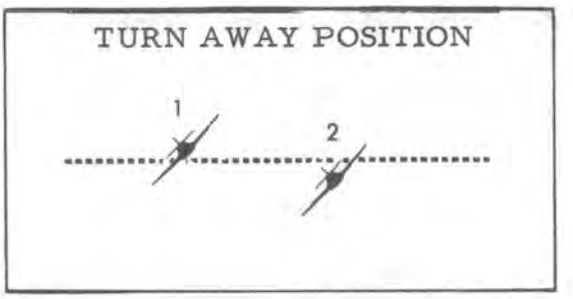


Figure 22-3

c. Bank toward the new position using exceedingly shallow bank to change the aircraft heading a few degrees. Roll the wings level and fly across to the opposite side. Keep proper nose-tail clearance with power; a power increase will be necessary to maintain this clearance. DO NOT CROSS DIRECTLY UNDER ANY PART OF THE LEADER'S AIRCRAFT!

d. When you have wing tip clearance on the new side, return your aircraft to the leader's heading, add power and move forward. Keep your position slightly below normal, and the speed used to advance will be partly dissipated as you perform the next step.

e. Pull up into proper vertical position, adjusting power as needed.

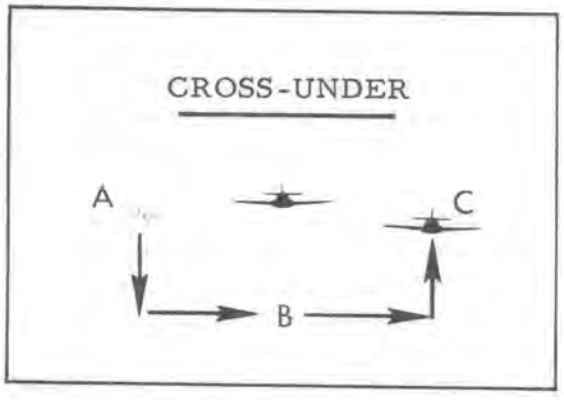


Figure 22-4

REJOINS AFTER PITCHOUT

The signal for pitchout (or peel off) at altitude is the same signal used for pitchout for landing. The leader's pitchout will be a level, steep-bank turn away from the wingman and will be identical in time interval, rate of roll and bank angle to pitchout for landing from formation. Speed brake need not be lowered prior to the peel off, although it may be lowered if the leader so indicates. The wingman will follow the leader's pitchout after a 3-second interval with an identical turn in the same direction. Roll out in trail with lead.

The signal for rejoin to normal formation is a rocking of the leader's wings. The leader will start a turn immediately after giving the rejoin signal. The wingman will intercept the leader by moving inside the leader's turn, adding a little power if needed to speed join-up. The wingman will always join on the inside of the turn and keep nose-to-tail spacing when arriving into position. The leader should make pitchout turns to the left in the T–37 to afford the wingman better visibility. The leader will normally use 90% power.

After the signal for rejoin is given, the instructor may call over the radio, "Red 2, take spacing before join-up". In this case, remain on the outside of the leader's turn until your spacing is about one mile (or approximately ⅔ of a runway length) behind the lead aircraft. Then rejoin normally. This is to simulate the distance that would separate you on takeoff if you take off individually and then join up. Good join-up is an art that is best acquired through demonstration and practice, but the following technique will assist in learning the fundamentals:

a. The first requirement is to get inside the turn of the leader. Do not hesitate or spend time in trail position, but move at once to point the nose of your aircraft well ahead of the leader. This is called a cut-off angle. Stay slightly beneath the leader's altitude at all times during the join-up so you can keep him in sight.

b. The angle ahead of your leader that you should point your nose when starting join-up will depend upon your distance behind. The more distance to be overcome, the greater should be the cut-off angle.

c. If a high cut-off angle were maintained until almost in position, the final step would require an extremely steep bank and tight turn to prevent overshooting. This would hide the leader from sight under your wing because of your steeper bank. To avoid this—shallow out your bank as you approach within a few hundred *yards* of the leader. You will then be slightly more in a trail position and you will be intercepting at a lesser angle. When you

are a few hundred yards from join-up, you should be on a line-of-position at about a 30° angle back from the leader—along a line that would pass through your normal 30° position next to the leader. By this time your cut-off angle should be much less than 30°. Try to slide in toward your leader along this imaginary 30° line by "playing" your bank—decreasing your bank to close the gap, or increasing it to slow down your rate of closure. Throttles should be adjusted to the leader's known setting as you start to close along this imaginary line; then you may use it during the latter part of the join-up to keep from overshooting or dropping back.

d. Ease off throttles to reduce your rate of overtaking. Make all corrections easy and gradual. As you approach the leader, you should be slightly below your normal altitude in respect to him.

e. Angle of bank and power should be planned so that you are moving slowly into position the last few hundred feet before join-up. If your planning has put you too far into trail, do not try to move into position with a mighty burst of power. Move inside the turn again—not too far inside if you are close to position. If, despite reduced power, it is apparent that you are going to join with excess airspeed, simply pass a couple of plane lengths behind and below the leader; move outside the turn in a wider arc, until your reduced airspeed permits you to return to the inside of the turn and proceed with a normal join-up. Never lose sight of the leader on join-up. On the next rejoin attempt after swinging wide, try to adjust your RPM to the appropriate known setting of the leader, cut him off in the turn again, and then ease in from the 30° position as described above.

FUEL CHECKS

Fuel checks are included in the 5,000 foot-climbing, level-off and 5,000-foot descending checks.

The formation will be loosened during all fuel checks. When the leader yaws his aircraft alternately left and right, the wingman will move out two ship widths and hold this position while making checks. No turns will be made during fuel checks. As soon as all flight members complete and acknowledge the fuel check, the formation leader will give the normal rejoin signal (rocking of the wings).

Whenever a fuel check is made, check indications of the fuel gage in comparison to time airborne. If you understand the fuel system, you will spot any discrepancies. Acknowledge the completion of your check with a radio call stating your call and the number of pounds of fuel remaining.

DESCENTS AND LANDINGS

All descents to the field for landing will be made in normal formation. If leading the formation at high speed, enter turns slowly and smoothly. The flight leader should have his formation on initial approach when the number 2 man in the flight has no less than 400 pounds of fuel.

The flight leader will maintain a power setting which will allow the wingman sufficient power margins to maintain position. A power setting of 80% rpm should be used for all let-downs. Power settings of below 80% will not be used in formation flying because at low power settings an overrunning pilot must chop the power, then open speed brake to keep from overrunning; he decelerates rapidly and then finds himself hanging on the edge of a stall before he can reapply power and retract speed brake.

During let-down, the speed brake may be used but will not be extended or retracted while in a turn because of the sudden change of pitch control and the possibility of losing sight of the leader during induced pitch oscillations. Once extended, the speed brake may be left down throughout the descent to pattern entry. The speed brake will be retracted in the traffic pattern and then extended during pitchout for landing.

The 5,000-Foot Descending Check will be performed when the formation is at least

5,000 feet above the terrain. The leader will give the spread signal and will call for the check. Normally, radio channels will be changed during this check:

a. Switch radio channel (if so directed).

b. Fuel quantity—Check.

c. Shoulder harness—Lock.

d. One-and-Zero system lanyard—Hook to "D" Ring.

e. Check in with fuel check call. Example: "Red 2—500 lbs".

f. Resume normal formation on rejoin signal from leader.

Prior to the entry to the initial approach, the wingman will be ordered into position on the wing of the leader which is away from the direction of the intended pitchout. The same type of traffic pattern will be used in formation as for any other flight. Initial approach should be long enough to allow the wingman to settle down in proper position prior to pitchout. Entry on initial approach will be further out than for normal traffic. Normal traffic will give way to formations on initial approach.

The leader will give the pitchout signal (circular movement of index finger) approaching the pitch point. After the lead aircraft pitches out, the wingman will pitch out after a three-second interval and pick up spacing in both the pitchout and the downwind leg. The pitchout should be planned so that on the downwind leg the wingman places himself slightly outside the leader's flight path. Adjust the final turn so that adequate approach and touchdown spacing can be maintained. The leader will land on the inside of the runway and the wingman on the outside. (Example: Left hand traffic, leader will land on left side of runway.)

The wingman will use his flight call sign when making the gear check in the final turn.

Remember that while flying wingman in normal formation, your movements were dictated entirely by the movements of the lead aircraft. Upon pitching out, you are planning your own flight path. Maintain proper spacinc, altitude and airspeed for your pattern and landing.

LEAVING FORMATION

The wingman will leave the formation:

a. Whenever he loses sight of the aircraft ahead.

b. Whenever he is unable to join up or to stay in formation without corssing directly under or in front of the lead aircraft.

c. At any other time he feels that his presence in the formation constitutes a hazard.

d. When he is directed by the leader to break out.

When you leave the formation, notify the flight leader.

If you have lost sight of the lead aircraft, break out of formation away from the direction he was last seen. Prior to breaking formation, CLEAR YOURSELF IN THE DIRECTION OF THE BREAK.

If leaving formation or abandoning join-up with the aircraft ahead in sight, break DOWN and AWAY from the formation.

A pilot that has left a formation will not rejoin until he requests permission to do so by radio call and the call has been acknowledged and permission granted by the leader.

FORMATION ABORTS

The primary reason for formation flying is the mutual protection and support of the aircraft involved. This applies to non-combat hazards as much as it does to action against enemy aircraft. If any member of the formation must return to the airfield because of mechanical or other difficulty, the other aircraft will accompany him. (Exceptions to this may be made by the instructor if the difficulty is routine and the field is in sight.)

SPEED BRAKE

Speed brake will be lowered or raised on verbal signal by the flight leader. The signal for the speed brake is "(Red) Flight, speed brake—NOW!"

Speed brake exercises may be given by the

flight leader to give practice in maintaining position when the speed brake is operated. A slight pitch change must be anticipated, and pressure applied as necessary to avoid bobbing up and down. Actuate the speed brake promptly on the "NOW" signal, and do not wait to see the leader's speed brake operate.

COMMON STUDENT ERRORS IN FORMATION FLYING

- Overshooting the lead aircraft.
- Slowness in anticipating change of position.
- Overcontrolling of throttle corrections.
- Overcontrolling of elevators, aileron and rudders.
- Looking away from the lead aircraft.
- Slowness in joining up.
- Failure to know signals.
- Failure to hold relative position during turns.
- Flying in position with one wing down.
- Failure to use trim.
- Failure to plan ahead to avoid other traffic when landing.

VISUAL SIGNALS

Visual signals are utilized during formation flying in order to keep radio transmissions to a minimum. They are as follows:

SIGNAL	SIGNIFICANCE
1. Flutter ailerons. Repeated rapid movements of ailerons.	1. ATTENTION. Also notification that individual aircraft is ready for takeoff. Wingman will acknowledge by nodding his head.
2. Raise right hand and make series of circles.	2. START ENGINE(S) OR RUN UP ENGINE(S) FOR CHECK. Pitchout for landing or trail formation.
3. Head forward. Sharp distinct forward movement of the head.	3. RELEASE BRAKES FOR TAKEOFF.
4. Fist forward of head. Repeated sharp distinct movement in direction of desired power change.	4. CHANGE OF POWER SETTINGS.
5. Upward motion with thumb extended upward.	5. RAISE GEAR.
6. Downward motion with thumb extended downward.	6. LOWER GEAR.
7. Hold hand at eye-level, palm down, fingers extended toward horizon; then move hand from side to side on horizontal plane.	7. LEVEL OFF.
8. Upward motion with open hand, palm up.	8. RAISE FLAPS.
9. Dip wing slightly but briskly in direction in which wing position change is to be made.	9. CHANGE OF WING POSITION.

SIGNAL	SIGNIFICANCE
10. Rock wings. Slow rocking motion of plane about its longitudinal axis.	10. ASSUME NORMAL FORMATION. From any other formation, this is a signal to go into the normal formation of the unit concerned.
11. Fishtail or yaw. During flight, cause the tail of the plane to move alternately right and left.	11. OPEN UP FORMATION (as for a scheduled check).
12. Pushing open hand. Movement of the open hand along a definite direction indicated by the palm.	12. CHANGE RELATIVE POSITION. Small change of position within the formation being flown. Formation leader will nod when desired position is reached.
13. Cupped hand at chin. Steady cupped hand, palm up at chin, fingers forward and glance at formation members.	13. FUEL CHECK. Care must be exercised by the wingman to insure sufficient spacing for pilot to look into the cockpit.

EMERGENCY SIGNALS

The "HEFOR" system will allow you to signal any one of the five following emergencies or systems checks by the use of one to five fingers:

H—Hydraulic — one finger.
E—Electrical — two fingers.
F—Fuel — three fingers.
O—Oxygen — four fingers.
R—Radio — five fingers.

In all cases, hold up the finger(s) so the pilot being signalled can easily see your signal. If the "HEFOR" signal is not preceded by swinging the hand vertically, the system indicated should be checked for proper operation.

SIGNAL	SIGNIFICANCE
DAY	
1. Swing open hand, with palm toward face, up and down several times, then:	
a. Hold up one finger	a. *H* – hydraulic malfunction.
b. Hold up two fingers	b. *E* – Electrical malfunction, not to include complete electrical failure. Affected aircraft should be led back to the field by the other aircraft in the element or by the instructor.
c. Hold up three fingers	c. *F* – fuel malfunction. Point to affected aircraft.
d. Hold up four fingers	d. *O* – oxygen malfunction.
e. Hold up five fingers	e. *R* – radio malfunction, not to include complete radio failure.

2. Hold hand to headset; then swing open hand up and down in front of face several times. Point to self (or other affected aircraft).	2. I have complete radio failure.
3. Clench fist and hold at top of canopy.	3. I have complete electrical system failure.
4. Hold hand to headset; then display the number of fingers desired.	4. Change radio channel. Change to the channel indicated by the number of fingers displayed. Channels over five will require two or more signals, separated by a distinct hand movement.
5. Pat top of helmet and point at wingman.	5. Change lead. Aircraft pointed to is now leader.
6. Pat top of helmet and point at yourself.	6. I want the lead or I have the lead.

NIGHT

7. Flash landing or navigation lights.	7. I have complete radio failure.
8. Point flashlight at next aircraft and give series of short flashes.	8. I have complete electrical system failure. Affected aircraft should be led back to the field by the other aircraft in the element.

CHAPTER 23

LOST PROCEDURES

Becoming lost, or "temporarily disoriented," is something that could happen to you at almost any time. You may be flying locally and wander out of your prescribed area or, if the winds at altitude are high enough, you could gradually be blown out of your area without knowing it because you were concentrating on your assignment for that period. Or, you may be caught out in one of those situations where the weather deteriorates and visibility goes down before you can get back home. Whatever the case may be, becoming lost is a very uncomfortable situation, and the first tendency sometimes is to panic. This is about the worst thing you could do in this situation. Remain calm and think about your situation and it will not be near so bad as it originally seemed. Of prime importance also is fuel conservation. If you are not at altitude when you first realize your predicament, initiate a climb immediately to altitude, then throttle back for maximum endurance.

By remembering a few basic procedures, re-orienting yourself will not present too much of a problem. They are:

Check your omni set for proper operation, tune and identify your local or nearest omni station and home in on it. A word of caution is in order, however. Be sure to check your bearing on both the Directional Indicator and RMI (ID 250) against the Standby Magnetic Compass. The latter compass is a simple instrument which depends only on the earth's magnetic field and is practically infallible when the aircraft is straight-and-level, whereas the other two compasses are both magnetic and electrical and more subject to failure. It is possible for the Directional Indicator and the RMI to get "out of phase," thus giving erroneous indications. If your Directional Indicator and RMI are not reliable, the VOR Bearing Pointer may confuse you, for although it identifies the proper no-wind bearing to the station, it will give a false and erroneous *relative* bearing with respect to the aircraft nose—even though the audible signal on the VOR receiver may be clear. If this is the situation, there is a simple means for homing to the selected VOR station. Simply rotate the Course Set Knob on the Course Indicator (ID 249) until the Course Deviation Indicator centers.

With the Course Deviation Indicator centered check the TO–FROM window. If it indicates *FROM* continue to rotate the knob until the indicator centers again with *TO* in the window. Now simply read the numerals in the Course Window. It displays the correct no-wind course to the selected station. But now that you know the correct course, how will you turn to it if neither your Directional Indicator nor the RMI Bearing Index are reliable? The answer is the Standby Magnetic Compass. Turn the aircraft until your Standby Magnetic Compass shows that you are flying the course displayed in the Course Window. Your Course Deviation Indicator will continue to function normally, and you will track to the station so long as you keep the Course Deviation Indicator centered. The Heading Pointer ("doughnut pointer") will not be reliable and cannot be used for drift. Station passage can be recognized in the normal manner by a fluctuation of the Course Deviation Indicator and the word *FROM* appearing in the window.

If you are unable to pick up a known omni station on your set call "any DF station" on channel 14 and request assistance. UHF/DF

homing facilities are usually available within range of most training flights. The location of these DF facilities are listed in the FLIP En route Supplement. In the event of an emergency situation when a DF steer is required, remember these items:

Check the Directional Indicator against the Standby Magnetic Compass. If they do not coincide trust only the Standby Magnetic Compass.

Call a known DF station on Channel 14 if within a reasonable vicinity of one. If you do not establish contact with this known station, switch to "Guard" channel and call any station with the call: "MAYDAY, MAYDAY, MAYDAY" and state your aircraft number. This will alert all DF stations in the area inasmuch as this is the international distress call. You will probably get immediate responses from several stations. However, the closest one will be loudest. Listen for the name of the loudest station, reply to him using his Call Name and request "all other DF stations to stand by."

After contact is established state definitely that you are requesting an emergency DF steer.

Follow instructions issued by the DF station.

After you have set course for the DF station, try to locate yourself by surveying the terrain and comparing it with the map, but do not wander.

NOTE: DF means direction finding. The heading you receive from the DF station is only a magnetic heading and NOT A FIX. It only indicates your position as being somewhere along a line from the station assisting you. It does not correct for wind, but it will "home" you to the station in a succession of corrected steers.

A typical DF homing procedure is as follows:

1. The pilot calls DF station at Kelly AFB: "Kelly DF this is Air Force jet 60694, over."

2. Kelly DF replies: "Air Force jet 60694 this is Kelly DF over."

3. The pilot replies: "Kelly DF, this is Air Force jet 60694 request emergency (or practice) steer to Kelly AFB, over."

4. Kelly DF replies: "Air Force jet 694 this is Kelly DF, transmit for steer, over."

5. The pilot replies: "Kelly DF, this is Air Force jet 694 transmitting, (hold mike button for 20 seconds or as instructed by DF followed by) Air Force jet 694, over." The controller may ask you to transmit a "tone" signal. In this case, you will transmit using the tone button on the UHF set instead of using the mike button. Normally, however, you will be asked simply to transmit. In this case you hold the mike button as described above but do not talk except to give your number at the beginning and end of transmission. He can usually plot you best without voice.

6. Kelly DF replies: "Air Force jet 694, this is Kelly DF, Steer 180 for Kelly, over."

7. The pilot replies: "Kelly DF, this is Air Force jet 694. My steer is 180, over."

Continue to monitor the DF channel. The DF operator will call again and request another transmission, or you may request another steer if a few minutes elapse and no call is heard from DF.

When you have the field in sight or when you no longer desire the service of the DF facility, you must close out by informing the DF operator.

1. The pilot calls: "Kelly DF, this is Air Force jet 694. I have Kelly Air Force Base in sight; leaving your frequency."

2. Kelly DF replies: "Air Force jet 694, this is Kelly DF, roger. Kelly DF out." (Do not change frequency until this acknowledgement has been received).

Remember that UHF works on a line-of-sight transmission principle. The higher your altitude, the more likely you are to obtain a good steer. The following is an approximate range for transmission over flat terrain:

Aircraft Altitude	*Range*
1,000 feet	25 miles
2,000 feet	35 miles
5,000 feet	55 miles
10,000 feet	75 miles

If you are unable to contact a DF station because of radio failure or electrical failure, try to pick out some outstanding landmark on the ground. A significant body of water, a town, or a railroad crossing are all good landmarks. Try to orient your selected landmark with your local area map. You should have some idea of the general direction you are from the home field or from your last known checkpoint, so look for your landmark in that general direction on your map. Orient your map on your lap with the aircraft heading. If you are unable to locate the landmark on your map don't just wander around aimlessly; fly a definite heading until you can pick up another good landmark. Set up an orbit around it and identify it. Many small towns have water towers with the name of the town printed in large letters on the water tower. These names can usually be easily seen from 500 feet. Such towns may be circled and the name identified from 500 feet altitude without the aircraft flying over any part of the town. If a town is identified in this manner, climb back to a higher altitude before concentrating too much attention on the map for orientation. Aircraft control is always primary at low altitudes.

If all else fails and you cannot locate yourself by any of the methods listed above, look for an airfield and land before you deplete your fuel supply. Even if it is an abandoned airfield you can still accomplish a safe landing by using a normal pattern.

If you cannot locate an airstrip before running out of fuel, BAIL OUT. Do not attempt to make a forced landing. In any event, as soon as you get on the ground go to the nearest telephone and call your base, "Government Collect," and inform them of your location, the circumstances surrounding your emergency, and the condition of the aircraft. If down in a desolate area, use the emergency signaling procedures outlined in the booklet provided with your parachute. The chances are that before you have to bail out the base is already aware of your absence and has started a search for you. Therefore your chances are much better if you remain where you are with your parachute. If the crashed airplane is in sight, make your way toward it, taking your parachute with you. The smoke or wreckage is often easily visible from the air.

GLOSSARY

(Words and Terms used in Undergraduate Pilot Training)

Abort:
To discontinue, cancel or stop (e.g., abort takeoff mission, etc.)

Active:
In operation. The runway in operation is frequently referred to as the "active" runway.

Affirmative:
Yes. (Radio usage usually.)

Aircraft attitude:
The position of the aircraft with relation to some fixed reference, usually the natural horizon.

Aircraft configuration:
The position of the movable parts which affect the profile of the aircraft. Such parts are flaps, landing gear, speed brakes, etc. An aircraft is said to have clean configuration when all such parts are retracted or streamlined.

Altimeter setting:
A pressure reading set into the altimeter to adjust for the existing barometric pressure.

Anticollision lights:
High intensity lights mounted on some aircraft designed to attract the attention of pilots of other aircraft while airborne. Such lights are readily visible both day and night.

Apply opposite rudder:
Move the rudder pedal in the opposite direction from applied aileron pressure on the control stick; reverse the positions of the rudder.

Apply opposite stick:
Move the control stick in the opposite direction from applied pressure on the rudder pedal; reverse the position of the control stick.

APU:
Abbreviation for "auxiliary power unit," an external power source for starting aircraft engines, etc. The proper term is "JASU" — Jet Aircraft Starting Unit.

Around the horn:
Movement of the throttle from "Off" to "Idle," or the reverse.

Auxiliary field:
An airfield used to supplement the facilities of another airfield.

Back pressure:
Pressure applied to the control stick in a backward direction affecting the aircraft elevator and tending to increase pitch attitude.

Back side of the power curve:
A condition of flight in which the thrust required is greater than the thrust available.

Balloon:
To float upward from the ground when attempting to land as a result of applying too much back pressure for your airspeed.

Barrier:
An arresting device used to prevent aircraft from going off the runway.

Belly-in:
To land an aircraft with the gear retracted.

Bend it around, rack it around, reef it in, pull it in:
Slang expressions which mean "fly the aircraft more aggressively."

Black out:

A temporary loss of vision or consciousness owing to a fall in blood pressure in the head with a resultant insufficiency in oxygen. This is caused by pulling "G's."

Blast pad:

A specified location on the runway or apron for run up of jet engines, constructed specifically to withstand the back wash from the tailpipe.

Blip:

A radar return or reflection.

Blow the canopy:

Jettison the canopy of an aircraft by an explosive process. One step in the emergency procedure for bailout.

Blurp:

Noise made when jet engine switches from one fuel control system to another.

Bogey (bogie):

Any flying aircraft that the pilot can see or radar operator can see as a scope return or "blip."

Boondocks (toolies):

Any field, pasture, meadow or the like as opposed to a runway. Frequently used in reference to aircraft landings. For example, to land in the boondocks would refer to landing your aircraft at some point other than on a prepared runway.

Boxed in:

Maneuvered into a dangerous or untenable position.

Break:

Bank and turn abruptly; pitchout.

Break out:

A term used to clear one or all aircraft from a traffic pattern or formation.

Broken up:

A radio message which has been intermittently interferred with.

Buffeting:

The knocking about sustained by an aircraft surface when turbulence is encountered.

Burble:

Separation in the boundary layer of air about a streamlined body, resulting in divergent velocities and pressures, especially over the upper surface of an airfoil. Burble causes loss of lift and increase in drag.

Call initial:

Identify yourself to the mobile controller (or tower) by making a radio call when turning on initial approach.

Call sign:

Tactical name and/or number for an aircraft or flight of aircraft.

Ceiling:

Maximum height at which an aircraft can fly. In weather, an overcast of clouds above a given area limiting vertical visibility.

Check in:

To report by radio.

Checkout:

Instructions or training given a pilot to familiarize him with a given aircraft. A checkout in a particular aircraft is complete when the pilot has accomplished all of the requirements outlined by regulation or directives.

Chocks:

Blocks to keep aircraft from rolling.

Chock time (ramp time):

That time designated for any group of aircraft to be parked on the apron.

Chop:

Reduce throttle rapidly to idle.

Clean aircraft:

A finely streamlined aircraft with landing gear, flaps, etc., in a retracted position.

Clear:

To look before turning or proceeding. Good reception. Less than 1/10 closed coverage.

Cleared:

Authorized by proper authority to do certain specific acts, not a part of the usual routine. When used as reference to "flight clearance" it means that authorization has been granted for a flight of

one or more aircraft to depart from an airfield or to fly a given route under designated conditions.

Climb out:

After traffic exit, climb to a desired altitude by executing climbing turns.

Clock position (o'clock):

A system used to refer to the position of objects or other aircraft in relation to your aircraft. The system is that your aircraft is always located in the center of an imaginary dial. Thus, to refer to location of another aircraft which is directly ahead of your aircraft you would say that it was located at 12 o'clock; if object was 90° to your right it would be at 3 o'clock; directly to your rear it would be at 6 o'clock, etc.

Closed traffic:

A specific type of traffic pattern normally used in emergencies for jet aircraft. This type of pattern enables a pilot to position his aircraft for landing in the shortest possible time with the least amount of fuel from a go-around.

Cobbed:

Throttle full open (slang).

Cocked nose wheel:

The nose wheel has swiveled beyond controllable limits.

Contact flying:

Flight in which the pilot determines attitude and position by contact references (see below).

Contact references:

Outside references that allow the pilot to determine the attitude of the aircraft by visual reference to the earth or clouds.

Crab:

To turn an aircraft partly into the wind to compensate for drift.

Cross control:

Uncoordinated (opposed) use of aircraft controls.

Cruising level flight:

Operating the aircraft in level flight with normal power settings.

Day glo:

A luminous paint or covering used on aircraft to cause them to be highly visible during daylight flight.

DF:

Abbreviation for "Direction Finding."

Directional Indicator:

An instrument which indicates the direction the aircraft is headed.

Dish out:

The flight path resulting from the improper use of the controls and characterized by nosing down and to the side.

DNIF:

Abbreviation for "Duty Not Including Flying."

Dragged in:

A long, low approach using power.

Drift correction:

A change in the bearing of an aircraft to compensate for drift.

Drift off course:

To move laterally from the direction in which the aircraft is bearing.

Drop in:

To stall an aircraft while landing at a point high enough above the ground that it drops more or less violently to the runway.

Drop the nose (wing):

Lower the nose (wing).

Dry run:

Drill or practice before final event.

EAC:

Expected approach clearance.

Ear defenders:

Device to protect ears from aircraft noise.

Echelon:

Placement of aircraft in a stair-stepped angular line in formation. Level of command.

EGT:

Abbreviation for "exhaust gas temperature."

Element:

Smallest integral unit of a formation.

"Firewall it," "Give it the needle":

Slang expressions meaning "use full power."

Fix:

A positively known or confirmed geographic location of the aircraft. Also a known radio station.

Flameout:

The extinguishment of the flame in a reaction engine, especially in a jet engine.

Flare:

See "Roundout." Also a signalling device used by mobile control units.

Flight clearance:

Any authorization for a flight of one or more aircraft to depart from an airfield or to fly a given route under designated conditions; also, any form granting such clearance.

FOD:

Foreign object damage by ingestion into engine.

Following through on controls:

The act of lightly resting hands on the dual control stick and feet on the dual rudder pedals and, without exerting any pressure whatsoever, following through the movements as the instructor pilots the aircraft using his set of controls.

Full drag:

Gear, flaps and speed brake (if available) extended.

Full stop:

Landing followed by turn off at taxi way.

Garbage:

Extended devices resulting in increased drag (gear, flaps, speed brake, etc.).

Gear:

Short for "landing gear." Used also to refer to personal equipment or special flying equipment.

Gear check:

A radio call to the control tower or mobile control unit to indicate that you have checked your landing gear and it is down and locked.

G Force—(Sometimes referred to as G's):

The gravitational force or pull of the earth.

Go around:

To continue in the traffic pattern without, or instead of, landing. A wave off, especially in naval parlance.

Grease in:

To make an exceptionally smooth landing in an aircraft.

Green light:

A green-colored light used in a control tower to give permission to a pilot to do something. Used especially when the pilot's radio is not receiving. Hence, "to get a green light" means to obtain approval.

Ground track:

The path over the ground that an airborne aircraft makes while in flight.

Hard landing:

A landing in which the ground impact is great enough to require an inspection of the aircraft because of possible damage.

Head up and locked:

A slang expression meaning "not thinking."

Hold:

Stop (if on ground); orbit (if airborne).

Hold it off:

Hold the aircraft off the ground until you have set up the proper landing attitude.

Home on, or home in on:

To fly toward a ground radio navigational aid using the aircraft's radio navigational equipment.

Hood (or visor):

A covering used to block out outside references when practicing "instrument" flying.

Horizon:

The line formed by the apparent meeting of the earth and sky as observed from any point.

Hot mike:

An interphone which permits either pilot or instructor to speak without the use of microphone switches.

Indicated altitude:
The altitude of an aircraft as shown by a pressure altimeter which is set to local atmospheric pressure.

Initial approach:
The approach of an aircraft preparatory to beginning a landing procedure.

Instrument references:
Flight instruments which can be used to determine the attitude of the aircraft.

Interphone:
Any telephone, microphone or receiver by which crew members of an aircraft or pilot and instructor communicate with each other.

In the green:
A slang expression meaning "engine instruments are within the operating limitations."

Jet blast: See **Jet wash.**

Jet wash:
The exhaust that comes out of the tailpipe of a jet or rocket engine. It is very noticeable when flying directly behind a jet aircraft or when landing or taking off close behind a jet aircraft.

JP–4:
Fuel used in a jet aircraft.

Letdown:
The descent of an aircraft from a cruising altitude preparatory to an approach and landing.

Letdown area:
An area designated for aircraft to make descents from cruising altitude preparatory to the approach and landing.

Level-flight attitude:
An attitude of flight by which an aircraft maintains a constant altitude.

Line up:
Align your aircraft straight wtih the runway in preparation for takeoff.

Local area:
The prescribed airspace limits for a particular airbase out of which you will not normally fly without first obtaining clearance.

Lose an engine:
An engine failure.

Low go (low go around):
A go-around from final approach.

Mach:
The speed of a moving body as measured by the speed of sound in the medium in which it moves.

Manifold pressure:
The pressure in the intake manifold of an internal combustion engine.

Mayday:
A voice radio distress call (from the French "m'aidez" meaning "help me").

Mike button:
A microphone switch which, when depressed, permits pilot to instructor, pilot to ground and/or pilot to other aircraft communication.

Minimum fuel:
That fuel which is held in reserve for emergencies.

Mobile Control:
Small temporary control tower; RSU.

Mush:
To gain little or no altitude or to lose altitude when the angle of attack would normally indicate a gain, without, however, going into a complete stall. Where referring to an aircraft's controls: to react ineffectively or sluggishly.

Navigation lights (running light):
Light mounted on the exterior of an aircraft to make its dimensions and position visible at night. They consist of a green light on the right wingtip, a red light on the left wingtip, and one or more white lights prominently located at the tail end of the aircraft.

Negative:
No. (Radio usage usually.)

Normal oxygen:
One of two settings (see also "100% oxygen") for the diluter lever of a demand type oxygen regulator. The lever in the normal position allows a mixture of air and oxygen to the oxygen mask at altitudes up to 34,000 feet.

Number one position:
First aircraft in line for taxi out or takeoff.

Off center (night) vision:
Looking slightly off to one side of an object in order to see it best at night.

On (off) flying status:
A term used in the Air Force to describe whether or not a person (rated or non-rated) is currently authorized to participate in regular and frequent aerial flights.

100% Oxygen:
One of two settings (see also "normal oxygen") for the diluter lever of a demand type oxygen regulator. When the lever is in the 100% oxygen position cabin air is shut off and only 100% oxygen enters the oxygen mask.

Out-and-back:
Cross-country flight on which you land at another base, refuel, and return the same day.

Overcontrol:
To move an aircraft's control or controls too far in one direction, then to attempt to compensate by a greater movement in the opposite direction, resulting in erratic flight.

Overrun:
To run or roll beyond the end of a runway, landing strip, or the like on takeoff or landing. Also, that portion of a runway (usually at both ends) that has not been properly prepared for aircraft to land on. Some overruns are graded and surfaced but many have simply been cleared of obstacles so that an aircraft landing long or short will receive a minimum amount of damage.

Overshoot:
Opposite to undershoot. To fly beyond, over, or past a specific place, boundary, or object. To fly beyond or to bring an aircraft down beyond an airfield, runway, or the like, or beyond a designated spot thereon, while attempting to land on that runway.

Overspeed:
To run an engine or propeller at a speed in excess of that determined to be safe or economical.

Paint:
Receive a radar return.

Pan:
A voice radio urgency call.

Panel:
A mount for instruments or control devices in an aircraft's cockpit.

Panic button:
A slang term used to describe any emergency control, button, switch or procedure.

Passing light:
On some aircraft a steady red light usually located in the leading edge of the wing or in the nose of the aircraft.

Penetration:
Instrument letdown from an intermediate altitude; flight through a thunderstorm.

Performance characteristic:
A characteristic that appears during the operation of an aircraft in a particular maneuver.

Pink slip:
Failing grade.

Pins:
Metal clips or pins used to prevent some system of the aircraft from being used. For example, downlock pins are placed in the landing gear system of a parked aircraft to prevent anyone from retracting the gear while on the ground. Pins are used in ejection systems to prevent the canopy and/or ejection seat from being fired on the ground.

Pitchout:
The action of making a steep turn from a straight line of flight in order to enter a landing pattern. Also, the point at which this turn is made.

Porpoise:
Violent bouncing from nose gear or main gear, etc., when aircraft is landed. Usually result of attempting to force aircraft on ground nose wheel first.

Postflight:
After the flight. Hence, a postflight inspection or a postflight report is an inspection or a report made at the conclusion of a flight.

Prang:
Crash.

Preflight:
Previous to flight. Hence a preflight inspection is an inspection made prior to takeoff.

Prop wash:
Propeller backwash. The backwash of air resulting from the rotation of a propeller.

Pump your brakes:
Smoothly and briskly apply and release toe pressure on the brake pedals several times and then hold to build up and hold pressure in the hydraulic brake lines.

Ramp out:
Radio call to announce aircraft is returned to parking place on ramp.

Read:
Hear or understand (clearly).

Red cross (diagonal) (dash):
Symbol in AFTO 781 depicting maintenance status of aircraft.

Red line:
A red mark or line on the airspeed indicator which indicates the safe maximum speed of the aircraft; also a line on other indicators to indicate a danger point.

Redout:
A temporory vision disturbance, sometimes accompanied by a loss of consciousness during which a red screen appears before the eyes. Usually occurs when excessive negative "G's" are encountered.

Release back pressure:
Ease off on the back pressure which you are presently holding on the control stick.

Roger:
Message received and understood; ok; all right.

Roll:
Any movement of an aircraft about its longitudinal axis. The movement or travel of an aircraft along the ground or other hard surface on its wheels.

Roll-in:
The movement about the longitudinal axis of an aircraft when establishing a bank for a turn.

Roll-out:
The movement about the longitudinal axis of an aircraft when unbanking at the end of a turn.

Rough air:
Turbulent air in the atmosphere that may cause bumpiness for an aircraft during flight.

Round out:
To bring an aircraft down in a smooth flight path tangentally to the ground preparatory to touching down.

Round-robin:
A cross-country flight in which takeoff and landing are made at the same place.

RSU:
Runway Supervisory Unit; Mobile Control.

Rudder bar:
Rudder pedals or rudder-actuating device.

Runaway prop:
A propeller operating out of control.

Runaway trim:
One or more trim tabs operating out of control or remaining at a limit of travel as a result of an electrical malfunction in the aircraft's trim mechanism.

Say again:
Proper radio term for the word "repeat" which is never used on aircraft radio.

Section lines:
Ground boundaries between sections of land that can be used for maintaining your orientation during some maneuvers. Roads, fence rows, tracts of land usually serve as section lines (generally oriented North-South and East-West in the USA).

SFO:
Simulated flameout or simulated forced landing.

Shutdown:
Engine and related equipment turned off.

Siphon:
Fuel being lost overboard by suction or vacuum action.

Skidding:

The sidewise sliding of an airborne aircraft away from the center of the curve while turning. Also, rotation of the aircraft about the vertical axis when not accompanied by bank.

Skin:

The outside covering of an aircraft.

Skin paint:

Radar return (or blip) from aircraft not using or not equipped with transponder.

Slip:

The slipping or sliding motion of an aircraft in certain flight attitudes. A slip occurs when the aircraft yaws and slides downward when the wings are banked.

Speed brake(s):

A drag device designed for slowing down an aircraft in flight. Sometimes referred to as dive flap or dive brake.

Spoiler:

A projection from an aerodynamically designed body, used to interrupt the airflow around the body so as to slow down its movement or decrease its life.

Stagger:

Align your aircraft to the side and the rear of the aircraft ahead of you. Takeoff or landing at specified time interval before or after other aircraft.

Standby:

Wait for further instructions.

Static port:

An opening in an aircraft through which air is channeled to certain flight instruments which operate by static pressure. The static port usually consists of several small holes which are unaffected by dynamic pressure.

Status of flying:

Specified types of flight missions currently permitted owing to weather condition.

Stick:

Short for "Control stick," a lever used to control the attitude of an aircraft.

Stopcock:

Throttle OFF.

Surge:

A sudden and abnormal increase in power or energy, as may occur in an aircraft engine.

Tach:

Short for tachometer.

Take it around:

Do not land but make a go-around. Sometimes called a "wave off" especially in navy parlance.

Throttle technique:

The manner in which you move the throttle to adjust the flow of fuel to an aircraft engine.

Thrust/drag relationship:

A term dealing with the rate of movement of aircraft. When thrust is greater than drag the rate of movement is accelerated. When drag is greater than thrust the rate is decelerated. When thrust and drag are equal, the rate of movement is constant.

Touch-and-go:

Land and takeoff in continuous straight run without stopping.

UHF:

Abbreviation for "ultra high frequency" radio.

Undershoot:

Opposite to overshoot. To land or crash an aircraft short of a runway, or short of a line or spot thereon.

Unreadable:

Not understandable.

VHF:

Abbreviation for "Very high frequency" radio. Omni radio in the T-37 aircraft is VHF.

Visor: (See Hood)

VOR:

Abbreviation for "VHF omnidirectional range."

Washout:

A designed warp in an aircraft's wing giving a decrease in the angle of attack toward the tip. A slang expression meaning to fail a course or fail

below acceptable standards. A totally destroyed aircraft.

Wilco:

I will comply with your request.

Windsock:

A tapered sleeve-like device made of cloth, pivoted at one end from a standard so that the wind catches it, showing the wind direction.

Wind tee (tetrahedron):

A large weather vane located on a landing field to indicate to aircraft the direction of the wind.

Write up:

To report defects in an aircraft or discrepancies in flying techniques employed by personnel.

Zilch:

Zero; nothing.

Zoom up:

To pull the nose of the aircraft up in an effort to exchange altitude for airspeed. This term is usually associated wtih low-altitude bailouts or ejections when it is necessary to gain altitude before abandoning the aircraft.

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