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PRIMARY HELICOPTER

OH - 23D

Training Manual

UNITED STATES ARMY PRIMARY HELICOPTER SCHOOL

FORT WOLTERS, MINERAL WELLS, TEXAS

ARMY HELICOPTER TRAINING MANUAL

HEADQUARTERS
UNITED STATES ARMY PRIMARY HELICOPTER SCHOOL

FORT WOLTERS, MINERAL WELLS, TEXAS

OCTOBER 1965

FOREWORD

The techniques, procedures, and maneuvers described in this manual will help you become proficient in the fundamentals of helicopter flying.

In order to provide continuity of instruction and to give you the necessary background for beginning each successive phase of your flight training, all subjects covered here are in the logical sequence in which they will be presented to you by your instructor.

Theory in this manual will be supplemented by your academic training. The repetition of theory here and in your academic studies is considered necessary to insure a positive transfer of the theory to practical application. Your instructors and supervisors will be held responsible for presenting all primary flying training in accordance with the contents of this manual.

Although this material is designed primarily to give you a sound foundation for primary pilot training, you will use these same techniques throughout your Army career.

E. P. Fleming Jr.

E. P. FLEMING, JR.
Colonel, Arty
Commandant

TABLE OF CONTENTS

SAFETY FIRST

CHAPTER I

INTRODUCTION TO PRIMARY HELICOPTER PILOT TRAINING

This manual is designed as a guide for students, helicopter pilots, and instructors in organizing and standardizing the course of rotary-wing instruction. You can learn to fly without reading this manual, but you will find that your helicopter flying is better, safer, and more enjoyable if you understand why the helicopter behaves as it does under various conditions of flight.

Primary training is your opportunity to learn precision and maximum performanc flying. Pilots who treat flying as a hobby can get by without knowing the fine points. But, Military pilots, like all professional pilots, must develop the highest degree of proficiency possible.

Flying Army aircraft requires initiative, good judgment, and trained reflexes, as well as skillful flying technique. To become an Army pilot, you must acquire all of these qualities. Becoming a pilot in Army Aviation should be incentive enough for you to make every effort to complete your training successfully. Hard work and determination offer you this reward.

Everyone at this training facility, from the Commanding Officer to the men who wash the aircraft will do everything in their power to help you. If the program sometimes seems impersonal or rigid, remember that everyone is carrying a heavy load of responsibilities.

Primary Helicopter Pilot Training:

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

The objective of the flying training presented at this facility is to develop you into a skilled pilot in the basic principles of helicopter flying. Your muscular responses will be developed to the point where they become reflex actions. As you gain flying proficiency, the acuteness of your senses - hearing, seeing, and feeling - will develop along with your muscular responses.

Your Instructor:

Your instructor is a well-qualified pilot. He knows the OH-23 helicopter and he knows the maneuvers and how to teach them. His only objective is to graduate expert pilots, and to this end he will expect you to do your best. If he places great importance on exactness, it is because he is trying to train you as close to perfection as possible. 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. Do not be afraid to ask questions. You can never learn too much about flying. Pilots with years of experience and thousands of hours of flying are still asking questions and still learning.

Your instructor will brief you before each flight. In this pre-flight briefing, he will tell you what you will do, 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 mistaken ideas and to learn the correct procedure. Your instructor's review will clarify these points, but be sure to ask questions if you have failed to grasp all the steps in any maneuver being discussed. Becoming an Army pilot demands that you grasp each lesson fully. Be sure to get a complete understanding of your mistakes and the action you should take to correct them. The time to ask questions is immediately after the flight, when your problems are still fresh in your mind.

Pilot's Handbook of Flight Operating Instructions:

Technical Manuals known as TM's are published for every piece of equipment in use by Army Aviation activities. The ''Flight Handbook, U. S. Army Model OH-23D Helicopters'' TM55-1520-206-10 pertaining to your training aircraft is the Technical Manual which contains all the essential information you should know about the aircraft you are to fly. It is the ''bible'' for your aircraft's operation. You will be issued a copy of this handbook.

Following is a brief summary of the information to be found in the ''Flight Handbook, U. S. Army Model OH-23D Helicopters'' TM55-1520-206-10 (refer to this publication continually):

CHAPTER 1	INTRODUCTION
Section I	Scope
II	General
CHAPTER 2	PILOT'S FLIGHT INFORMATION
Section I	Description
II	Normal Procedure
III	Emergency Procedures
III.I	Signal Electronic Equipment Configuration
IV	Description and Operation of Auxiliary Equipment
V	Operating Limitations
VI	Flight Characteristics
VII	Systems Operation
VIII	Crew Duties (Not Applicable)
IX	All Weather Operations
X	Performance Data
CHAPTER 3	WEIGHT AND BALANCE DATA
Section I	Introduction
II	General Loading Instructions
III	Chart E, Loading Data
IV	Chart A, DD Form 365A, Basic Weight Check List
V	Chart C, DD Form 365C, Basic Weight and Balance Record

B E   P R E P A R E D

THE APPENDIX contains all operating data charts necessary for efficient pre-flight and in-flight mission planning.

Local Flying Regulations:

As the Rotary Wing Handbook 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 because of local conditions. This type of information is published by USAPHS as ''Training Directives.''

USAPHS Training Directives set forth rules to be followed while flying at this training facility. They cover such subjects as flying areas, traffic rules, and traffic patterns. They are written to insure safe, efficient operation; these local Training Directives are in many cases based on regulations from higher levels of command.

Copies of pertinent Training Directives will be available in your flight room and at each Stage Field. You will be required to read these Training Directives and to abide by the rules they contain. Any violation of applicable flying regulations will seriously jeopardize your chance to complete your course successfully as well as subjecting you to trial by courts martial.

Be Ready to Fly:

In order to utilize a flying period fully, you must be completely prepared for the lesson. Be sure that you read and understand all available material which will contribute to the work to be done. Be sure that your flying equipment is in good order and ready for use. You were chosen for your initiative, resourcefulness, and intelligence. Officers, WO, and WOC in the Army are expected to be alert and to think ahead. Be eager and enthusiastic, and you will find that your instructor will reflect your enthusiasm.

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 of the aircraft, its controls, instruments, and nomenclature. 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. CAUTION: do not manipulate control switches while becoming familiar with the cockpit. During your study of the cockpit, examine the checklist, and study the prescribed procedures. As you go through the checklist, visualize the movement 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 procedures. The sooner you become familiar with the checklist, the cockpit arrangement, and the aircraft in general, the sooner they will become second nature to you. Your attention may then be devoted to flying the aircraft.

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. Mental stress causes this. Your first flights will not be long: adjust your mental attitude so that your mind is free to consider the techniques of flying. Good physical conditioning helps to improve your mental condition.

Ground Safety:

Municipal, state, and national officials must enforce rigid traffic regulations to insure the safety of pedestrians and automobile traffic in areas where they intermingle. The Army 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 abide by them to the letter.

Some of the problems of the ground safety officers will be discussed in this section so that you may better understand the importance of these regulations. Also included here are some practical common-sense rules or suggestions that you should consider before you get on a heliport or stage field or in the proximity of aircraft operation on the ground. At most flying facilities there is considerable activity on the ramp, heliport or stage field parking area. Fuel trucks are driving up and down, mechanics are running up engines, aircraft are hovering in and out, and you will at first 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 aircraft. It would be extremely ironic, to say the least, if you were run down by a fuel truck on your way to fly. When approaching your assigned aircraft, look all around for obstructions and articles that you might hit when you begin to hover the aircraft. After you have completed your preflight inspection and are ready to start the aircraft, ALWAYS be sure to call "Clear." When leaving your aircraft after flight, use the precautions as when you first came out to fly. You may be tired from the flight, but this is not the time or place to relax. Under some light conditions it is difficult to see a rapidly revolving tail rotor or main rotor. This may give the impression that it is not there. For this reason, or out of pure carelessness, the files of ground safety officers contain cases that read: "Victim walked into a rapidly turning rotor." Don't become the subject of one of these reports. Stay away from them. Never for a second let your mind stray or you may walk into trouble.

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 precaution and planning. Before you take-off, do all the things you are supposed to do. Plan the flight and make all necessary checks. A careless pilot may let himself, his crew, and his fellow pilots down because he failed to make a thorough pre-flight check. Remember that any item on a pre-flight check, if neglected, can easily become the most important factor in your life. Do not take your responsibility lightly. For your sake, as well as for that of others, get into the habit of making thorough pre-flight checks. The safe operating limits of your OH-23 trainer are outlined in the "Flight Handbook, U. S. Army Model OH-23D Helicopters" TM-55-1520-206-10. Your instructor will discuss them; you must abide by them.

Throughout your entire flying career you will be concerned with safety. Observe this rule always: LOOK AROUND, it means flying with safety:

Look above you
Over your left shoulder
Over your right shoulder
Keep alert
Always look before turning
Rigid necks are dangerous
Once is not enough
Under you is a blind spot
Never assume that others see you
Divide 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. 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.

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 the pressures on the controls will change the attitude of the aircraft. Review the lessons of each day, visualizing the "why" behind each operation. Use the "Rotary Wing Handbook", the "Flight Handbook, U. S. Army Model OH-23D Helicopters", TM-55-1520-206-10, and the checklist to prepare, review, and answer your questions about flying. In addition to these sources of information, you must become thoroughly acquainted with the Training Directives, traffic patterns, and special technical orders on equipment made available to you.

Check Rides:

Purpose: The Military Flight Evaluation Division of the Department of Instruction, USAPHS, is responsible for evaluating student pilots flying proficiency in all maneuvers and procedures in curriculum, and for controlling the standardized performance of these maneuvers and procedures.

Method: The Military Flight Evaluation Division administers check rides to students to check students' flying proficiency, quality of instruction, and standardization of maneuvers. Pre-solo stage check rides will be given by your own instructor, another instructor in your flight or by a civilian supervisor. Primary stage check rides will be given by Military Flight Evaluation Division check pilots at approximately the half-way point, flying time wise, of the course. Advanced stage check rides will be given by Military Flight Evaluation Division check pilots during last two weeks of the course. These check rides consist of the maneuvers taught during the stage of training being checked plus the maneuvers of the preceding stages of training. No attempt will be made to trick students during a check ride; a student is expected to fly these rides as though he were solo.

The Helicopter:

The helicopter is comparatively new in the field of aviation and many overly enthusiastic individuals consider it capable of performing fantastic feats without difficulty. It is true that the helicopter is the most versatile aircraft presently assigned to Army Aviation units, but disadvantages and limitations do exist which to some extent offset the many advantages and capabilities of rotary-wing aircraft. It is important that you understand the characteristics of this versatile flying machine in order to assure its most effective tactical employment.

The advantages of the helicopter are derived from its peculiar flight characteristics and design. Under normal conditions, the helicopter can take-off and land without horizontal movement over the ground which enables it to operate in terrain that would prohibit the use of conventional aircraft. It has a speed range of from 0 to 84 knots and can be flown forward, backward or any direction in between. It is also capable of extended hovering flight without movement over the ground and 360-degree turns may be executed while at a hover.

You can decelerate rapidly while in horizontal flight and bring the helicopter to a hover and accomplish a landing at any time.

One of its most desirable characteristics from a safety standpoint is the ability to autorotate in case of mechanical failure necessitating a forced landing. Autorotation is a characteristic of the helicopter whereby the rotor blades continue to rotate through a free wheeling unit without power and still produce sufficient lift to land the aircraft safely. You have complete control of the helicopter in autorotation and can land in a confined area but the landing must be accomplished immediately.

The plexiglas bubble and absence of other restricting surfaces increase visibility, and this desirable feature contributes to safe operation in conditions of restricted visibility. Slow speed combined with greater visibility will also enable you to conduct a detailed study of ground features and obstructions when operating in marginal conditions.

Disadvantages include highly intricate flight and engine controls systems of relative recent development. This contributes to the high initial cost of rotary-wing aircraft as compared to conventional types. Skilled labor and critical materials, combined with initial research and development costs of a new and complicated product, also increase the cost.

Pilots and mechanics must receive special training in addition to that received on conventional type aircraft to assure successful operation of the helicopter.

Amount and distribution of load are factors affecting rotary-wing operation as weight and balance tolerances are comparatively small. Pilot fatigue is also considered greater in the helicopter due to additional controls to be operated, closer attention that must be given to the instruments, and the vibration that is experienced by the pilot.

The demand for helicopters is constantly increasing as it fills definite need in the field of aviation. You, as a competent rotary-wing pilot, can contribute to the development and employment of the helicopter in Army Aviation if you master your job and yourself diligently.

HISTORY OF THE OH-23 SERIES HELICOPTER:

Stanley Hiller, Jr. became interested in the future of helicopters and began research in 1939 to develop a practical, low-cost, rotary-wing aircraft. His initial work produced America's first successful coaxial helicopter, the XH-44, flown in San Francisco in 1944 and which has recently been placed in the Smithsonian Institute.

The early experiments with the XH-44 led Stanley Hiller and his associates to investigate other helicopter designs including both twin and single-rotor aircraft. The result of this research was the Hiller 360, a 3-place, single main rotor helicopter designed specifically for commercial application to business and agriculture. This helicopter was granted a certificate of airworthiness by the CAA in 1948. Hiller was one of the first three manufacturers to obtain a certificate of airworthiness.

In 1950, the Hiller 360 was quickly converted into a military helicopter both for Navy and Army use. The Navy version was designated the HTE-1 and the Army version the H-23A. These were immediately pressed into service in the United States, Korea, and Europe. It was soon apparent that these converted civilian helicopters were not completely adaptable to military service. With suggestions from the field and with knowledge gained from production of its first military aircraft, Hiller Helicopters developed a new rotary-wing aircraft: the H-23B for the Army and HTE-2 for the Navy. Today OH-23D helicopters are in production and in service with the Army.

Description and Performance Data, OH-23D:

The OH-23D helicopter is a 3-place, semimonocoque, all metal, reconnaissance helicopter, utilizing a single main rotor with a torque compensating tail rotor. This aircraft uses the skid type gear with two ground handling wheels. The skid gear provides a mount for two standard litter installations which can be heated by hot air duct from a shroud around the exhaust manifold. The engine is uncowled and easily accessible for maintenance..

The collective pitch control stick is conventional with a hand grip throttle control incorporating a friction lock. Directional control pedals may be adjusted to the comfort of the pilot.

The main rotor assembly incorporates a new type of cyclic control system known as ''Rotor Matic Control''; this system is a combination of dual cyclic control sticks, linkage, push rods, wobble plate, scissors assembly, control rotor assemblies. The control rotor paddles are controlled by the cyclic sticks and aerodynamic reaction of these paddles forces the main rotors into the desired plane. The control rotor assemblies perform none of the functions of the stabilizer bar assembly found on the OH-13 Bell reconnaissance type helicopter.

The fuel cell is located inside the basic body section, at the center line of the main drive tube. Balance problems are simplified by this fuel installation, in that fuel used in flight does not, for practical purposes, move the CG of the aircraft.

The OH-23D is powered with an 0-435-23B Lycoming engine that develops 250 horsepower, at 3200 revolutions per minute, at 27 in. Hg. The maximum allowable gross weight is 2700 lbs.

The main rotor blade is 35' 5'' from tip to tip and the control rotors are 10' 0'' from tip to tip. The overall length of the OH-23D, from the tip of the main rotor in the fore and aft positions to the tip of the tail rotor in the horizontal position, is 40' 8.5''. The overall height of the OH-23D is 10' 1.5''.

The OH-23D helicopter is a reconnaissance type helicopter which was introduced to the military services in 1950. The present OH-23D model incorporates a great number of improvements over the original converted civilian model 360. The present skid type landing gear, 245 hp engine, improved litter installation, more efficient fuel and oil systems, plus field experience, has made the OH-23D fully adaptable to the needs of the military services.

STAGE FIELD INFORMATION

Field Tower Call	Trans. UHF Channel	Rec. UHF	Field Elev.	Tower Monitor
SF#1 Pinto	9	248.2	1003	241.0
SF#2 Sundance	10	248.4	1013	241.0
SF#3 Ramrod	11	248.6	955	241.0
SF#4 Mustang	12	248.8	1094	241.0
SF#5 Rawhide	2	229.6	845	241.0
Wolters Tower (1)	1	129.4	892	241.0
Wolters Alternate	5	241.0		
Wolters Tower (2)	6	241.1		
Air to Air	7	242.4		
EMERGENCY	8	243.0		
FAA TOWER	15	257.8		
FAA RADIO	13	255.4		

NOTE: The altimeter will be set to the exact field elevation at the heliport and stage fields. The field elevation is also painted on the roof of the respective stage house.

PLAN AHEAD

CHAPTER II

INTRODUCTION TO PRE-SOLO STAGE

Local Flying Area:

The student should be thoroughly familiar with the local area and those areas in which certain maneuvers are to be performed.

There is an aeronautical map of the local area in each flight room and in each stage house. (See Figure 1). Each student should study it and become familiar with all prominent landmarks.

Except during the take-off, climb-out, traffic patterns, and approaches, the altitude should never be below 500 feet above the ground while solo, unless otherwise directed by local authority.

Unless directed by local authority, do not fly lower than 2000 feet over any town or city within the local area. In the case of large cities, maintain sufficient altitude to make an autorotative approach to a clear area in an emergency.

Be familiar with all prominent landmarks in the local area as soon as possible. The student should be able to identify his position at any time, even in conditions of lowered visibility. This familiarization will be accomplished during the dual instructional flights.

Mineral Wells Municipal airport is a Control Zone within the Fort Worth control area and student training flight should stay clear of this area. Due to high density traffic the Carswell Air Force Base is a Prohibited Area.

Radio Procedures:

The OH-23 in use here for student training is equipped with 2 multi-channel UHF sets. Nine through twelve channels are student frequencies used at the five Stage Fields; one is Tower frequency. There is also an emergency frequency and there are interphone positions. The frequencies and their uses are listed in the Training Directives and in the current issue of the Radio Facility Chart. All frequencies and channel assignments are interim. Call signs used at this training facility are listed in Training Directives.

Air Discipline:

Radio voice communications will be kept to a minimum at all times. The call to the Tower will serve as the radio check.

Decide exactly what should be said on the radio before depressing the mike button. Say it, then get off the air.

Remember that when the mike button of the radio is depressed, the entire channel is blocked for other aircraft. Before depressing the mike button, check to see that the radio IS ON, PROPER CHANNEL IS SELECTED, AND MESSAGE IS CLEAR. BE CONCISE AND BRIEF. Monitor the air before transmitting.

Comply with all instructions from Stage Field Control or supervisory personnel. Do not transmit any comments as to the instructions received. Give them to your instructor after the flight.

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

Line of Sight Transmission:

A peculiarity of UHF is that the radio waves travel in 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 is altitude of the aircraft; another is obstructions such as a hanger, mountain, or any object that is between the transmitter and in a direct line with the receiver. The following is an approximate range for transmission over flat terrain.

AIRCRAFT ALTITUDE	RANGE
1,000	55 mi.
2,000	75 mi.
5,000	110 mi.

Set Operation:

The set is operated by means of controls located on the center console of the cockpit. It is tuned by crystals and therefore cannot be adjusted in flight. It is possible to transmit and receive on only one frequency at a time.

Standard Procedure:

Before flight and during the warm-up, check the radio in accordance with Training Directives.

Before landing, determine the direction of traffic by observing existing traffic; call only when you are unable to determine the landing direction.

When prescribed by Training Directives or supervisory personnel, a base leg call will be made before turning final approach.

Inspections and Checks:

As helicopters have become larger and more complicated, the checklist has become more and more important to the pilot. The Pre-flight Inspection and Cockpit Procedure checklist is as important on the modern military aircraft as the radios or other auxiliary equipment. The largest single cause of aircraft accidents is pilot factor. Many accidents could have been avoided by proper use of the checklist.

Use of the Checklist:

Use of the checklist by a visual reference is required by regulations. Remember - the checklist sets up procedures, but will never take the place of good judgment and headwork. They must be used together.

The checklist for the OH-23D is designed to check all necessary items in a logical sequence so that they will be easy to remember, i.e. left to right, or from top to bottom.

The sequence may not follow the exact order as they are outlined in 55-1520-206-10; however, where deviations in sequence exists, they have command approval. The checklist gives the items to be checked, but does not tell you how. This information is obtained from 55-1520-206-10 and from instructor briefings.

NOTE: A detailed preflight and cockpit procedure is to be found following Page 56.

LOCAL AREA

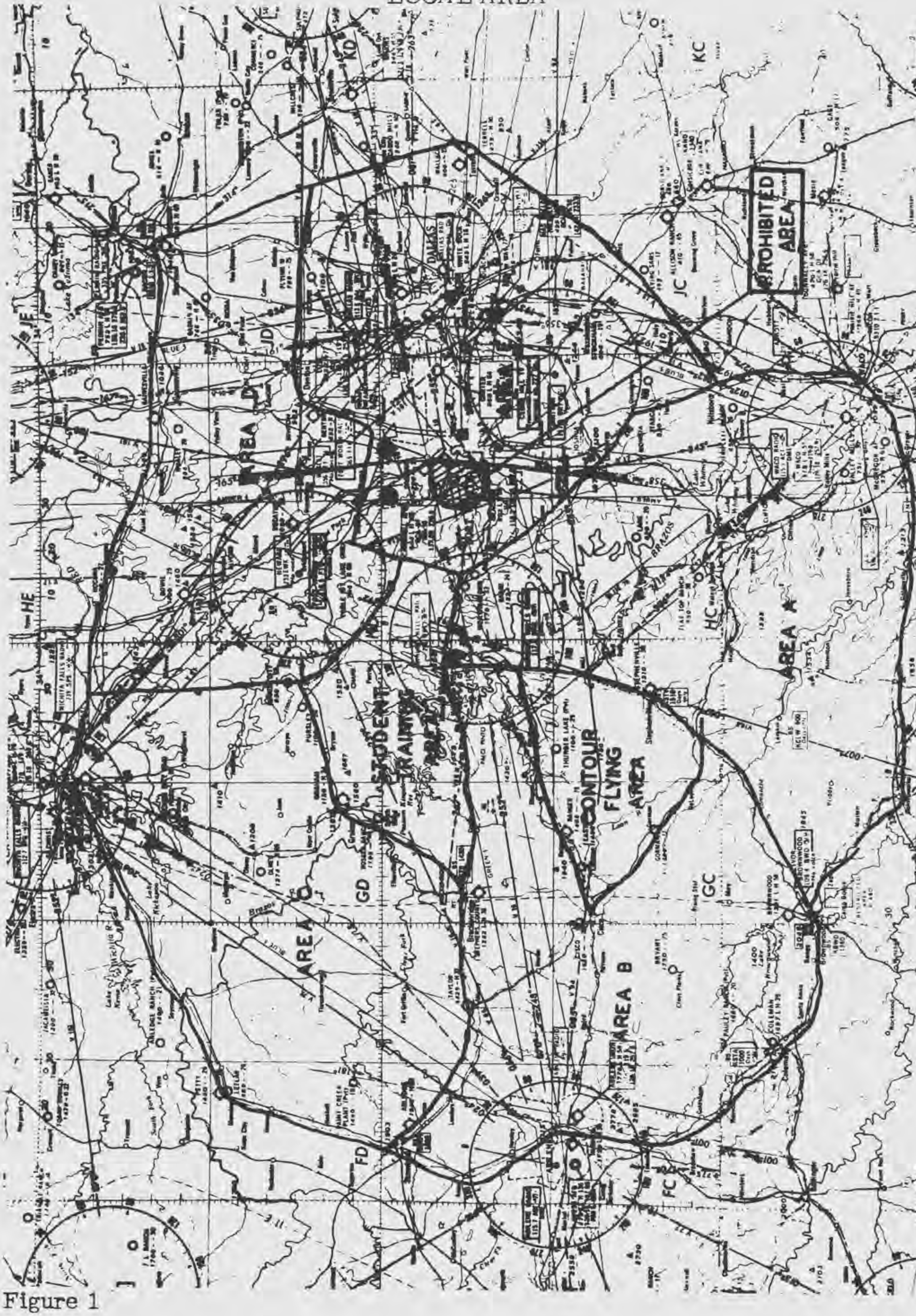


Figure 1

R E L A X

CHAPTER III

FUNDAMENTAL MANEUVERS OF FLIGHT

All flying technique is based upon one or more fundamental maneuvers of flight. In learning to fly, as in any process, you must master fundamentals before you can undertake the more advanced problems of flight. Your ability to master these fundamentals will greatly speed up your progress in mastering the more advanced maneuvers in the primary flying curriculum.

Effect and Use of Controls:

A proficient helicopter pilot must be thoroughly familiar, not only with the cockpit in general, but with the function and proper application of each of the four separate controls.

Your flight instructor will carefully explain each control function and demonstrate its proper application. These same effects will apply, regardless of the maneuver being performed. Don't be afraid to ask questions if you fail to understand any explanation or demonstration as it is impossible to fly the helicopter in a satisfactory manner without this knowledge.

There are three axes about which an aircraft will rotate and two flight controls which may be used to control the rotation. They are the lateral, vertical, and longitudinal axes; the flight controls are the cyclic and anti-torque pedals. The axes are defined as follows:

Lateral Axis: An imaginary line which runs from side to side through the center of gravity and is perpendicular to the longitudinal and vertical axes. Rotation about this axis (pitch attitude) is controlled by the fore and aft movement of the cyclic control.

Vertical Axis: An imaginary line which runs through the center of gravity and is perpendicular to the lateral and longitudinal axes. Rotation about this axis (yaw) is controlled by anti-torque pedals.

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

This chapter is devoted to a basic explanation of the four separate controls that make up the helicopter control system. The system consists of the cyclic control, the collective pitch control, the anti-torque pedals, and the engine throttle. Each control can be operated directly by the pilot independently of the other three, but it is necessary, in most cases, to smoothly coordinate two or more controls of the system at the same time to obtain the desired result.

The Cyclic Control:

The cyclic controls the attitude, direction of movement, and airspeed. It is located directly in front of the pilot and is similar to the control stick in a conventional aircraft. The attitude of the aircraft is the relationship of the nose and sides of the aircraft to the horizon. Without the horizon as a reference you would not be able to fly except on instruments. The cyclic pitch control rotor consists of a pair of fabric covered blades trunnion-mounted on the main rotor hub and extending at right angles to the spanwise axis of the main rotor blades. The function of the control rotor is to provide forward, aft and lateral directional control of the helicopter by tilting the main rotor disc on its vertical axis. Control rotor pitch change is accomplished by means of the cyclic control system. The helicopter will always change its attitude and move in the direction of rotor disc tilt; this movement also corresponds to the cyclic control stick movement made by the pilot in the cockpit. Forward pressure on the cyclic causes the nose of the aircraft to go down and the airspeed will increase. The lower the nose the faster the airspeed will be. If the airspeed is stabilized at a given speed, the aircraft is in a corresponding attitude; by observing the relation of the top of the console and other objects in the cockpit to the horizon, the attitude can become fixed in your mind, so that desired airspeed may be maintained by primarily referring to the attitude of the aircraft.

The lift force of the main rotor can be resolved into two components; a vertical force and a horizontal force. The vertical force supports the helicopter; the horizontal force moves it through the air. Cyclic control, therefore, allows you to control horizontal movement of the helicopter, since by application of cyclic control you can change the direction of tilt of the main rotor to produce a resultant force in the desired direction.

The cyclic control movements you make are transmitted to the main rotor blades, and since the disc area created by these rotating blades is of considerable size, it is necessary to make each movement of this control smoothly.

SMOOTHNESS IS THE VERY ESSENCE OF PROFICIENT HELICOPTER FLYING.

The Collective Pitch Control:

It is located on the pilot's left at approximately the same level as the seat and is operated with the left hand. It is used to vary the lift of the main rotor by increasing or decreasing the pitch of both blades at the same time. The greater the pitch in the rotor blades the more power you need to maintain proper engine RPM. Since in powered flight you always maintain a constant engine RPM, an increase or decrease in power is effectively controlled by the collective pitch.

To gain altitude, apply pressure upward on the collective pitch, which will increase lift and power. To lose altitude, apply downward pressure on the collective pitch, which will decrease lift and power. The manifold pressure gauge is your index of power. Notice as you reduce collective pitch the manifold pressure goes down and you start to lose altitude. As you increase collective pitch, the manifold pressure goes up and you start to gain altitude.

In a normal climb you hold 24" dual, 23" solo, inches of manifold pressure. In a normal descent you hold approximately 15-16 inches of manifold pressure. When you are cruising straight and level at 50 knots, your manifold pressure will be approximately 20 inches although you hold whatever power setting is necessary to maintain airspeed and altitude. The collective pitch may also be used in coordination with the cyclic to regulate your airspeed.

Throttle linkage (synchronization) in the OH-23 is designed to increase power automatically when the collective pitch is raised and to decrease power when pitch is lowered. This feature helps to maintain the engine at a constant RPM during normal flight maneuvers, while permitting you to change power as desired. Of course, if your RPM falls below or rises above the proper RPM even slightly, you will want to apply or reduce the necessary amount of throttle.

The Throttle:

Regulates the amount of fuel-air mixture going to the engine. It is mounted on the collective pitch and is similar to a motorcycle throttle.

You are required to maintain 3100 RPM at cruise; 3200 at all other times. If the engine RPM falls below the proper RPM, advance the throttle by turning it away from you until the RPM is back to normal. If RPM gets above the proper RPM, you turn the throttle toward you to reduce engine RPM. Changes in engine RPM can be detected by checking the tachometer and listening for variation in the sound of the engine.

It will take considerable practice before you can judge your engine RPM very accurately by sound. However, as you gain experience you will find that you have to refer to the tachometer less frequently. Throttle should be handled smoothly as a sudden movement of this control will increase or decrease the torque effect rapidly and cause the helicopter to yaw from side to side. Generally, only a slight movement will be necessary, and some instructors refer to this as "squeezing the throttle" rather than turning it. Your grip on the throttle should be firm but not tense.

Anti-Torque Pedals:

The pedals are used to maintain the heading and counteract for the effects of torque. Anti-torque control in the single rotor helicopter is accomplished by means of a variable pitch rotor, called a tail rotor. This rotor is mounted at the rear of the fuselage which acts as a lever arm. By increasing or decreasing the pitch of the anti-torque rotor, it is possible to counteract the torque forces created by applying power to the main rotor blades. Notice during cruising flight that if you hold the pedals stabilized in a neutral position and increase power, the aircraft will turn to the right. If you reduce power, the aircraft will turn back to the left. The amount of torque varies with the power applied, so the amount of thrust developed by the tail rotor must be varied by the pilot as the power is increased or decreased. This is done by connecting the anti-torque pedals to a pitch changing device on the tail rotor. As power is applied, it is necessary to add left pedal to increase the pitch on the tail rotor blades to keep the helicopter from turning or yawing to the right. As power is decreased, you add right pedal to decrease the pitch on the tail rotor blades to keep the helicopter from turning or yawing to the left.

You must remember that the anti-torque pedals are used only to counteract torque and to keep the longitudinal axis (heading) of the helicopter properly aligned. It is very important to properly coordinate the anti-torque pedals with power changes during airwork to keep the fuselage streamlined with the direction of flight so as not to create excessive drag by an unstreamlined condition which would decrease the helicopter's performance. Be very careful during a climbing or a descending turn to properly compensate for the changes in torque to avoid skidding or slipping in the turn.

Using the Controls:

Now that 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.

How to Use the Cyclic:

You should grasp the stick lightly with the fingers, not grab or squeeze it. Hold the cyclic the same way you would hold the steering wheel of an automobile - relaxed and comfortable. It is important that your arm and hand be relaxed so that you feel any pressure that may be exerted on the cyclic. The right forearm should rest on the leg. It is the pressure exerted on the cyclic and anti-torque pedals that causes the aircraft to move about its axis.

How to Use the Collective Pitch:

You should grasp the collective pitch by the throttle grip and the same type pressure should be used on the collective pitch as the cyclic stick. If the collective pitch is heavy, your instructor will demonstrate the technique of pulling pitch to relieve excessive pressure. All pitch movements should be slow and smooth so that the throttle and pedals may be coordinated with the power changes.

How to Use the Anti-torque Pedals:

The position of the feet should be comfortable with all the weight on the heels; this allows a fine sensitivity of touch in the balls of the feet. Let the heels of your feet rest comfortably on the floor until the balls of your feet rest comfortably on the pedals. Don't let your legs become tense but keep relaxed just as you do when driving an automobile.

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

Don't try to fly with your heels on the pedal bars as if you were steering a sled or scooter. If you do, your legs will become tired and tense and you will not be able to feel the pedal pressures properly.

How to Use the Throttle:

You should grasp the throttle lightly with the fingers of your hand. Keep your arm relaxed and your wrist straight in a comfortable position. All movement must be very slow and smooth, usually only a slight wrist movement is needed to make normal throttle changes. When large movement if the throttle is necessary, the hand should be re-positioned to keep your wrist in a comfortable position.

Throttle and Pitch Coordination:

The throttle, located on the end of the collective pitch control, is coordinated woth collective pitch to maintain a constant operating rpm. Although most helicopters have a certain amount of designed synchronization between collective pitch and throttle controls, the pilot is primarily responsible for throttle control. For the purpose of expediting development of pilot technique, collective pitch and throttle control may be considered to be effected as follows:

(1) Coordination of throttle and collective pitch controls is used to obtain desired manifold pressure and rpm. RPM corrections are made with reference to the dual tachometer. Collective pitch corrections are made with reference to the manifold pressure gauge. In effect, the throttle adjusts rpm and collective pitch adjusts manifold pressure; however, correction of either control changes both rpm and manifold pressure. These controls are normally very sensitive, and corrections should be small and smoothly performed to prevent overcontrolling.

(2) Raising the collective pitch control increases manifold pressure and, normally, decreases rpm. Lowering collective pitch control decreases manifold pressure and, normally, increases rpm. Increased throttle gives higher rpm and manifold pressure; decreased throttle gives the opposite effect. To hold a constant power setting, coordination of pitch and throttle corrections should be simultaneous.

(3) If full throttle is utilized, further raising of collective pitch control decreases rpm. Use the minimum amount of collective pitch and throttle to get the job done. The closer the utilized power is to the maximum power output of the helicopter, the LESS the safety margin.

(See Figure 2)

CARBURETOR HEAT CONTROL IN FLIGHT

Purpose: In addition to the pre-flight warm-up checks, carburetor air temperature needs to be frequently re-checked. This is especially true just before take-off and when you are using cruising power.

Instrument: On the OH-23 helicopter the carburetor air temperature gauge is divided into three parts as follows:

Green Arc - 32° to 54° Centigrade: Desired operating range.
Yellow Arc - 0° to 31° Centigrade: Caution operating temperatures.
Red Mark - 54° Centigrade: Maximum operating limit.

Indications: The best indication of a need for carburetor heat occurs when the needle on the carburetor air temperature gauge is not in the desired operating range. Additional indications are (1) when the engine runs rough, and (2) when you have a loss of RPM.

Correction: Apply sufficient carburetor heat to bring the carburetor air temperature needles to the desired operating range. For continuous operation, 45°C is the recommended temperature.

STRAIGHT AND LEVEL FLIGHT

Preparatory:

Straight and level flight is just what the name implies, flight in which a constant altitude and direction are maintained. In the pre-solo stage of training, it demonstrated one of the basic fundamentals of flying. You will learn the use of the controls; the use if visual references to help determine aircraft attitude; that is, noticing the position of the nose and top of the doors of the aircraft with reference to the horizon; and the importance of dividing your attention, that is, constantly checking all reference points and not concentrating on any one point. Your training objective in this maneuver is to attain proficiency in these three things.

Before practicing straight-and-level flight, you must understand thoroughly the effect and use of controls; be comfortably seated in the aircraft; and be completely relaxed and at ease.

It is important that you understand the effect and use of the controls so that when attitude corrections are necessary, you will know what pressures to apply to which controls.

Your perspective of the visual references on the aircraft, in relation to the horizon and ground, change as your eye level changes; consequently, different seating arrangements will result in different perspectives, although one flight attitude is being held constant.

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 that may be exerted on it by centrifugal force or gravity; also, you can better gauge 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 remain relaxed and your visual reference points will always appear the same. Looking around and maintaining a constant flight attitude are very important in this and all other maneuvers.

Ground Track:

Attaining level flight, at first, is a matter of consciously fixing the relationship of reference points on the aircraft with the horizon. These reference points will be used in varying degrees on all maneuvers and will continue to be your best aid for precision contact flying throughout your training. Initially, your instructor will establish straight-and-level flight and show you the visual reference points around the cockpit so that regardless of where you look, you can accurately judge the attitude of the aircraft.

As you look around and check your flight attitude, you will find many other references that can be used to help judge the ground track. For instance, roads, and fences on the ground offer excellent guide points. You may fly straight along them, or you may fly parallel or perpendicular to them. (Wind drift, which will be explained later, will affect the track made across the ground). Other points such as fields, town, lakes or railroads may also be used. If you follow these guide points, you are less likely to get off course and will thereby reduce the need for control changes, which should be kept to a minimum.

Air Speed Control:

The airspeed for straight-and-level flight is usually the normal cruising airspeed of 50 knots. Constant attitude of flight with respect to the lateral axis (pitch attitude) is accomplished by selecting a point on the bubble or the relative position of the console and keeping it in a fixed position below the horizon. You determine your airspeed by the attitude of the ship using the airspeed indicator as a cross-check to maintain 50 knots. Any noticeable deviation from this attitude means the ship is not in a 50 knot attitude, and you will gain or lose airspeed. Forward or back cyclic pressure is used to correct and to reestablish the relationship between your cockpit reference points and the horizon.

Level Flight:

You accomplish level flight about the longitudinal axis (bank attitude) by visually checking the relationship of the tops of the doors and other objects in the cockpit with the horizon. The tops of both doors should be equal distance above the horizon. If the right side is lower to the horizon than the left side, this probably means you have too much right cyclic applied and left pedal is being applied to keep the aircraft from turning. This situation means the aircraft is in a slip, and, although you may be flying a straight ground track, the aircraft is not level and is uncoordinated. You correct this by adjusting the cyclic laterally to level the aircraft and adjusting the pedals to trim the aircraft.

You achieve level flight about the vertical axis (yaw or heading control) by selecting a real or an imaginary point on the horizon directly in front of the aircraft. Left or right pedal pressure is used to control yaw and trim of the aircraft. Pedals usually require very little adjusting in straight-and-level flight, but must always be used as power is increased or decreased to compensate for the variance of torque effect and avoid any yawing or turning of the nose.

Altitude Changes:

In the early part of your practice in straight-and-level flight, your instructor will emphasize maintaining constant flight attitudes through the use of visual references. But as you progress and become more proficient in holding a constant attitude, he will also require you to hold a constant altitude. This will require the use of the altimeter as a check against your visual references to assure a constant altitude. Make altitude changes slowly. Exert a slight upward or downward pressure on the collective pitch if you wish to gain or lose altitude. If you take your time making altitude corrections, the changes will be small and will minimize the effect on your heading and RPM.

Because of the throttle linkage design, at cruising speed the throttle ordinarily need not be operated manually for minor adjustments with the collective pitch. Of course, if a change in collective pitch is made, you should still check the tachometer to see that you have 3100 RPM, and during altitude corrections the pedals must also be adjusted proportionately with the changes in power.

Wind Correction:

Turbulence and gusts are usually not a big problem in straight-and-level flight. They rarely call for more than minor corrections, however, when the air is rough the flight attitudes may change with each "bump." Don't try to fight the controls to prevent these bumps from occuring. Just make smooth adjustments in the flight attitudes as needed, like driving over a very bumpy road you can't keep the car from bouncing but you can keep it in your lane.

If you have a cross-wind, you should crab the aircraft into the wind to compensate for drift and keep a straight ground track. You establish a crab by (1) turning with the cyclic into the wind a sufficient amount for the wind velocity, and (2) maintaining proper trim with pedals. You can be sure you have the proper crab established if you are making good your ground track over your guide points, and the cockpit reference points are parallel with the horizon, indicating the aircraft is level laterally and not in a slip. (See Theory of Wind Drift for further information.)

To attain precision in straight-and-level flight, or any other maneuver, you must divide your attention continually between the visual references; this is called "cross-checking" or "division of attention". The sooner you learn to look around and divide your attention properly the sooner you will advance to another maneuver.

During your cross-check, occasionally include the altimeter to determine whether or not you are gaining or losing altitude.

CAUTION:

Time spent looking in the cockpit is harmful to visual flying, especially in the early stages of your flight training. Spend as little time as possible checking your engine instruments, carburetor air temperature, etc., but don't forget them. Keep the carburetor air temperature as close to 45° C as possible.

After you have had a little practice in straight-and-level flight and have learned to check your visual references properly, you can establish the correct attitude in a matter of seconds. Power change and trim technique will also become second nature.

Let your eyes rove all around the horizon and look for other aircraft that might be flying in your area while you check your visual references and orientation to the home field.

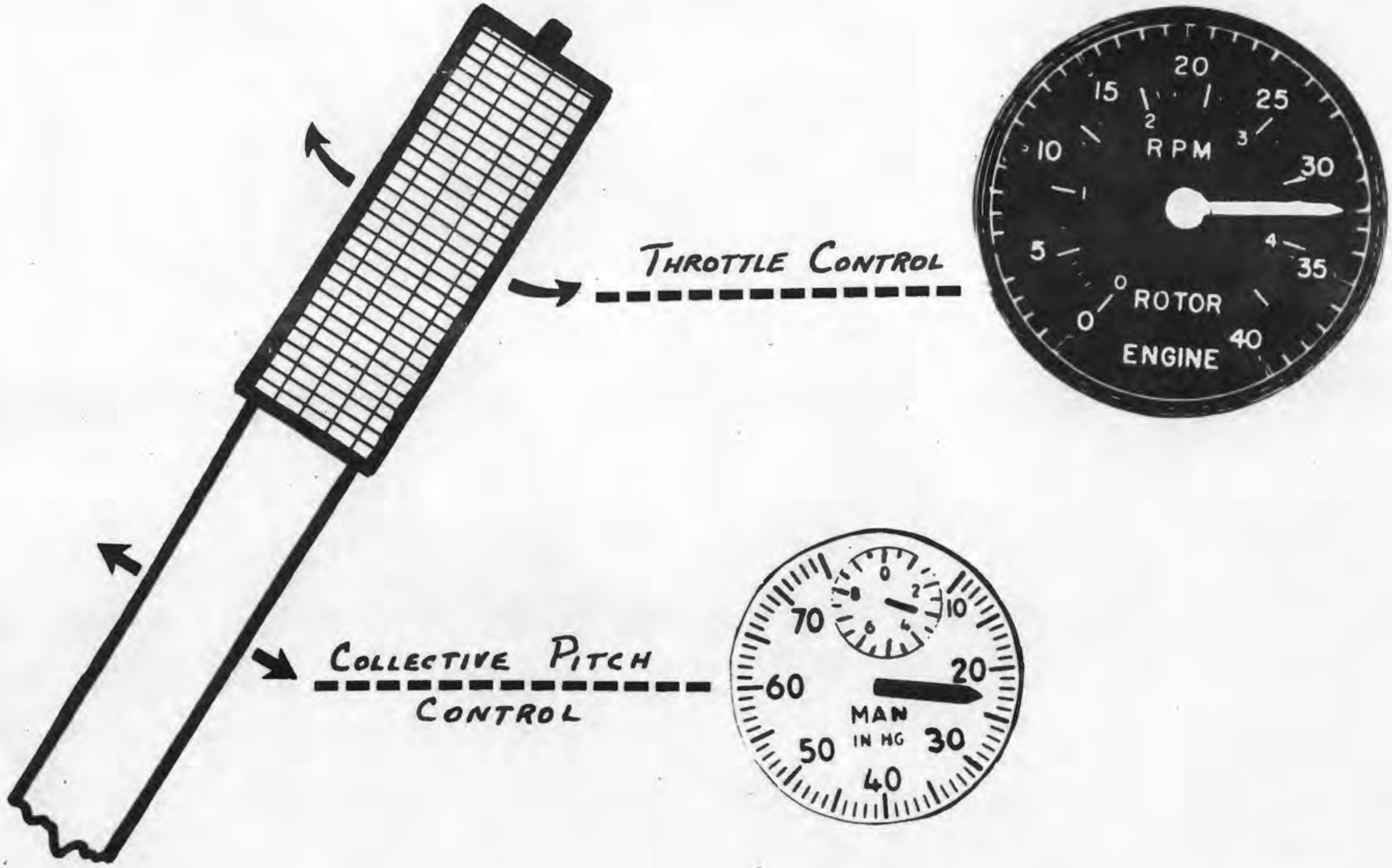

THROTTLE CONTROL
COLLECTIVE PITCH CONTROL
RPM
ROTOR
ENGINE
20
15
25
10
30
5
35
0
40
MAN
IN HG
70
10
60
20
50
30
40

Figure 2

REMEMBER THE WIND

Things to Remember:

Constantly cross-check all visual reference points.

Maintain a comfortable seating arrangement in the aircraft.

Watch for tenseness and tight gripping of the controls. If you find yourself becoming tense, take a deep breath and relax as you exhale.

Fly by pressures on the controls, and not by movement of the controls. Apply the pressure smoothly and evenly. Later in your training you will learn that nearly all flying is done in terms of "constants" - constant pressures on the controls, constant roll-in and roll-out of turns, constant rate of movement of the nose, etc.

THEORY OF WIND DRIFT

Whenever any object frees itself from ground friction, that is, when it no longer has any connection with the ground, it can only be affected by the medium with which it is surrounded. This means that it is free to move, and must move in whatever direction the medium is moving, and at the same velocity.

For example, when you were younger, you probably made little cork or wooden boats to float in a ditch, or a small stream. Your buddy probably made similar boats so you decided to have a race. You placed both boats in the flowing stream of water, and released them simultaneously. The boats then began to move along the water, in the same direction, and at the same velocity as the water. Now and then one of them would get into a certain section of the stream which was moving faster than the water where the other boat was floating. Naturally, this would result in one boat getting ahead of the other.

Up to this time we have been discussing the movement of the boats with respect to the water. We saw that the boats were motionless in respect to the water in which they were floating, because they drifted along only as fast as the water would allow. Now let us take into consideration the movement of these boats in relation to the ground, or the bottom of the stream or ditch. Obviously, they were moving at a certain rate in relation to the ground, because you had to walk along the side of the stream to keep up with them. You noticed also that they were moving only at the rate that the stream dictated, which was its own speed. You also noticed that when one boat floated into the section of the stream that was moving faster, you had to walk or run faster to keep even with it, proving that the speed the boat was making in relation to the ground changed as the speed of the water around it changed.

Now then, as soon as the aircraft becomes airborne, it is free from ground friction. It, therefore, can only be affected by the wind, i. e. move with the air mass in which it is flying. In your flying training you will notice that the aircraft does not always follow the ground in the same direction the nose is pointed. You will probably at one time or another be flying parallel with a road. The longitudinal axis of the aircraft is lined up perfectly with the road and you were flying a straight-and-level course. Suddenly you realize the aircraft is getting closer to the road or had actually crossed it, without any turn having been made.

This would indicate to you that the air in which you were flying was moving in a direction that caused it to cross the road at some angle. Of course, whenever air moves, we feel the pressure of its movement when we are standing on the ground, and we call this movement of the air the wind. Since the aircraft is flying in this certain body of air, it tends to move along with the air in the same direction and at the same velocity just as the boats moved with the stream.

Suppose you were flying along straight and level and the wind was blowing 30 mph from your left and precisely 90° to the direction the aircraft was pointed. At the end of one hour the body of air in which you were flying would have moved 30 miles to your right. Since the aircraft is in this body of air, and moving right along with it, you and the aircraft would also have drifted 30 miles to your right in one hour. Of course, in relation to the air you only moved forward; but, in relation to the ground you have moved forward and 30 miles sideways. This effect is known as drift, and must be compensated for, in order to cause the aircraft to pass over a desired track, or course, on the ground.

The proper way to correct for drift when you are flying straight and level, and wish to follow a selected ground track, is to turn the aircraft slightly into the wind. This may require only a turn of a few degrees. When you seem to have the drifting effect neutralized, or stopped, roll level. Now the aircraft is flying straight and level again, but is pointed into the wind slightly. This causes the aircraft to fly into the wind at the same rate that the wind is attempting to move the aircraft sideways. Since the drifting effect has now been neutralized, the aircraft flies a straight and desired ground track. This effect is known as "crabbing" because the aircraft appears to be flying slightly sideways in relation to the ground.

This effect may be compared to that of rowing a boat across a river. If the river was not flowing, or moving, you would merely head the boat for a place on the opposite shore where you desired to land, and row straight across. If the water was flowing, however, you would have to keep the boat pointed up-stream as you rowed across. This would cause you to move into the stream at the same rate it was attempting to move you down-stream. Your resulting track across the bottom of the river, or your ground track, would then be a straight line from the bank on one side to the bank on the other. If you failed to point the boat up the stream as you rowed across, the boat would drift down-stream as you rowed across. This would cause you to land some distance down-stream on the opposite bank, meaning your ground track across the bottom of the river was diagonal to the direction you desired to take.

There will be times when you will want to correct for drift while in a turn. As you know, the wind in relation to the ground will be acting on the aircraft from constantly changing directions when the aircraft is turning. The length of time you remain in any particular part of a turn, in order to make a certain ground track, is governed by the direction and velocity of the wind. At times the wind will be blowing opposite to the way you are turning, and at other times in the same direction. The effect of wind drift, plus or minus the turn and the movement of the aircraft, will cause the ground track to vary. Therefore, in order to make good a desired ground track in a turn, you may have to increase or decrease the rate of turn. As you already know, the rate of turn is governed by the angle of bank and the airspeed of the aircraft. Assuming a constant airspeed, you can change the rate of turn by changing the angle of bank. The greater the bank, the faster the rate of turn. The shallower the bank, the slower the rate of turn.

Let us analyze the ground tracks that are created by performing turns first without, and then with, a wind condition 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 blowing. Later, however, you will benefit more from the maneuver, if it is performed when a fairly strong wind is blowing and, thus, causing a more noticeable drifting effect.

Let us assume there is a no-wind condition existing. It would be simple in this case to make arcs of 180° over the ground, because the air track and ground track are identical. All you have to do is approach a road from a 90° angle, and when you are directly over the road, roll into a turn with any angle of bank and maintain this same angle of bank for 180° of turn. If the bank is steep, the turn will be fast. If the bank is shallow, the turn will be slow. In any case, if you cause the aircraft to turn 180° in the air, the aircraft will follow the same path over the ground. This means that if you were to start your turn directly over the road, and turned 180° while maintaining the same angle of bank, you should be back over the road just as you complete the turn. Remember, a constant angle of bank at a constant airspeed means a constant rate of turn.

You could then lead the roll-out so as to be level just as the aircraft reaches the road and roll immediately into a turn in the opposite direction, with the identical amount of bank. This would cause the aircraft to turn 180° in the opposite direction, make exactly the same size semi-circle and be back to the road just as the turn is completed. This would be an ideal situation and would only be possible if there were no wind blowing, and if the angle of bank and the rate of turn remain constant throughout the entire maneuver.

Very rarely, however, does a no-wind condition exist. If you attempt to maintain a constant degree of bank, with the wind blowing perpendicular to the road, you would make a true semi-circle track through the air; but, with the air mass moving constantly, this would cause your ground track to differ from a true circle. Of course, the greater the wind velocity, the greater would be this difference.

To counteract for this wind drift effect, you can vary your air track in such a manner as to neutralize the drift effect of the wind, and cause the projected ground track to be a true semi-circle. This is accomplished by varying the angle of bank, consequently varying the rate of turn, to compensate for the drift effects caused by the various wind angles encountered in a turn.

These wind-drift effects, and the proper techniques just discussed, will apply in principle to all ground-track maneuvers. These maneuvers will then help develop your ability to correct for wind drift in straight-and-level flight, and also in turns.

RECTANGULAR COURSE:

The rectangular course is a maneuver in which the ground track of the aircraft describes a rectangle on the ground, equidistant on all sides from a selected rectangular area on the ground. This maneuver simulates the actual traffic pattern.

You should by this time have sufficient experience to be able to learn easily the minor problems of ground-track maneuvers. You should be able to grasp the details of the problems peculiar to the rectangular course and should be able to display a fair amount of technique while flying it.

Flying a rectangular course will give you an opportunity to learn how to fly a practical ground track. It will also help give you the ease and confidence necessary to permit you to fly properly in traffic. This maneuver not only simulates an actual traffic pattern but also teaches the establishment of "crabbing" angles and ground tracks necessary on all legs of the pattern. It also provides experience in the practical application of turns.

Like all other ground-track maneuvers, however, its most important objective is to teach you the division of attention between flight path, ground objects, and the subconscious handling of the aircraft.

The best way to begin the entry to a rectangular course is to fly at sufficient altitude to enable you to see large portions of the terrain. Approximately 500 feet above the terrain is sufficient. Select a field, or a group of fields, having a rectangular or square border outline. This field should be well away from any traffic at the Heliport or the Stage Fields, and should be of sufficient size to simulate one of these. When you have selected the rectangle, check the wind direction from smoke movement or other signs. Now visualize a traffic pattern set up around the rectangle with the landings into the wind. Turn your aircraft to a heading that is opposite the simulated 45° entry leg. Continue out on this heading to where you have reached a point that will allow you to make a 45° entry leg, of normal length. Remain oriented; when you have reached traffic altitude, you should be heading toward the rectangle, on a simulated 45° entry leg.

Turn onto the down-wind leg at what you consider the proper place. After you have rolled out of the turn and are on the down-wind leg, check your distance from the rectangle. If your distance is not correct you will know that you turned onto the down-wind either too soon or too late. Practice will give you the judgement to make this turn at the proper time. After you have rolled out and checked your distance, make any corrections necessary to place your aircraft at the correct distance from the rectangle.

Theoretically, there should be no wind drift on this leg, because the wind should be directly behind you. Continue to divide your attention in order to hold the aircraft the same distance from the boundary and at a constant altitude and airspeed. Of course, if you begin flying too close or too far from the boundary, make a slight turn to regain the desired distance.

Continue the down-wind leg, watching the base-leg boundary of the field as you approach it. This is located at the down-wind end of the field. Remember, the wind is behind you, so wait until you fly slightly past this down-wind boundary, anticipating your turn to a simulated base leg. Now turn to the base leg. The wind, being behind you, will attempt to move the aircraft away from the field during the turn. For this reason you must start the turn soon enough to neutralize this effect. Continue the turn until you are paralleling the down-wind border of the field.

Remember, however, the wind will now be affecting the aircraft from the side, trying to force it away from the field. A "crab", or drift, correction must then be established to counteract this drift effect. The proper thing to do is to continue the turns so as to turn slightly more than 90°, then when you roll level, the drift correction is automatically established. If you turned at the proper time to correct for drift and radius of turn, the aircraft should be the same distance from the base-leg boundary as it was from the down-wind-leg boundary.

Continue the base leg, constantly dividing your attention and correcting for wind drift. The next boundary of the field will be the up-wind-leg boundary, because you will be flying up-wind when following this boundary. When you have passed this boundary, slightly make a medium-bank turn toward the up-wind-leg. You were holding a slight drift correction on base leg, so this turn will be slightly less than 90°. It should be anticipated sufficiently, however, to compensate for turning radius and any drift that may be apparent.

Continue the turn until you are paralleling this new boundary. Lead the roll-out so that you become level as the longitudinal axis of the aircraft becomes parallel to the boundary. Once again you should be at the same distance from the field boundary as on the two preceding legs, if the turn was anticipated and executed correctly. Continue to fly along the up-wind leg, keeping your attention constantly divided. Maintain the aircraft at a constant distance from the field and at a constant altitude and airspeed. The next boundary you will approach is the cross-wind leg boundary. This is located at the up-wind end of the field.

When you make the turn, the wind, which now meets you head on, will attempt to force the aircraft toward the field boundary. It is necessary, therefore, in order to properly compensate for wind drift and turning radius, to continue farther past this boundary than you did on the boundary of the base leg.

You must remember also, that if the aircraft is turned until it is parallel to the boundary, the wind will begin forcing it toward the field, even as you are rolling out of the bank. You should, therefore, lead the roll-out sufficiently, so there will be a slight drift correction automatically applied when you become level. This turn will then be less than 90°, with the aircraft pointed slightly away from the field and into the wind. The aircraft, with drift correction applied, should now be the same distance from the field as the other legs were. Continue the cross-wind leg until you once again approach the boundary, anticipating the turn to correct for wind drift and turning radius. Roll into a turn in the direction of the down-wind leg. Remember, the drift correction you were holding on the cross-wind leg entailed flying with the aircraft pointed away from the field. In order to turn the aircraft parallel to the down-wind-leg boundary, you must turn it slightly more than 90°. Lead the roll-out sufficiently to insure paralleling the boundary of the field just as you become level.

Once again, you should not encounter any drift on this leg, nor should you encounter any on the up-wind leg. It is sometimes difficult, however, to find a situation where the wind is blowing exactly parallel to the field, making it necessary to "crab" slightly on all the legs. Remember to anticipate the turns to correct for drift and turning radius. When the wind is behind you, turn sooner; when it is ahead of you, turn later. These same techniques apply in the traffic pattern. You might ask, "Couldn't I merely use a steeper or shallower turn to correct for errors and drift?" You could, but the main purpose of this maneuver, in regard to turns in traffic is to teach you to properly anticipate the turn. You will notice all the turns used in this maneuver are the same as those used in traffic. Airspeed and angle of bank are constant, making the rate of turn uniform; this requires constant anticipation and thinking ahead of the aircraft.

When you have completed a rectangular course in one direction, break traffic and re-enter to practice in the other direction. This will give you practice in making both left and right-hand traffic patterns.

Things to Remember:

Divide your attention: If you become too engrossed in watching the road, you may meet someone who is using the road in the opposite direction.

Know the direction from which the wind is blowing. Check smoke or wind trails over water. Remember your wind direction when you take off.

Think about a forced landing during these maneuvers.

Relax, and make all of your turns smooth.

NORMAL CLIMB

Climbs are executed to gain altitude in a safe, orderly manner. You will practice normal climbs in the pre-solo stage of your training to continue increasing proficiency of coordination and to develop your tehnique (control touch) so that you will make smooth and accurate changes of attitude and power while accomplishing the maneuver.

The conditions of flight are:

(1) Airspeed 40 knots.

(2) Manifold pressure 23 inches. (24 inches dual)

(3) RPM 3200.

The airspeed of 40 knots utilizes the maximum effect of translational lift and obtains the best rate of climb for the power expended. The normal power setting of 23 inches (24 inches dual), is the manufacturer's recommended power setting for a normal climb, and 3200 RPM gives you maximum controlability and allows the engine to develop its rated horsepower.

Entry:

In the early portion of the pre-solo stage, you will usually enter a normal climb from straight-and-level flight of 50 knots and 3100 RPM. To establish a normal climb apply (1) a slight aft pressure on the cyclic to raise the nose to a 40 knot attitude; (2) at the same time, simultaneously "squeeze" on throttle to increase RPM to 3200 and apply upward pressure on the collective pitch to establish a power setting of 23 inches solo, (24 inches dual); (3) apply a slight pressure on the left pedal to counteract the increased torque effect and to keep the aircraft in trim.

Maintaining:

The 40-knot climbing attitude will be shown you by your instructor and he will point out the visual references which you can use to determine it, that is, the relation of the console and other cockpit reference points to the horizon. If you keep these references in the same relative position to the horizon, your airspeed will not vary excessively.

After you have attained the proper flight attitude, airspeed, and power setting, relax and look around. Although your visual references are different, maintain a constant cross-check on them just as you did while flying straight and level.

Recovery:

To return to straight and level flight from a climbing attitude, start the level-off approximately 50 feet below the desired altitude. Apply a slight forward pressure on the cyclic to lower the nose to a 50-knot attitude. Hold your normal climb manifold pressure 23 inches (24 inches dual) until you have reached the desired altitude and increased your airspeed to approximately 50 knots, squeeze off throttle to reduce rpm to 3100, then simultaneously adjust collective pitch to re-establish your cruising manifold pressure and hold the desired altitude. Apply a slight amount of right pedal to keep the aircraft in trim and readjust your attitude.

Things to Remember:

Always sit relaxed in the aircraft so that you feel the control pressures and maintain a constant cross-check of the visual references.

As the climb or level-off is started, the airspeed changes gradually. This change in airspeed is gradual rather than immediate because of the momentum of the aircraft. Always start or terminate a climb by establishing the appropriate attitude and letting the airspeed gradually assume the desired setting. Rushing will result in overcontrolling.

NORMAL DESCENT

A descent is a maneuver in which the aircraft loses altitude while in a controlled attitude. It is also a maneuver in which the aircraft loses altitude at a controlled rate. For descents at the same , or lower airspeed than used in straight-and-level flight, obviously, the power must be reduced as, or before the descent is entered.

The normal descent is practiced in the pre-solo stage of training to develop your coordination and technique in this maneuver, to prepare you for other maneuvers (traffic patterns and approaches) that utilize similar technique.

The conditions of flight for normal descents are:

(1) Airspeed 40 knots.

(2) Manifold pressure 15 inches.

(3) RPM 3200.

The power setting of 15 inches is utilized only for practice of descents when there are no requirements that necessitate the variance of the rate of descent. To accomplish descents in the traffic and during approaches the power used will be governed by the atmospheric conditions and the distance in which the descent must be completed.

Entry:

You will normally enter a normal descent from straight-and-level flight of 50 knots and 3100 RPM. To establish a normal descent (1) apply downward pressure on the collective pitch to establish a power setting of approximately 15 inches of manifold pressure and simultaneously adjust the RPM to 3200; (2) at the same time, apply a slight pressure on the right pedal to counteract the decreased torque effect and keep the aircraft in trim; (3) simultaneously apply a slight aft pressure to raise the nose to a 40-knot attitude.

Maintaining:

The 40-knot descending attitude will be shown you by your instructor and he will point out the visual references which you can use to determine it, that is, the relation of the console and other cockpit reference points to the horizon. If you keep these references in the same relative position to the horizon, your airspeed will not vary excessively. The attitude used to maintain 40 knots in descents is slightly different from the attitude used in a normal climb due to the difference in thrust while climbing and descending. Thrust varies as power is changed, that is, as power is added the lift and thrust is increased, and conversely, as power is reduced lift and thrust is decreased.

Recovery:

To return to straight-and-level flight from a descent, start the level-off approximately 50 feet above the desired altitude. Apply a slight forward pressure on the cyclic to lower the nose to a 50-knot attitude. As the desired altitude is reached, apply upward pressure on the collective pitch to re-establish your cruising manifold pressure setting and simultaneously apply a slight pressure to the left pedal to keep the aircraft in trim, adjust the throttle to establish 3100 RPM (usually squeeze "off" a slight amount).

Things to Remember:

Always maintain a constant attitude. Fly the aircraft by attitude and use the airspeed indicator only as a check.

Try to develop a "feel" for the descent. You will find after some practice, that you can establish the proper attitude and trim the aircraft almost by "feel" alone.

The altimeter has a slight amount of lag, so the initial application of collective pitch must be made before the altimeter actually shows the desired altitude to avoid passing below it during leveling off.

LEVEL TURNS

A turn is a maneuver used to change the heading of the aircraft. Since turns are incorporated into almost all other maneuvers, it is important that you be able to perform them well.

There are three types of turns - level, climbing, and descending - with variations in each of these. For instance, there are three classes of level turns - gentle, medium, and steep-banked turns.

Before practicing turns you must thoroughly understand the aerodynamics that effect the aircraft while it is in a turn.

Lift Components of a Turn:

Turns are made in an aircraft by banking. Banking causes the direction of lift to move from the vertical to one side. This causes lift to pull the aircraft in the direction of the bank as well as to overcome gravity. This is done by using the cyclic to roll the aircraft in the direction that you desire to turn.

When the rotor disc on the aircraft is tilted, the resultant force is resolved into vertical and horizontal components, lift and thrust. As the aircraft is rolled into a turn, the vertical component acts perpendicular to the ground. The other, the horizontal component, acts parallel to the ground. These components act at right angles to each other, causing a resultant lifting force to act perpendicular to the rotor disc of the aircraft. It is this lifting force that turns the aircraft.

Loss of Vertical Lift:

As the angle of bank increases, the vertical lift component decreases and the horizontal component increases; this causes the resultant lifting force to act more and more towards the horizontal component. Since the resultant lifting force acts more horizontally, the effect of lift acting vertically is decreased.

When your aircraft is in a turn, you will find that a greater angle of attack is necessary to keep it from losing altitude. Increasing a slight amount of collective pitch will increase the angle of attach and maintain altitude. The steeper the angle of bank, the more collective pitch you will have to use to keep altitude. Shallow and medium angles of bank require very little pressure on the collective pitch to maintain altitude. With an increase in bank and a greater angle of attack, the resultant lifting force will be increased and the rate of turn will be faster.

Increased Load Factor (Disc Loading):

The rotor blades of a helicopter create a disc area and in straight-and-level flight support a weight equal to the total weight of the aircraft and its contents. As long as the mass, or weight, of an aircraft is moving at a steady rate of speed and in a straight line, the load imposed on the rotor blades (disc area) remains constant. When the aircraft assumes a curved flight path, however, additional weight in the form of centrifugal force must be supported by the rotor blades.

Any time the aircraft is flying in a curved path the load supported by the rotor blades is greater than the weight of the aircraft. This is true regardless of the plane of curved flight; i.e., whether the curved path is a level turn, a pull-out of a dive, or flare. (Hovering turns made with pedal only are not included.)

As explained previously, a turn is produced by allowing the lift of the rotor disc to pull the aircraft from its straight course while lift of the rotor disc still continues to overcome gravity. Thus, the rotor disc must produce lift equal to the weight of the aircraft plus the centrifugal force caused by the turn. This can be done by increasing the angle of attack with the collective pitch; application of aft cyclic will increase the angle of attack, however, airspeed would decrease and this is usually not desired and not used in practice.

Normally, turns will be executed slowly and without excessively steep angles of bank so the effect of centrifugal force is minimized and will require only a very slight increase in the angle of attack.

Since this maneuver is executed from level flight, the conditions of flight are the same as for straight-and-level flight.

Preparatory:

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 that may interfere with safely executing the turn. All practice turns in flight unless otherwise specified are 90-degree turns, so while you look to clear the area also pick out some object to use as a guide point for completion of your turn.

Entry:

When the area has been cleared, apply a slight sideward pressure on the cyclic in the direction you wish to turn, this is the only control movement necessary to start the turn. Do not use your pedals to assist the turn. The further you move the cyclic, the more the aircraft will be banked, also the greater the bank the faster the rate of turn. You should practice using a slight pressure on the cyclic, and roll into your turns slowly to aid you in learning to feel the pressures properly. Approximately fifteen degrees of bank is most commonly used.

Maintaining:

It is important to maintain a constant altitude and airspeed during the turn. This can best be done by holding a constant relationship between cockpit reference points and the horizon. If these references are kept in the same relative position to the horizon throughout the turn, you will have a relatively constant altitude and airspeed. Cross-check by occasionally glancing at the altimeter and airspeed indicator and continue to clear the area into which you are turning for other aircraft. Throughout the turn, the degree of bank should be held constant with the cyclic, just as it was to keep the aircraft level in straight-and-level flight.

Recovery:

Your recovery from a turn is the same as the entry except the pressure you use on the cyclic is in the opposite direction. Since the aircraft will continue to turn as long as there is any bank, start the roll-out before reaching your desired heading. This will allow the aircraft to turn during the time it takes to roll the aircraft from a banked attitude to a level attitude. As the aircraft becomes level, you should be aligned with your previously selected guide point and in straight-and-level flight.

Things to Remember:

Your posture while seated in the aircraft is very important in all maneuvers, especially in turns. Sit upright comfortably so that your body is equidistant from the doors. Don't lean from side to side and during turns maintain this position. Don't lean away from the turn or attempt to keep your body vertical with the horizon, ride with the turn.

Always look around before starting a turn. Be sure that you are not turning into another aircraft. Be relaxed. You always fly better if you are relaxed.

Divide your attention between looking around and flying the aircraft.

Apply constant and even pressures to the controls.

Maintain a constant rate of bank. If you do not attain the angle you desire, make slight positive corrections.

Anticipate the roll-in and roll-out of a turn so that you enter and recover from the turn at the exact desired point.

Expect the unexpected. Just as in driving a car, always expect that the other person may not see you and may turn into you, or may act as you do not expect him to. Think and plan ahead.

CLIMBING TURNS

There are two ways to establish a climbing turn. You can first establish a normal climb and then execute the turn, or you can establish both climb attitude and bank attitude simultaneously from straight-and-level flight. Since the first method is probably easier, your instructor will have you practice it in the early part of your training. However, after you have attained a fair degree of proficiency in this method, he will require you to use the second method. This second method is better because it allows you to clear the area as the climb is being established.

Climbing Turns from Normal Climbs:

Entry:

To begin this maneuver from straight-and-level flight, establish a normal climb airspeed and power settings of 40 knots, 23 inches manifold pressure, and 3200 RPM. Squeeze on throttle, if necessary, to maintain 3200 RPM, and apply pressure to the left pedal to trim the aircraft.

When you have the aircraft stabilized in a normal climb and no further power on pedal changes are necessary, clear yourself and smoothly roll into a turn just as you would from straight-and-level flight.

Maintaining:

You hold the ship in the proper degree of bank (usually about 15°) with cyclic. Do not use the pedals to assist the turn. It is important to hold your 40 knot airspeed throughout the turn. Note the visual references the same as in any turn (cockpit reference points relative to the horizon); if these references are kept constant to the horizon, your airspeed will not vary excessively, and you will maintain your normal climbing turn. Cross-check by occasionally glancing at the altimeter and airspeed indicator.

Recovery:

Shortly before the completion of your turn, you begin your roll-out by applying a slight pressure on the cyclic away from the direction of the turn. By the time the aircraft is in a level attitude, you should have turned 90 degrees. After your turn is completed, increase your airspeed to 50 knots and decrease power for cruising.

In order to make precision turns, align the aircraft with the road or section line on the ground and turn perpendicular or parallel to this line. In the absence of good section lines, you may make precision 90-degree turns by selecting a point directly out one door and simply turning to that point. This is a very good method because you will automatically clear the area in the direction of the turn when you select the 90-degree point.

Climbing Turns from Straight-and-Level Flight:

To establish a climbing turn from straight-and-level flight, use the same procedure as to establish a normal climb; but as the nose rises, coordinate pressure laterally on the cyclic so that the bank will be established simultaneously with the climb attitude. If it is perfectly established, the climb and bank attitudes will be attained at exactly the same time. Since this does not always occur, hold whichever one that is attained first then effect the other.

Recover by rolling out of the bank simultaneously establishing cruising flight so that as 90 degrees of turn is completed, you are flying straight and level.

Things to Remember:

Hesitate after each climbing turn to check for proper attitude, airspeed, and RPM, and to clear the area for the next turn. After the aircraft is properly trimmed for straight-and-level flight, do not adjust it in the turn unless you are holding abnormal pressures.

Always sit relaxed in the aircraft so that you can feel the control pressures and maintain a constant cross-check of the visual references.

DESCENDING TURNS

There are two ways to establish a descending turn. You can first establish a normal descent and then execute the turn or you can establish both descent and bank attitude simultaneously from straight-and-level flight. Your instructor will probably have you practice this maneuver in the same sequence used for climbing turns, i.e. the first method and later the second method. The second method is better because it allows you to clear the area as you are descending.

Descending Turns from Normal Descents:

Entry:

To begin this maneuver from straight and level flight, establish a normal descent, 40 knots attitude, manifold pressure between 15 and 17 inches, and 3200 RPM. Coordinate right pedal as power is reduced to maintain proper trim.

When you have the aircraft stabilized in a normal descent and no further power or pedal changes are necessary, clear yourself and smoothly roll into a turn just as you would from straight-and-level flight.

Maintaining:

You hold the aircraft in the proper degree of bank (usually about 15 degrees) with the cyclic. Do not use the pedals to assist the turn; use them to compensate for the decrease in torque effect. It is important to hold your 40-knot airspeed throughout the turn. Check visual references as in any turn (cockpit references relative to the horizon); if these references are kept constant to the horizon, your airspeed will not vary excessively, and you will maintain your normal descending turn. Cross-check by occasionally glancing at the altimeter and air speed indicator.

Recovery:

Shortly before the completion of your turn, you begin your roll-out by applying a slight pressure on the cyclic away from the direction of the turn. By the time the aircraft is in a level attitude, you should have turned 90 degrees. After your turn is completed, increase your airspeed to 50 knots and increase power to maintain altitude, simultaneously decrease right pedal to keep the aircraft in trim for cruising flight.

Descending Turns from Straight-and-Level Flight:

To establish a descending turn from straight-and-level flight, use the same procedure as to establish a normal descent; but simultaneously coordinate lateral pressure on the cyclic so that the bank and the descent attitude (40-knot attitude) are attained together. If it is perfectly established, the descent and bank attitudes will be attained at exactly the same time. Since this does not always occur, hold whichever one that is attained first and then effect the other.

Recover by rolling out of the bank and simultaneously establishing cruising flight so that as 90 degrees of turn is completed you are flying straight and level.

SKIDS AND SLIPS

In a perfectly coordinated constant bank turn, the aircraft makes a flight path which is a true circle with respect to the area of air in which it is turning. In short, it has a constant radius of turn. (The flight path is not necessarily a true circle over the ground because of the effect of wing drift.) Any variation in its circular path results from uncoordinated control usage or erratic bank.

Skids or slips present no problem in reconnaissance type helicopter during level turns if there is very little or no power change, however, in climbing or descending turns care must be exercised to keep the pedals coordinated with the variance of power. When a turn is initiated from a normal climb or a normal descent you can observe the nose of the aircraft for any yawing to detect improper pedal coordination as the power is changed. You should start to develop a "feel" for applying the proper amount of pedal as power is changed because when a climb or descent and a turn are started simultaneously you cannot readily detect yaw of the nose since the aircraft is already starting to turn as the power is changed. If you do not properly coordinate pedals with changes of power the aircraft will not be trimmed (streamlined) with the flight path and excessive drag will be created by the fuselage causing a decrease in the performance (loss of airspeed, slower rate of climb, or increased rate of descent) of the aircraft. It is important that you learn to coordinate pedals and collective pitch automatically, for the more advanced maneuvers you will practice later will require that you effect control movements positively and smoothly while directing your attention to something else.

Skids:

A skid occurs when the aircraft slides sideways away from the center of the turn. It is caused by too much pedal pressure in relation to the amount of cyclic pressure used. In other words, if you try to force the aircraft to turn faster without increasing its degree of bank, the aircraft will skid sideways away from its radius of turn: that is, instead of flying in its normal curved pattern, it will fly a straighter course.

In right climbing turn, if insufficient left pedal is applied to compensate for increased torque effect, a skid will occur; in a left climbing turn, if excessive left pedal is applied to compensate for increased torque effect, a skid will occur.

In a right descending turn, if excessive right pedal is applied to compensate for decreased torque, a skid will occur; in a left descending turn, if insufficient right pedal is applied to compensate for the decreased torque effect, a skid will occur.

A skid may also occur when you are flying straight and level if the nose of the aircraft is allowed to move sideways along the horizon when the aircraft is level. This condition would occur when pedal pressures are held or when the aircraft is improperly trimmed.

Slips:

A slip occurs when the aircraft slides sideways toward the center of the turn. It is caused by an insufficient amount of pedal in relation to the amount of cyclic used. In other words, if you are holding improper pedal and keeping the nose from following the turn, the aircraft will slip sideways toward its center of turn.

In a right climbing turn, if excessive left pedal is applied to compensate for the increased torque effect, a slip will occur; in a left climbing turn, if insufficient left pedal is applied to compensate for the increased torque effect, a slip will occur.

In a right descending turn, if insufficient right pedal is applied to compensate for the decreased torque effect, a slip will occur; in a left descending turn, if excessive right pedal is applied to compensate for the decreased torque effect, a slip will occur.

A slip may also occur in straight-and-level flight if one side of the aircraft is low (other than unbalanced lateral loading), and the nose is held straight by pedal pressure.

Things to Remember:

A skid occurs when the nose (rate of turn) is turning too fast for the amount of bank.

A slip occurs when the nose (rate of turn) is turning too slow for the amount of bank.

HOVERING OVER A FIXED SPOT

Preparatory:

This maneuver requires a high degree of concentration and coordination. When hovering, you keep the helicopter over a spot by using the cyclic control stick, and govern altitude by the use of collective pitch. A constant heading is kept by using the anti-torque pedals. Only by the proper coordination of all controls can you achieve successful hovering flight.

All control corrections should be pressure movements rather than abrupt movements. This is necessary to prevent overcontrolling, which is the most common fault of the new helicopter pilot when learning to hover.

In hovering, as in straight-and-level flight, the attitude of the helicopter is again the governing factor which determines the aircraft's movement over the ground. In the early stages of your training, your instructor will head the helicopter into the wind and trim the cyclic while maintaining approximately three feet of altitude. Check the visual references in the cockpit relative to the horizon, this attitude will keep the aircraft hovering over a spot. Direct your attention well out in front (about 50 feet) of the aircraft, and do not stare directly at the ground near the aircraft. When you are looking in too close it is difficult to detect changes in attitude and you will also tend to over-control because of attempting to correct every little movement of the aircraft. Your primary concern when you first practice hovering is to keep the aircraft under control and not to be hovering absolutely motionless.

Your instructor will probably demonstrate and allow you to practice using the controls individually and as you increase your proficiency, he will have you use all controls while hovering.

Usually while you are hovering you will have to maintain some left pedal because of the high power setting required to hold the aircraft at a hover, also there is no streamlining effect of the fuselage as in forward flight, so it is usually a matter of relaxing a little left pedal pressure to turn right. Vary the pedals as necessary to maintain a constant heading.

Maintaining:

Hovering altitude is maintained by use of the collective pitch, coordinated with the throttle to maintain a constant 3200 RPM. The amount of collective pitch needed to maintain three feet hovering altitude will vary under different conditions of wind, air density, and gross weight. When a steady wind is blowing, it is not necessary to manipulate the collective pitch a great deal to hold three feet of altitude. Notice how the ground looks while you are hovering at three feet. When the aircraft starts to settle, you will notice that objects on the ground become more level with your line of sight, and when the aircraft starts to climb, your line of sight becomes steeper. When you notice the aircraft start to settle, apply a light upward pressure on the collective pitch, and if necessary, squeeze on throttle to maintain 3200 RPM and add left pedal pressure to counteract for increased torque effect. When the aircraft starts to climb, apply a slight downward pressure on the collective pitch and, if necessary, squeeze off throttle to maintain 3200 RPM and relax some left pedal pressure to remove some of your torque correction.

The cyclic is used to maintain your fixed position over the ground. The aircraft will not move if it is in a level attitude for the load distribution of this particular helicopter and the presently existing wind. Notice the relationship of the top of the console and other cockpit reference points to the horizon. As long as the reference points remain in this relation to the horizon the aircraft will be in a level attitude and will not move over the ground unless there is a variation in wind. In order to hover the aircraft you have to hold this attitude with the cyclic.

If the level attitude changes to a nose-low attitude, the aircraft will start to move forward. Notice the relation of the console to the horizon in the nose-low attitude. To stop the forward movement of the aircraft, you bring the nose back to a level attitude by applying a slight aft pressure on the cyclic. When the nose reaches the level attitude, the aft pressure on the cyclic is relaxed and the aircraft will drift to a stop.

If the level attitude changes to a right-side-low attitude, the aircraft will start to move sideward. Notice the relation of the console top and other cabin reference points to the horizon in the right side low attitude. To stop the sideward movement of the aircraft, you apply a slight left pressure on the cyclic. When the aircraft returns to the level attitude, the left pressure is relaxed and the aircraft will drift to a stop.

The same technique is used when the aircraft gets into a left-side-low or nose-high attitude.

Notice that there is a lag between the time that the aircraft gets into a nose-low attitude and the beginning of forward movement over the ground. In order to hover the aircraft without forward movement, it is necessary to recognize a nose-low attitude and correct for it before the aircraft starts to move forward. When the aircraft starts to go into a nose-low attitude, bring the aircraft back to the level attitude before it starts to move forward. In this way by detecting changes away from the level attitude, you can maintain your position.

The same technique is used to prevent sideward or rearward movement.

The coordination of all controls when hovering cannot be over-emphasized. Any change on one control almost always requires a coordinated correction on one or more of the other controls. Hovering can be accomplished with precision only when corrections are small, smooth, and coordinated.

HOVERING TURNS: RIGHT

Preparatory:

You get set up at a hover approximately three feet above the ground with the aircraft headed generally into the wind. Maintain normal operating RPM.

Before starting your turn, pick out two objects that are in line 90 degrees to your right. When you complete your 90 degree turn, you should be lined up with these objects.

Entry:

To start your turn, add a little right pedal - just enough pressure to start the nose slowly turning to the right. Since adding right pedal will decrease the pitch on your tail rotor, you will need less power to keep your proper RPM. So, at the same time you add right pedal, you want to squeeze off a little throttle to maintain RPM.

Maintaining:

As you turn more and more to the right, whatever wind there is will be blowing on your left side, and the aircraft will tend to drift downwind. You prevent this drifting by applying a slight left pressure on the cyclic. As you continue the turn keep the cyclic into the wind as required to maintain the same position over the ground.

As you approach the completion of your turn, you relax the pressure on your right pedal, and the aircraft should drift to a stop at a point in line with the two objects you selected before starting the turn.

Return:

When you are ready to recover from your turn, you merely add a little left pedal to start the nose turning back to the left. Since adding left pedal increases the pitch on the tail rotor, you will need more power. Therefore, you want to squeeze on more throttle to maintain your RPM.

As you turn more and more to the left, you will have the streamlining effect of the wind blowing over the fuselage. However, your rate of turn will generally not tend to speed up when turning back to the left, so you usually won't need to put counter-pressure on the right pedal.

As you approach your original heading, add a little right pedal, and you will come to a complete stop. At the same time you want to squeeze off a little throttle to keep your RPM.

HOVERING TURNS: LEFT

Preparatory:

You get set up at a hover approximately three feet above the ground with the aircraft generally into the wind. Maintain normal operating RPM.

Before starting your turn, pick out two objects that are in a line 90 degrees to your left. When you make your 90 degree turn, you should be lined up with these objects.

Entry:

To start your turn, you add a little left pedal - just enough to start the nose slowly turning to the left. Since adding left pedal increases the pitch on your tail rotor you will need more power to keep up your proper RPM. So, at the same time you add left pedal, you will have to squeeze on a little throttle to maintain RPM.

Maintaining:

As you turn more and more to the left, whatever wind there is will be blowing on your right side, and the aircraft will tend to drift downwind. You prevent this drifting by applying a slight right pressure on the cyclic. As you continue the turn keep the cyclic into the wind as required to maintain the same position over the ground.

As you approach the completion of your turn, you relax the pressure on your left pedal, and the aircraft should drift to a stop at a point in line with the two objects you selected before starting the turn.

Return:

When you are ready to recover from your turn, you merely add a little right pedal to start the nose turning back to the right. Since adding right pedal decreases the pitch on the tail rotor, you will need less power. Therefore, you want to squeeze off throttle as you apply right pedal to maintain your RPM.

As you turn more and more back to the right, you will have the streamlining effect of the wind blowing over the fuselage, which will tend to speed up your rate of turn. So you want to apply a little counter-pressure on your left pedal to keep a constant rate of turn.

As you approach your original heading, add a little left pedal and you will slowly come to a complete stop. At the same time you should squeeze on a little throttle to keep your RPM.

HOVERING FLIGHT: FORWARD

Preparatory:

You are set up at a hover three feet above the ground with engine RPM at 3200. Select a near and distant object to line up with as you hover forward.

Entry:

Apply a slight forward pressure on the cyclic to lower the nose of the aircraft below a level attitude. As the nose lowers, the aircraft will begin to move forward.

Maintaining:

You want to hover the aircraft at approximately a walking speed. At this speed you will maintain your ground cushion which will reduce the need for power and pedal corrections. Your ground speed is controlled with your cyclic; altitude is controlled with collective pitch; heading is controlled with pedals.

Recovery:

You stop your forward movement with a very slight aft pressure on the cyclic to level the aircraft. When the nose comes back to a level attitude, the aircraft will drift to a stop.

HOVERING FLIGHT: SIDEWARD

Preparatory:

You are set up at a hover three feet above the ground with engine RPM at 3200 and the aircraft headed into the wind. Before you start sideward hovering pick out two objects in a line 90 degrees in the direction of flight to guide you. Next, make a 90 degree clearing turn in the direction of flight to make sure the path is clear.

To the Right:

Entry:

To begin sideward flight to the right, you apply a slight right pressure on the cyclic which puts the aircraft in a right-side-low attitude. Just after the right side lowers, the aircraft will begin to move sideward to the right.

Maintaining:

It is important that you hover no faster than a man's walking speed. At that speed you will keep your ground cushion which will reduce the need for power and pedal corrections. You control your ground speed with the cyclic. Altitude is controlled by collective pitch. Heading is controlled with pedals.

Recovery:

To stop your sideward movement to the right, you apply a slight left pressure on the cyclic to level the aircraft. When the aircraft has come back to a level attitude, it will drift to a stop.

To the Left:

Entry:

To begin sideward flight to the left, you apply a slight left pressure on the cyclic which puts the aircraft in a left-side-low attitude. Just after the left side lowers, the aircraft will begin to move sideward to the left.

Maintaining:

Be sure that you hover no faster than a man's walking speed. At that speed you will keep your ground cushion which will reduce the need for power and pedal corrections. You control your ground speed with cyclic. Altitude is controlled by collective pitch. Heading is controlled with pedals.

Recovery:

To stop your sideward movement to the left, you apply a slight right pressure on the cyclic to level the aircraft. When the aircraft has come back to a level attitude, it will drift to a stop.

TAKE-OFF TO A HOVER

Preparatory:

Before you pick the aircraft up to a hover, check carefully for any nearby obstructions - fore, aft, or to the sides.

With your collective pitch all the way down, pedals and cyclic in the neutral position, bring the engine RPM up to 3200. As the helicopter breaks ground add left pedal to maintain a constant heading. You can expect the aircraft to yaw to the right due to increased torque.

It is important to keep a constant heading when you break ground. Lining up with an object that is near to the aircraft and with one that is farther away will help you to do this. Direct your vision about 50 feet in front of the aircraft. You will be tempted to stare down at the ground. Try to avoid this.

Entry:

Maintain your engine RPM at 3200 and then apply a smooth, slow, upward pressure on the collective pitch maintaining normal RPM until the aircraft is light on the skids.

Once the aircraft is light on the skids, it will tend to turn to the right or left depending on how much pressure you put on the left pedal. Usually a slight adjustment of the pedals will get you back on your heading. It is also important to eliminate any skidding over the ground before you continue your ascent, this is always done with small adjustments of the cyclic; ordinarily you will have to apply a slight amount of aft cyclic to make a vertical ascent.

When you are more experienced, you will be able to make these corrections without hesitating in your ascent from the ground. However, as a beginner it is best to hesitate momentarily to get the aircraft set up for vertical ascent.

Maintaining:

When you have the aircraft set up, continue the upward pressure on the collective pitch until you break ground. In most cases this amount of pressure will be sufficient to raise the aircraft to three feet. On your way up to three feet, make the necessary throttle adjustments to keep your RPM. At the same time maintain your position over the ground with your cyclic and keep your heading with your pedals.

Guard against the tendency to apply collective pitch abruptly. If you jerk the aircraft off the ground, you won't be able to hold your RPM. Just take it slow and easy.

Termination:

As you reach an altitude of about three feet, ease off the pressure on your collective pitch until the aircraft sets at a hover. Check for proper engine RPM.

LANDING FROM A HOVER

Preparatory:

You have your hovering position approximately three feet above the ground with the helicopter headed generally into the wind. Keep your line of sight directed at a point about 50 feet in front of the aircraft. Don't stare directly down at the ground. An occasional glance should be enough.

Entry:

You begin your descent by applying a slight but continuous downward pressure on the collective pitch. As you descend, you squeeze off throttle to keep your engine RPM normal and put in a very slight amount of right pedal to maintain your heading.

Maintaining:

You continue to apply a smooth downward pressure on the collective pitch so that you will have a constant rate of descent to the ground. When you have reached a point about 4 to 6 inches from the ground, the effect of your ground cushion will become very noticeable. The aircraft will tend to stop at this point, and you will have the feeling that it is trying to slide off its ground cushion. A lot of students over-control the cyclic at this point to try to resist this sliding sensation.

After practicing this maneuver, you will find that you don't need to make large corrections with cyclic. Just continue your positive downward pressure on the collective pitch, and the aircraft will move through this cushion effect to a touchdown.

Termination:

When the skids touch the ground, lower your collective pitch smoothly and firmly to the full down position and reduce enough throttle to keep from overreving. Add right pedal as needed to maintain heading. At the same time apply a slight forward pressure on the cyclic so that the aircraft will stay firmly on the ground and the main rotor will be tilted away from the tail boom.

Things to Remember:

Watch for tenseness and tightly gripping the controls. If you find yourself becoming tense, take a deep breath and relax completely as you exhale.

Constantly cross-check all visual reference points. Hover the aircraft by maintaining a constant attitude.

Fly by pressures on the controls, and not movement of the controls. A series of small corrections are better than one large correction.

TAXIING

Purpose:

Taxiing is the movement of the helicopter under its own power on the ground. You may think that this is a very simple operation which requires little skill, but this is not true. You, as a pilot, must be alert at all times and be an expert at handling the controls. Most ground accidents are caused by failure to exercise alertness and in most instances they could have been avoided by being careful. A taxi accident is one of the worst offenses you can commit as there is absolutely no excuse for not being careful. The following points will help you taxi safely.

When in an area that is restricted by obstructions, it will be necessary to taxi the helicopter to a point from which hovering flight can be accomplished safely. The aircraft should be taxied slow enough to permit stopping immediately if an emergency arises.

Technique:

With engine at 3200 and the collective pitch full down, move the cyclic slightly forward of the neutral position and apply a slight upward pressure on the collective pitch to start you moving forward along the ground. Use your pedals to maintain heading and your cyclic to maintain ground track. Most students learn to handle the collective pitch and pedals fairly well but often apply excessive forward cyclic. Remember, only a slight amount of forward cyclic is required.

Collective pitch controls starting, stopping, and rate of speed while taxiing. The higher the collective pitch the faster you go. Beginners have a tendency to taxi too fast. Avoid this tendency, do not taxi faster than the speed of a normal walk.

If you have a cross-wind, you will have to hold the cyclic into the wind to keep your ground track. If the aircraft should start to tip, lower the collective pitch immediately and make the necessary cyclic corrections. Be sure to maintain normal RPM until you have come to a complete stop.

Things to Remember:

Divide your attention; watch in front of you, and on both sides of your aircraft.

Use courtesy and common sense in respect to the rotor wash.

Parking Procedure, OH-23D:

The helicopter should be parked with the wind from the right rear, approximately 135 degrees from the nose of the aircraft. If winds are high, land the helicopter into the wind then taxi the helicopter around terminating with the wind from the right rear.

"S" TURNS ACROSS A ROAD

Purpose:

This is a maneuver in which the ground track of the aircraft describes a half circle on both the upwind and downwind sides of a road by correcting for wind drift, while maintaining a constant air speed and altitude.

Preparatory:

Before starting the maneuver, you should evaluate the existing wind condition and velocity. Next choose an appropriate reference line such as a straight road, fence, section line or any predominant feature on the ground. This reference line should be as nearly as possible 90° to the wind and of sufficient length to accomodate several alternate right and left banked turns. Your selection should be over relatively open terrain and with good forced landing areas within reach.

Entry:

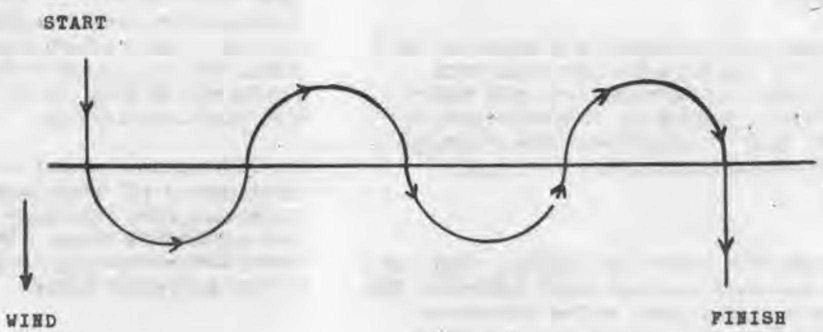
At cruising airspeed and at an altitude of 500 ft. above the ground, position yourself so as to approach the road going downwind, 90° to the reference line, straight and level. Just as the aircraft is over the reference line, initiate a degree of bank commensurate with the wind velocity that will accomplish a radius of turn of approximately 1/8 mile. The stronger the wind, the steeper the initial bank will have to be in order not to be drifted beyond the maximum radius. As the turn progresses and the aircraft starts heading back into the wind, the bank will have to be shallowed in order to accomplish a constant radius of turn. As the aircraft approaches the road, upwind, you should be completing a 180° turn of constant radius. Just as the aircraft is over the road, you roll from one bank to the next and prepare to execute another 180° turn on the upwind side of the road, equal in radius to the previous turn. The same procedure is followed from one turn to the next, shallowing or steepening the bank as necessary to compensate for wind drift.

It is advisable to be looking ahead of the aircraft's flight path and select predominant features on the ground that approximate a uniform radius of turn. The best features to select should be at the apex of the turn and the next point of interception on the road.

Things To Remember:

Divide your attention; watch in front of you and all sides for other aircraft.

Correct airspeed and altitude errors before they seriously affect the maneuver.



(1) Start the take off from a normal hover -- (three feet above and three feet behind the take-off panel).
Hover forward slowly, increasing forward speed, Maintain 3200 RPM and a 3' hover.

(2) If necessary apply additional power to maintain a 3' hover.
When the aircraft has accelerated to approximately 15 K. (translational lift) it will begin to climb on its own.
Additional forward cyclic will be required to continue acceleration to this point. Obtain an attitude that will allow a constant build of airspeed to 40 K.
Maintain 3200 RPM at all times in the take off. Establish the manifold setting at 23" (24" Dual), as soon as possible after the climb is commenced. Decrease left pedal as your airspeed increases.

(3) At about 50' let the aircraft go into a crab.

(4) At 70' to 100' you should reach 40 K. Again check the normal climb settings of 3200 RPM, 40 K airspeed and 23" (24" Dual) of manifold pressure.

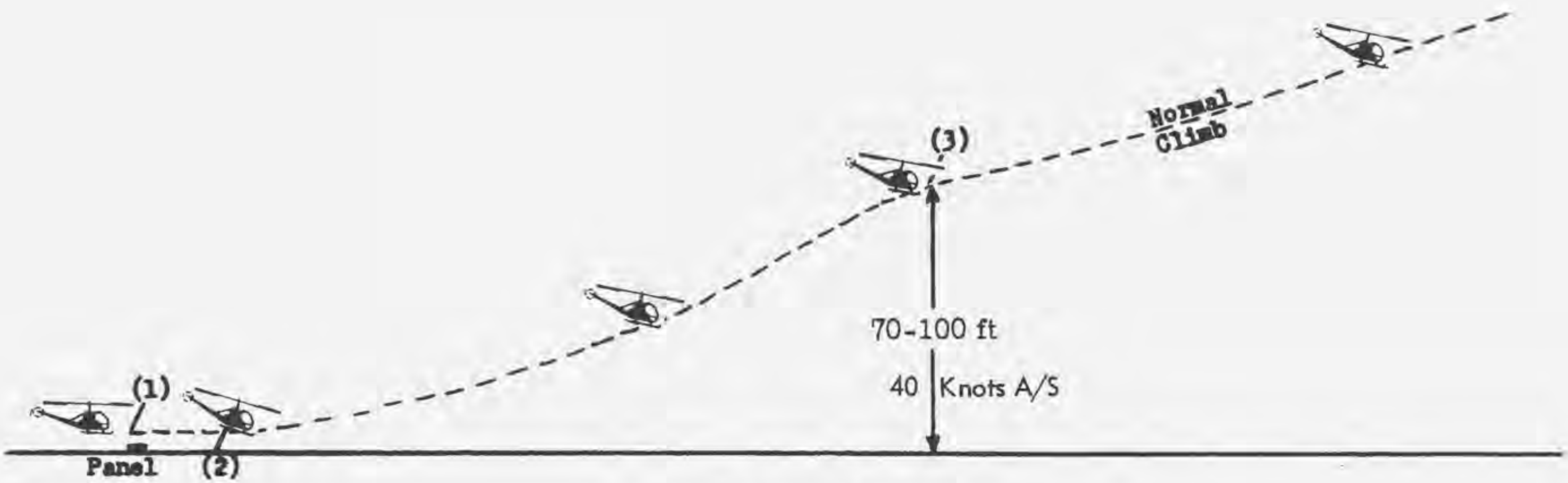


Figure 3

PAY ATTENTION TO INSTRUCTION

CHAPTER IV

PRE-SOLO STAGE FIELD MANEUVERS

NORMAL TAKE-OFF

The normal take-off will be made in the majority of cases. In order that the normal take-off may be accomplished safely, sufficient power to hover must be available and there must be no barriers in the flight path to restrict normal climb.

Preparatory:

Since normal take-off is executed from a hover, the conditions of flight are the same as for hovering. You are set up at a hover approximately three feet above the ground. Select two points along your intended take-off path that you can line up with. These guide points will be very helpful if you have a cross-wind that causes you to drift off your ground track. Next, make a clearing turn to make sure there are no aircraft near enough to prevent a safe take-off. Before starting to move forward, be sure your RPM is 3200 and your engine instruments are all in the green.

Entry:

To start moving forward, apply a very slight forward pressure on the cyclic. Apply just enough cyclic so that the aircraft starts to move over the ground. It is easy to make the mistake of applying to much cyclic which results in a nose-low attitude. With the nose too low, the aircraft will gain airspeed too rapidly and tend to settle just after you move off your ground cushion.

Usually, when you move off the ground cushion you may have to increase a little collective pitch to maintain your three feet of altitude. At the same time you will have to squeeze on the throttle to maintain RPM. You may also need to apply a little left pedal.

As you accelerate to effective translational lift (at an airspeed of approximately 15 knots), the aircraft will begin to climb, and the nose of the aircraft will tend to come up due to the increased lift. At this point you should apply enough forward cyclic to overcome this tendency. Hold an attitude that will allow a smooth acceleration up to 40 knots. Otherwise, your airspeed will not build, and you will not have a smooth acceleration in your take-off.

As you begin your climb, adjust the manifold pressure to the normal climb setting of 23 inches, (24 inches dual). In order to do this you may have to reduce or increase your power slightly at this point.

If you have a cross-wind, the aircraft is flown in a slip. That is, you keep your heading straight along the take-off path with pedals, but you hold the cyclic into the wind the amount necessary to make good your ground track over your guide points.

Maintaining:

Continue to build your airspeed up to 40 knots decreasing left pedal as your airspeed increases. Try to coordinate your increase in airspeed with your rate of climb so that you reach 40 knots at 70 to 100 feet.

When you reach an altitude of about 50 feet, you allow the aircraft to go into a crab. You can be sure you have the right amount of crab if you are making good your ground track over your guide points and the aircraft is level laterally.

As your airspeed approaches 40 knots, apply a slight amount of rear cyclic to get the aircraft into a 40-knot attitude and continue your normal climb.

Recovery:

When you reach an altitude of 300 feet, you make a climbing turn to your cross-wind leg and continue your normal climb to 500 feet.

(See Fig. 3)

Things to Remember:

Divide your attention; watch your aircraft's attitude and maintain proper ground track.

Gain airspeed and altitude simultaneously to avoid being in a critical position should your engine fail.

As your airspeed increases, the streamlining of the fuselage will offset engine torque effect requiring a gradual reduction of left pedal.

The object in making a normal take-off is to use a minimum of power to attain effective translational lift and without letting the aircraft settle as you move forward; so don't kill the effect of the maneuver by lowering the nose excessively to initiate forward movement, or by applying power to commence a climb before effective translational lift is reached.

TRAFFIC PATTERNS

(See Fig. 4)

When a number of aircraft are operating from the same field, it is absolutely necessary that each conform to some systematically established 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 for the fields from which you will fly.

To give you practice in take-offs, landings, and traffic patterns, your instructor will require you to fly to one of the auxiliary fields, and participate in concentrated training along with the other students in your class. Actually, most of your traffic pattern work will be practiced at the auxiliary fields, especially during the pre-solo and primary stage of training.

The ultimate goal of your flight line instructor is to train you to become a highly proficient pilot, capable of analyzing the factors of any situation and making correct decisions. He does not want you to be a sterotyped, mechanical pilot, who must rely on the analysis and decisions of others. 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 downwind leg over the highway," and "Make your base leg turn over the gravel pit."

It is important for you to realize that the instructor is using these things as instructional aids. Any time he gives you a ground reference, he means that it is appropriate for an average wind condition assuming that your altitude and airspeed are proper. He does not mean that they will be applicable for all landing situations. You should use these instructional aids to help you develop a keen sense of judgement. Remember that highways and gravel pits will not move with you to your next stage field. Therefore, you must be able to estimate distance and flight speed by selecting your own ground reference regardless of the destination.

The most prominently used landing pattern is the rectangular pattern. It will be used primarily during concentrated landing practice at auxiliary fields in your pre-solo and primary stage of training, as well as during all night flying.

Before entering traffic, check for proper radio channel and that volume is turned up. Do not ask for landing information unless there is a valid reason to do so. Normally the landing direction will be determined by watching other aircraft. Traffic pattern altitude should be reached before turning onto entry leg.

45° Entry Leg:

Enter the landing pattern on a course 45° to the downwind leg, so that the actual entry will be accomplished within middle 1/3 of the downwind leg. This will allow you to have a downwind leg of sufficient length to make corrections in flight attitudes. It will also allow you to anticipate the need for drift corrections, spacing in relation to other aircraft, and the execution of the turn onto the base leg.

On this leg of the traffic pattern, as well as all others, look for wind-drift and make necessary corrections so that a constant track across the ground will be maintained. Adjust your spacing to other aircraft so that you will know positively that they will not interfere with your pattern. Remember that if you are too close to an aircraft on the entry or downwind leg, you are certainly going to be too close on the final approach.

Downwind, Base, and Final Leg:

The turn from the entry to the downwind leg should be executed so that the ground track is parallel to the landing lanes. Fly at 50 knots and 500 feet for the entire downwind leg. There is no set point at which you turn on base leg. This will depend on the spot on which you intend to land and the number and location of other aircraft in the pattern. Initiate the base leg turn, and start descending to 300 feet simultaneously reducing airspeed to 40 knots. (500 ft.-50 Knots, 400 ft.-45 Knots, 300 ft.-40 Knots). At the same time increase RPM to 3200. Plan the descent to arrive at 300 ft. and 40 knots, using 2/3 of the length of the base leg, while maintaining a ground track perpendicular to the stage field. Plan the base-to-final turn just as you planned the downwind-to-base turn. This is a level turn. Plan the roll-out so that the turn will be completely recovered just as aircraft is aligned with the lane.

Once you are aligned with a lane, you are committed to the lane. Under no conditions are you allowed to cross over to adjacent lanes. Approaches are normally made to the upwind panel in your lane, however, never land beyond a helicopter in your lane. Panels on the lane are numbered 1, 2, 3 and 4. Panel 1 is always the closest panel to you while on final.

Take-Off and Cross-Wind Leg:

The normal climb after take-off is the first leg of the traffic pattern, You climb at 40 knots straight ahead until you reach 300 feet. At 300 feet you make a 90-degree ground track climbing turn to your cross-wind leg. Fly the aircraft in a crab if you have to make drift corrections. At about 450 feet, apply a very slight amount of forward pressure on the cyclic to slow your rate of climb. You should apply just enough cyclic to let the helicopter level off at 500 feet. Your airspeed will also start building up as you start levelling off. Keep your RPM at 3200 and your manifold pressure at 23" (24" dual) until the airspeed reaches about 50 knots. At this point if you have proper spacing, start your turn onto the downwind leg and reduce your power to 3100 RPM and the manifold pressure necessary to maintain 50 knots. You should roll out on the downwind leg on a ground track parallel with the runway. (See Fig. 4)

Go-around Procedures:

A normal climb straight ahead (avoiding flight over any aircraft) will be established, and the control supervisor advised of the go-around. The climb will be continued to traffic pattern altitude: aircraft either will exit traffic or remain in closed traffic as directed by Control Supervisor.

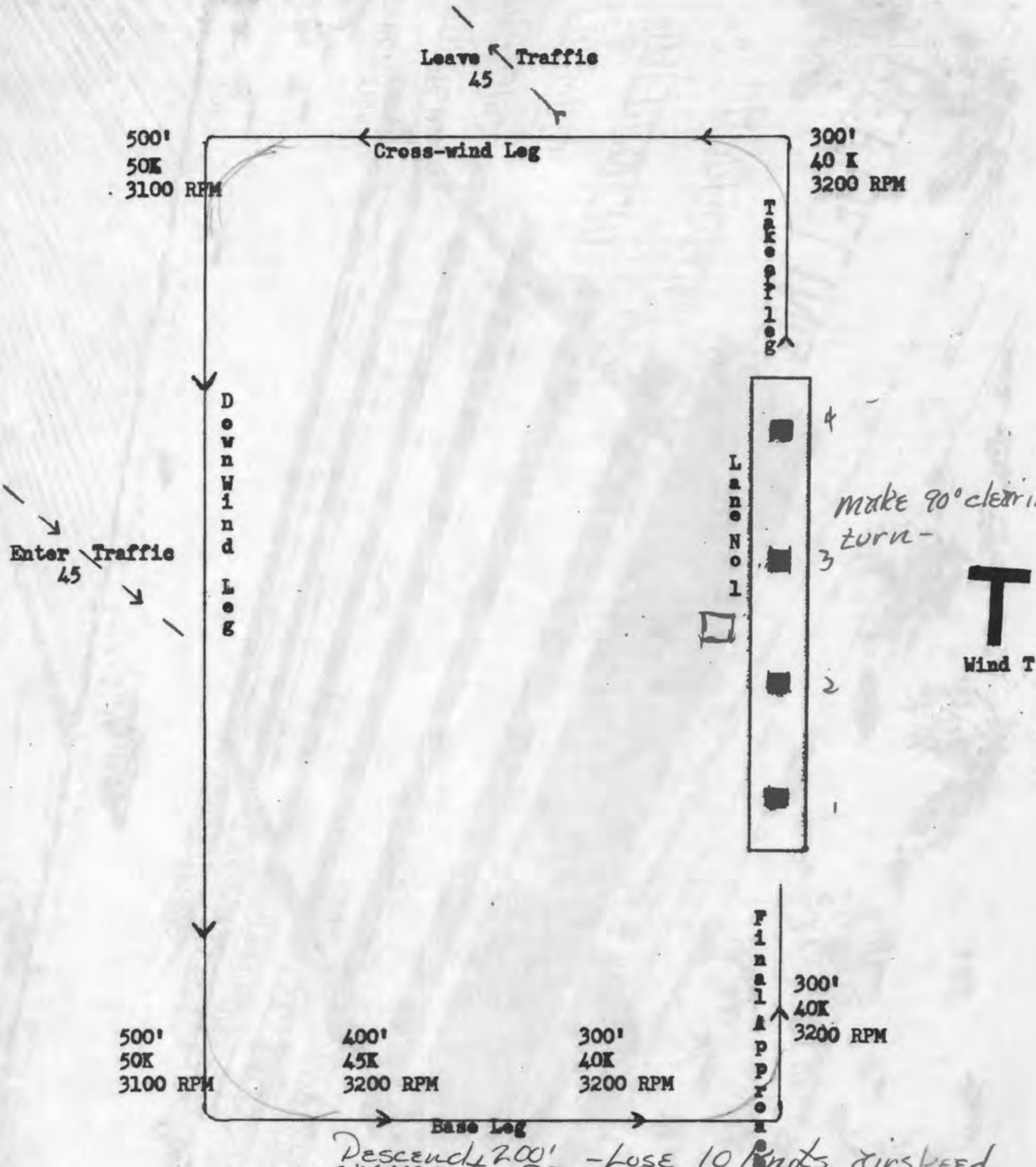
Tips:

Before and during the entry into the traffic pattern, you must think ahead and plan ahead of the aircraft. You must: determine the direction of the landing and analyze the wind conditions by checking the tetrahedron, wind sock, smoke, or any other indicator available; determine the number of aircraft in the traffic pattern. Continue to analyze the wind condition and traffic spacing throughout the remainder of the pattern.

Since the wind direction and velocity have a tremendous effect on your traffic pattern and landing, it is extremely important that you know how to recognize and gauge its surface speed. It's direction and to some extent it's velocity, can be determined from the tetrahedron, wind sock, smoke, or blowing dust. The Control Tower transmits unusual weather and wind reports, so monitor the Tower for latest developments.

When the wind sock is hanging limply straight down, the wind condition is calm or very light. When it is standing straight out parallel to the ground, the wind is strong and steady. When a wind sock is alternately rising and falling, it indicates that the wind is also rising and falling. This is known as a gusty wind. The more rapidly it rises and falls, the gustier the wind.

When the wind sock is swinging from side to side, it indicates that the wind direction is shifting from various angles. This is known as vari-



STANDARD TRAFFIC PATTERN FOR STAGE FIELDS

Figure 4

Ground track over ground
turn with constant shallow bank
terminate at 3' hover
approach angle 12° (sight picture)
control rate of closure with cyclic; angle with pitch

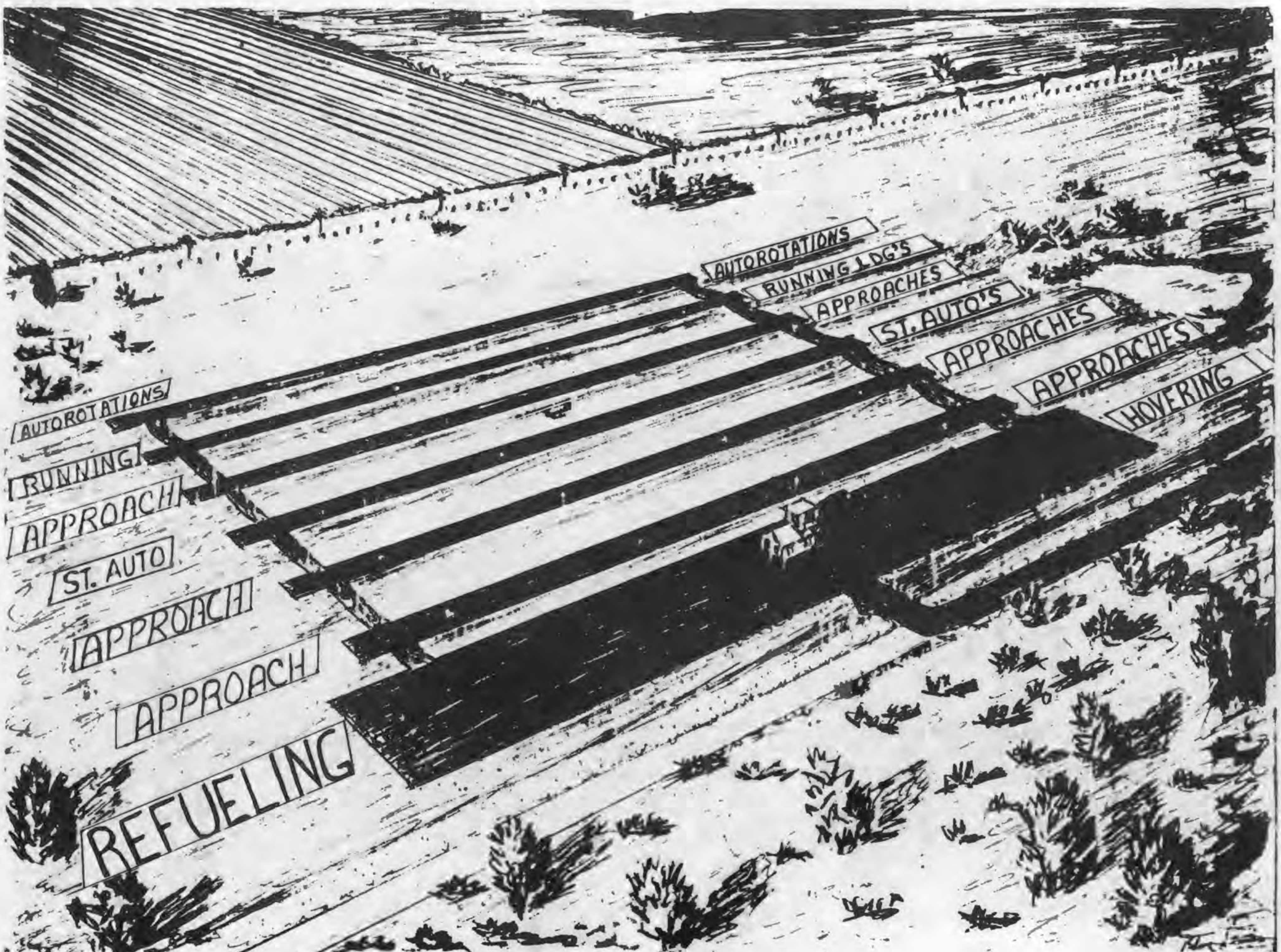

AUTOROTATIONS
RUNNING LDG'S
APPROACHES
ST. AUTO'S
APPROACHES
APPROACHES
HOVERING
AUTOROTATIONS
RUNNING
APPROACH
ST. AUTO
APPROACH
APPROACH
REFUELING

Figure 4a

able wind condition. If the sock is rising and falling as well as swinging from side to side, it indicates a wind condition that is both gusty and variable.

Smoke is also a good indicator of wind direction and velocity and should be used, when present, to check the accuracy of the tetrahedron and wind sock. When the smoke is rising straight up, it indicates a calm or very light wind condition. When it is lying flat along the ground, it usually indicates a strong wind; however, a temperature inversion may cause a similar occurance. Since smoke swirls, eddies, and spirals as it rises, it will not give as good an indication of a variable or gusty wind condition as does a wind sock, so always check the wind condition by as many methods as possible.

Things to Remember:

Be conscious of the wind drift at all times. Check for drift on each leg of the pattern. Maintain a constant track across the ground.

Account for the number of aircraft ahead of you in traffic. Be sure there is plenty of space between your aircraft and the one in front of you.

Always consider the effect that the surface wind may have on your approach.

Keep your aircraft properly trimmed so that you can relax and "feel" the pressure on the controls.

NORMAL APPROACH

You will learn to perform basic approaches during your flight: normal, steep, and to the ground. You will learn the normal approach first, and it will be used most of the time during your flying, so learn it well.

All approaches must be made to a predetermined point and are regarded as precision approaches. Inasmuch as rate of descent and airspeed are independently controlled, precision approaches are not difficult and little tolerance should be given to overshooting or undershooting the selected landing point.

Preparatory:

Before starting an approach, you should evaluate the existing wind conditions. The wind direction and velocity will determine the direction of your approach in most cases. Generally, the approach is made into the wind, and is started at an airspeed of 40 knots in winds of 0 to 13 knots. A proportionate increase in airspeed should be made in winds of higher velocity. For example, if the headwind is 14 to 20 knots, your airspeed should be approximately 45 knots; if the headwind is 20 to 25 knots, your airspeed should be 50 knots, and so forth. The angle of descent remains constant regardless of wind velocity, so in your evaluation of the wind conditions you plan the entry of the approach to start the descent at the proper angle.

During the pre-solo and primary stages you will concentrate your practice of normal approaches at a stage field. On base leg, slow the aircraft to 40 knots, simultaneously losing altitude until you are down to 300 feet. Pick out the lane in which you intend to land and the panel you will approach. Be sure to make these decisions on base leg so you will be free to get the aircraft set up, with the proper attitude, altitude and RPM, on your final approach. As you turn onto your final approach, line up with the lane you have already selected and make sure that you maintain a straight ground track in line with your approach panel. You can do this by observing the relation between your flight path and the boundaries of the lane.

In the pre-solo stage the approach is made in a slip if you have a crosswind. As you become more experienced, a crab or a combination of a slip and crab may be used for most of the approach and a slip must be used for the last 50 feet.

The normal approach is basically a power glide controlled approach made at an angle of descent of approximately 12 degrees. To determine this 12-degree angle of descent you use a "sight picture", i. e. with the aircraft in a 40-knot attitude and the approach panel in the sight picture position on the bubble of the aircraft. This sight picture will be demonstrated by your instructor by letting you observe the panel relative to your visual reference points in the cockpit. It will vary for different height people and you will have to learn what the sight picture is for you by practice.

The sight picture will not be accurate if the aircraft is not in the proper attitude; it is important that you maintain 40 knots and 300 feet on final so that you can pick up your sight picture with the aircraft in the correct attitude.

Entry:

During the first part of your final approach leg, your panel will appear well up on the bubble. As you continue flying up final, the panel will slowly move down the bubble until it is at the normal approach sight picture position.

Just before you reach your normal approach sight picture, firmly and positively reduce collective pitch to start the descent. The amount you lead the entry into the approach will be determined by the existing wind conditions, i. e. in a light wind you must reduce the collective pitch sooner than in a stronger wind. You should always evaluate the wind and its effect on your forward ground speed as you fly up the final leg and anticipate the entry to the approach. The initial airspeed (40 knots) should be maintained until the descent is started. Reduce throttle, if necessary, to maintain 3200 RPM, simultaneously add right pedal to maintain your heading as collective pitch is reduced. When you have completed these control changes, you should be on a 12 degree line of descent to the panel.

During the approach, corrections for vertical deviation from the desired flight path should be made immediately by proper application of collective pitch. The cyclic control is used to regulate groundspeed. Airspeed and altitude usually are dissipated simultaneously during the descent. This is called "power glide control."

Maintaining:

In the initial part of the approach momentarily use the sight picture to visualize the 12-degree line of descent. As you look down the line of descent to the panel, at the start of the approach, your ground speed will appear to be that of a brisk walk. You want to keep this same apparent ground speed all the way down to the panel. When you reach a point on the approach where the ground speed appears to be increasing, begin to decelerate by applying a slight amount of aft cyclic to maintain a constant apparent ground speed. The point where the deceleration is started will vary with different wind conditions. In light wind conditions you normally start to decelerate immediately as the descent is started, the higher the velocity of the wind the longer you must maintain the initial airspeed before decelerating to maintain the proper apparent ground speed.

After you begin decelerating, the panel will not remain stationary in the normal approach sight picture position because you are descending and changing the attitude of the aircraft, and the panel will not remain in the same position in relation to your cockpit reference points. You must visualize the desired line or angle of descent as you initiate the approach and be alert for deviations from the desired line of descent during the approach. If you fall below your desired line of descent, the panel will appear to be moving away from you, and the termination point is short of the panel. If you are above your 12-degree angle, the panel will appear to be moving toward you and the termination point is beyond the panel.

Termination:

In the last portion of the approach, due to the slower airspeed, you must apply additional power to compensate for the decrease in translational lift and to maintain the proper angle of descent. Usually you must simultaneously apply a slight forward cyclic pressure to maintain an apparent ground speed of a brisk walk. The application of collective pitch should be a smooth pressure coordinated with throttle application and phasing in left pedal. You should build up your power gradually, so that when you reach the hovering position, you can hover with little or no additional application of pitch and power. The helicopter should terminate with a level attitude in a position three feet above and three feet behind the panel.

(See Fig. 5)

Things to Remember:

Complete all adjustments to ground track, RPM, airspeed, and altitude on the final leg in sufficient time so that all of your attention may be given to planning the entry as the panel nears the sight picture position.

The angle of descent and rate of descent are primarily controlled by the collective pitch, and the ground speed (rate of closure) is primarily controlled by the cyclic control. However, any correction on either of the two will affect the other; therefore, all corrections for angle of descent, rate of descent and ground speed (rate of closure) must be coordinated to produce the desired result.

Make RPM corrections smoothly to avoid excessive yawing.

Keep the aircraft in a near-level attitude during the termination to avoid the possibility of the tail rotor striking the ground.

Closely cross-check the angle of descent and apparent ground speed during the approach to detect deviations quickly. The sooner a correction is started the easier it will be to make.

If you over-arc or let the angle of descent become too steep, either make a go-around or land beyond the original point of intended landing.

HOVERING AUTOROTATION

Purpose:

Hovering autorotation, as the name implies, is performed from a hover. It is not a difficult maneuver to perform; however, if it is not properly executed, the aircraft can be damaged extensively. You are required to become proficient in hovering autorotations so that you will automatically make the correct response when confronted with an in-flight mechanical failure.

Preparatory:

To practice hovering autorotations, set the aircraft up at a three foot hover headed into the wind. Stabilize the helicopter so as not to have any movement over the ground. Hold 3200 RPM. Focus your vision well out in front of the aircraft. Do not stare directly at the ground.

Entry:

To enter autorotation, close the throttle quickly to insure a clear split of the needles. As you close the throttle, apply enough right pedal to maintain your heading; usually a slight amount of right cyclic will be necessary to keep you from drifting. In any case apply cyclic as required to insure a vertical descent. Unlike most autorotations, the collective pitch is not lowered at the start of the maneuver. Leave the pitch where it is on entry.

Maintaining:

For a moment after the throttle is closed, the inertia of the rotor system will hold the aircraft at altitude. As the rotor RPM decreases, the aircraft will start to settle. Keep a level attitude with the cyclic and hold the heading with the pedals. The pitch is held constant.

Landing:

As the aircraft approaches an altitude of approximately one foot above the ground, apply a positive upward movement on the collective pitch to slow your descent and cushion your landing. The timing on this pitch application has to be just right for a smooth landing.

NORMAL APPROACH

(1) Fly final at 300', 3200 RPM, 40 K., on lane center line.

(2) Using a 12° angle sight picture, enter by lowering pitch to start a descent. Maintain 3200 RPM by squeezing off throttle as pitch is lowered, hold nose straight with lane using pedals. Note ground speed (apparent movement speed). Begin constant deceleration to panel. Keep same apparent ground speed. (Speed noted at entry--apparent brisk walk).

(3) When sufficiently slowed to cause loss of translational lift, start applying pitch to maintain angle of descent. The last 1/3 of approach is a decelerating hover to the panel. Squeeze on throttle to maintain 3200 RPM adding what pedal that is necessary to keep the nose straight with the lane.

(4) Terminate 3' above and 3' behind the approach panel, (a normal hover).
Maintain 3200 RPM, hold nose straight with pedals.

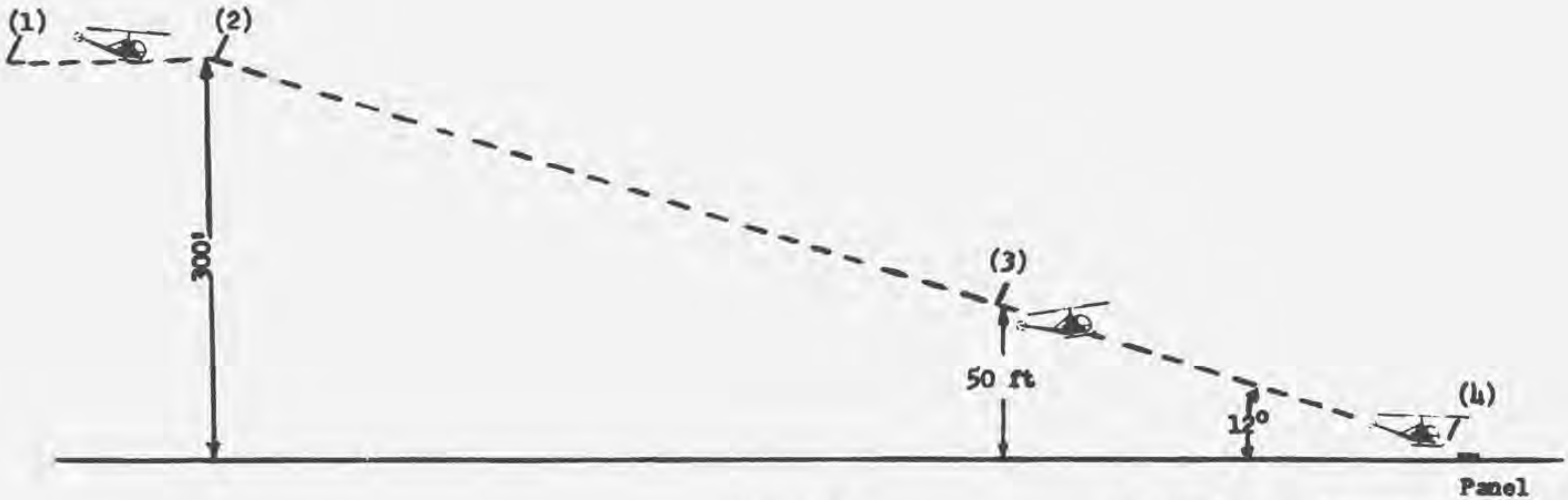


Figure 5

constant angle approach

More often than not, beginners will apply collective pitch too soon. When the skids first touch the ground, apply a slight amount of forward cyclic, as the aircraft tends to rock backwards if the cyclic is left in the neutral position. When the weight of the helicopter is entirely on the skids, you stop pulling the collective pitch. When the aircraft has come to a complete stop, lower the collective pitch all the way to the bottom.

Things to Remember:

The collective pitch must be held stationary until the helicopter starts to descend. Lowering of the collective pitch would cause an excessively hard landing.

Landing with rearward or sideward movement should be avoided.

Control movements should be smooth and coordinated, never abrupt or erratic. Stay relaxed, so that muscular response will not be impaired, and to develop a "feel" for the control pressure.

MODIFIED FLARE AUTOROTATION

General

In rotary-wing flying, an autorotation is a maneuver that can be performed by the pilot whenever the engine is no longer supplying power to the main rotor blades. In autorotation, lift is produced with air foils (the main rotor blades) that rotate because of the aerodynamic forces resulting from an upward flow of air through the rotor system. The lift produced by the freely rotating blades can be used, just as in normal flight, by tilting the plane of the main rotor with the cyclic control. The anti-torque (tail) rotor is driven by the main rotor and affords normal heading control.

In order to have air moving upward through the rotor system to produce lift, the aircraft itself normally must be moving downward through the air mass. Several factors, air density, load, rotor RPM, and airspeed effect the rate of descent in autorotation. The pilot's primary control of the rate of descent is the airspeed. Rate of descent is high at zero airspeed and decreases to a minimum at approximately 45 knots. As airspeed is increased beyond 50 knots, the rate of descent also increases. When an autorotative landing is to be made, the energy stored in the rotating blades can be used by the pilot to decrease the rate of descent and make a safe landing. Since a greater amount of energy is required to stop a helicopter with a high rate of descent than is required to stop a helicopter descending more slowly, it follows that autorotative descents at very low or very high indicated airspeeds are more critical than those performed at an airspeed of about 45 to 50 knots.

Purpose:

Practice autorotations are taught so that the helicopter pilot will automatically make the correct response when confronted with an in-flight mechanical failure.

The modified flare autorotation is the most commonly used type of autorotation.

On your base leg, you maintain traffic pattern altitude of 500 feet and 50 knots airspeed; increase RPM to 3200.

Technique:

After you have turned on the final leg and have lined up with the autorotation lane, continue to fly at 500 feet and 50 knots maintaining 3200 RPM. At a point commensurate with the existing wind, you will enter the autorotation. If you have a crosswind, establish a slip and maintain the slip all the way to the ground. The point of entry will vary with the different wind velocities and you can estimate this point with a relative point on the bubble. In a light wind condition, it will be higher on the bubble, and in a strong wind condition it will be lower. As you gain experience, you will be able to judge this entry quite accurately.

To initiate an autorotation, you should smoothly reduce the collective pitch to the full down position, simultaneously decrease throttle to split needles and apply right pedal to maintain heading and/or keep helicopter lined up with lane. Establish 2500-2700 engine RPM and maintain 45-50 knots of airspeed. Check to be sure your rotor RPM is in the green. (If rotor RPM is decreasing or increasing rapidly, make a power recovery and land immediately.) Be sure to hold collective pitch firmly in the full down position. At approximately 100 feet, roll the throttle into the closed position and check rotor RPM again. At approximately 35 to 50 feet of altitude, execute a modified flare to slow the rate of closure. The amount of flare will vary, but should be sufficient and positive enough so that you can definitely feel and see the aircraft slowing as far as the rate of closure, rate of descent and ground speed are concerned.

Landing:

At about 10-15 feet from the ground, apply sufficient collective pitch to check and slow rate of descent. As the aircraft descends closer to the ground, apply additional collective pitch as necessary to cushion the landing, and at the same time coordinate forward cyclic to level the aircraft. As a touchdown is made, hold the collective stationary. If breaking action is desired, collective pitch may be lowered as required.

NOTE:

Caution should be used when landing with a strong cross-wind from the left; since the right pedal loses effectiveness as RPM is decreased, you may not have sufficient right pedal to maintain the heading during the ground roll.

(See Fig. 6)

Things to Remember:

Touch down with skids level.

During an autorotation, devote your entire attention to flying the helicopter. Stay alert, treat every autorotation as if it were the first one that you have made that day.

During the descent, round out, pitch pull and landing, your vision is of prime importance. Your vision should not be focused on any fixed spot ahead of the aircraft, but should be about parallel to the line of descent and changing slowly and constantly from side to side, as well as from just below to just above the line of descent and back again. In other words, keep your head in one position (except during autorotative turns) 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. Actually without your recognizing them, there will be a multitude of these points that your eyes and brain will use for comparison.

Concentration of vision too close to the aircraft will result in a "speed blur," and you will tend to pull pitch at too high an altitude. Concentration of vision too far ahead will not provide any criteria to judge or determine relative speed and depth perception, and you will tend to pull pitch at too low an altitude.

The main thing to remember is to properly divide your attention and never hesitate to make a power recovery when you are not absolutely sure that a safe landing will be made.

AUTOROTATIVE TURNS

Initiate an autorotation. Be sure that you have the aircraft trimmed with right pedal before starting an autorotative turn.

The turn is begun by applying a slight sideward pressure on the cyclic in the direction you wish to turn. Do not use the pedals to assist your turn but maintain the trim you established.

It is best to make the first half of the turn as soon as possible. This allows you time on the last half of the turn to vary your airspeed, degree of bank, or whatever is necessary for a good approach to your intended landing spot. Thus, if you were making a 180-degree autorotative turn you would make the first 90 degrees of the turn fairly rapidly and play the last half of the turn.

To recover from your turn, you apply sideward cyclic in the opposite direction of your turn. Again, there is no need to apply pedals.

SIMULATED FORCED LANDINGS
(Engine Failure)
Dual Only

General:

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 closing the throttle. These simulated forced landings will prepare you to act promptly and efficiently in an emergency. They will develop accuracy, judgment, planning technique, and confidence. Normally you will never know in advance when a simulated forced landing will be given; so be alert at all times to the possibility of your instructor's giving you one. Probably at no other time in your training will your ability to use calm judgment be more severely tested.

The simulated forced landing procedures outlined in the following paragraphs will simulate, insofar as possible, the actual characteristics of the aircraft with a dead engine. The simulated forced landing condition will establish a glide ratio and rate of descent similar to that which would be encountered in an actual forced landing.

An alert pilot is constantly on the lookout for suitable forced-landing fields. Naturally, the perfect forced-landing field is an established landing area. The next best substitute is a hard-packed, long, smooth road or field with no high objects on the approach end; but since these are not readily found in many places, you must be able to select the best available field. Avoid selecting fields that contain large boulders, ditches which are contoured, or other features which are not characteristic of a good landing field.

You should always be aware of the direction from which the wind is blowing. Use the methods outlined previously in this manual to determine the wind direction. If you are unable to determine wind direction by any of these means, use the last known direction of the wind.

Entry:

In practice the maneuver is begun by your instructor as he closes the throttle to split the needles. You should then firmly and smoothly go down with your collective pitch all the way to the bottom. As the throttle is closed, you will need to add right pedal to trim the ship.

Maintaining:

Maintain a 45 to 50 knot attitude. Be sure to hold the collective pitch in the full down position. Your instructor will open the throttle to maintain 2500-2700 engine RPM. If you are flying downwind, make an autorotative turn into the wind. The direction of the wind is most important in the latter part of the approach and on touchdown. Therefore, if you have to fly downwind or cross-wind for awhile to make your landing area, it is permissible. Just be sure to be headed into or nearly into the wind during the last part of the descent and touchdown.

Although 45 to 50 knots is the desired airspeed you may vary your airspeed, maneuver your approach, or a combination of both in order to hit the desired touchdown spot.

Recovery:

On all simulated forced landings you should plan on making a touchdown. However, at any altitude during the descent, your instructor may ask you for a power recovery. When this happens gently apply collective pitch and squeeze on a small

(1) Fly final at 500', 50 K., 3200 RPM,
On lane center line.

(2) Lower pitch positively and split needles,
Hold nose straight by adding right pedal,
Rotor in the green,
Maintain lane alignment with cyclic,
Pitch checked on bottom.

(3) 45-50 K. attitude,
RPM in the Green,
Pitch down.

(4) RPM in the Green
Over-ride 100 feet.

(5) At approximately 35-50 feet execute a moderate flare to slow the rate of closure. This amount of flare will vary, but should be sufficient so that you can definitely feel and see the aircraft slowing as far as the rate of closure, rate of descent, and ground speed are concerned.

(6) At about 10-15 feet from the ground, apply sufficient collective pitch to check and slow rate of descent. As the aircraft descends closer to the ground, apply additional collective pitch as necessary to cushion the landing, and at the same time coordinate forward cyclic to level the aircraft.

(7) As a touchdown is made, hold the collective pitch stationary. If breaking action is desired, collective pitch may be lowered as required.

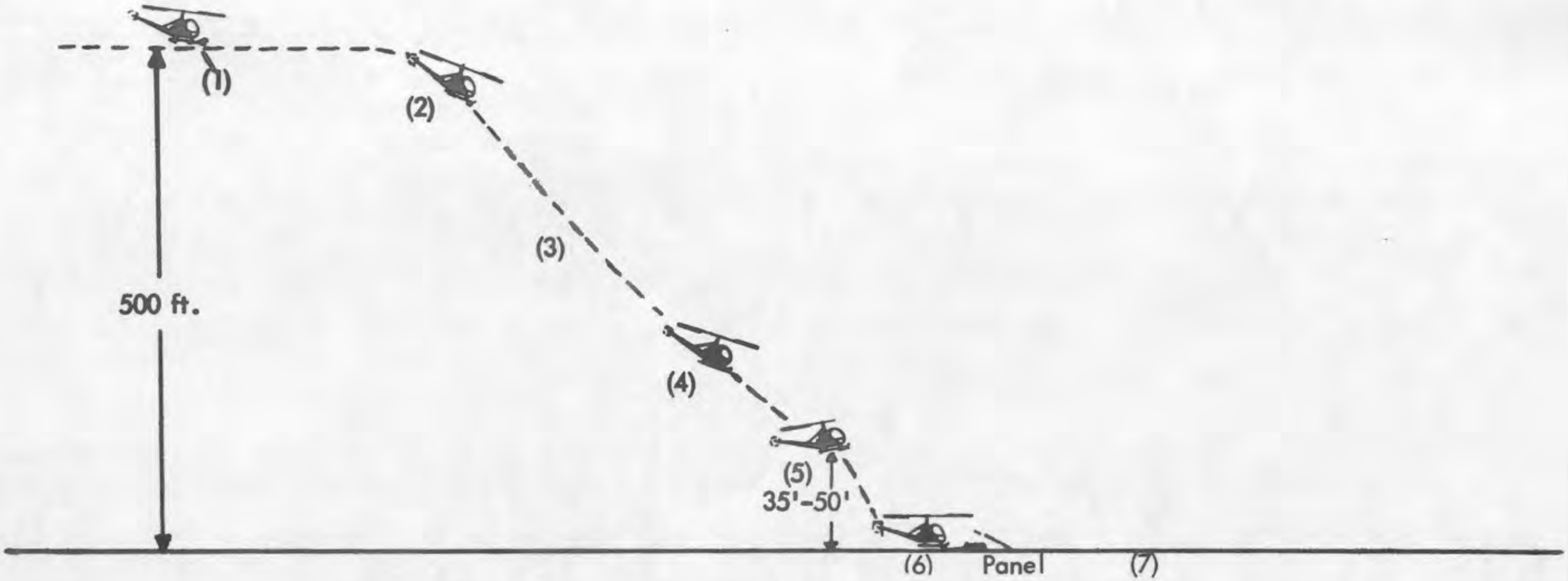


Figure 6

amount of throttle, coordinating the movement of collective pitch with a sufficient amount of left pedal to maintain heading. The needles should join at 3200 RPM. If the throttle and pitch are not coordinated, you are likely to get an engine overrev or a loss of rotor RPM. Continue to increase your power to 24 inches of manifold pressure and establish a normal climb.

Landing:

In the pre-solo stage the landing is made in the same way as in the modified flare autorotation. As you become more proficient, the precision autorotation will be used.

Should an actual power failure occur prior to or during an attempted power recovery, the helicopter must be levelled at an altitude that will permit a safe forced landing. If the helicopter "bounces" during the landing, the collective pitch should be lowered slightly to reduce the effect of the "bounce" and used together with proper cyclic application to avoid reaching an abnormal attitude prior to the next point of touchdown. Avoid abrupt or excessive rearward movement of the cyclic. Upon touchdown cyclic should be slightly forward of neutral to tilt the rotor away from the tail boom.

Tips:

An alert pilot always plans ahead. You will be flying from only a few stage fields during your training. You should memorize the terrain features and suitable forced-landing areas, especially the dual sod autorotation areas.

Things to Remember:

If you land into the wind, your touchdown ground speed is reduced by the wind velocity.

Plan every simulated forced landing so that an actual landing could be made.

A combination variance of airspeed and flight path will allow you to maneuver into the landing area, without extreme variance of either; this usually affords better and easier control of the landing.

FORWARD HOVERING AUTOROTATION:

Purpose:

To teach proper technique of landing the aircraft, should engine failure occur during forward hovering flight.

Preparatory:

Hover forward at normal speed, three feet altitude, maintaining 3200 RPM, generally into the wind (NEVER DOWNWIND). Stabilize the aircraft to prevent lateral drift. Focus your vision 20 to 30 feet in front of the aircraft. Do not stare at the ground.

Entry:

Close the throttle to obtain a clean split of the needles and apply right pedal to maintain heading. A slight amount of right cyclic will be necessary to keep the aircraft from drifting; if necessary, add forward cyclic to hold the aircraft level. Hold the pitch where it was upon entry.

Landing:

As the rotor rpm decreases, the aircraft will start to settle. Keep a level altitude with the cyclic and hold the heading with the pedals.

When at an altitude of approximately one foot, apply a positive upward movement on the collective pitch to cushion your landing. Maintain directional control with pedals. After the aircraft is firmly on the ground, slowly lower collective to the full down position.

Anti-Torque Failure from a Hover (Dual Demonstration Only):

Purpose:

This maneuver is designed to develop your timing and skill to the extent that you can recover from an anti-torque failure while at a hover.

Preparatory:

Set the aircraft up at a three-foot hover, 3200 RPM, and headed into the wind. Make a 90 degree hovering turn to your left so that you are in a crosswind hover with the wind from your right.

Entry:

Start a turn to the right to head the aircraft back into the wind. Right pedal is applied until you use about half the pedal you have available. Your rate of turn will be slow at first but will progressively increase in speed.

Maintaining:

As you apply right pedal, the engine will tend to overrev. This overrev in most cases will be slight and momentary. Therefore, it is better to concentrate your attention outside the aircraft, so that you can keep the aircraft over one spot rather than keeping your eyes focused on the tachometer. The maneuver is completed so rapidly that you need not attempt to coordinate throttle with the rest of your control movements. As you make your turn to the right, hold your cyclic into the wind. Once the aircraft is headed into the wind, apply forward cyclic to keep from drifting backwards.

Recovery:

After about 90 degrees of turn, your rate of turn will start to increase rapidly. At this point closing the throttle will bring the turn to a stop or near-stop. Hold the original pedal position stationary in order to simulate the actual condition as closely as safety permits. It is also important to make your turn over one point on the ground. Do not let the aircraft drift or hover backward or sideward. Do not stop the turn with opposite pedal.

BE AWARE OF CRITICAL CONDITIONS

Landing:

Closing the throttle starts the aircraft settling toward the ground as well as stopping the turn. Your landing is made in the same way as in a hovering autorotation. Maintain your collective pitch setting until you have descended to about one foot off the ground. You then apply positive upward movement on the collective pitch to slow your descent and cushion your landing. If you are still turning, in either direction, on ground contact, apply additional upward pressure on the collective pitch to cause the skids to brush the ground. This will stop your turn. When the weight of the aircraft is resting fully on the skids, return the collective pitch to the full down position.

Tail Rotor Failure in Flight:

Immediately close the throttle to maintain directional control. After directional control is established, cautious application of power may be made if necessary to lengthen the glide. Maintain an airspeed of at least 40 knots. Correct the torque effect of the main rotor by applying cyclic control slightly away from the direction in which the helicopter tends to turn. Make a normal autorotative landing into the wind if possible, on a straight flight path. When making an autorotative landing because of tail rotor failure, forward speed at the time of ground contact is desirable if the landing surface is sufficiently smooth. NEVER apply power during the actual landing operation.

Settling with Power (Dual Demonstration Only):

Purpose:

The phrase "settling with power" is used to describe a particular state of flight which involves high vertical rates of descent, power consumption, and reduced cyclic control effectiveness. It is a condition that can occur in all helicopters. Settling with power is a critical condition of flight. The maneuver is practiced for the single purpose of preparing you to recognize and avoid it. Settling with power can be dangerous if it occurs near the ground because of the fast rate of descent and reduced cyclic control.

Preparatory:

Settling with power, as a maneuver, is never entered at an altitude below 1000 feet above the ground and be recovered by 500 feet above the ground. The requirements for a settling with power condition are as follows:

(1) An airspeed of 0 to 10 knots.

(2) A rate of descent of 300 feet per minute or more.

(3) From 20% to 100% of the available engine power is applied to the rotor system.

Entry:

To deliberately get into settling with power, raise the nose and reduce airspeed 0 to 10 knots. Reduce pitch to establish a descent (Do Not split Needles) and maintain heading with pedals. When the descent is established increase collective pitch to induce the effects of settling with power. The aircraft will buffet and there will be a feed back in the controls. Increasing power will accentuate the condition.

Primary Recovery:

Recovery from power settling condition should be accomplished as follows:

(1) Increase throttle to maximum permissible RPM.

(2) Decrease collective pitch slightly.

(3) Apply cyclic and pedal control as required to increase airspeed and fly the aircraft out of the power settling condition by turning toward the right or toward the left. The thrust from the tail rotor will help drive the aircraft out of the turbulent air. You will have recovered with minimum loss of altitude.

If the power settling condition is allowed to become extreme, the above recovery procedure might not be effective due to loss of cyclic control.

Secondary Recovery:

While keeping the tachometer needles joined, slowly lower the collective pitch to minimum pitch setting and continue attempting to turn toward the right or toward the left. With the aircraft in this descending attitude, slowly lower the nose to gain airspeed. This secondary recovery technique entails a considerable loss of altitude: it should never be attempted near the ground.

LOW RPM RECOVERY

A low engine RPM can occur while hovering or in flight. During the early stages of training, it is normally caused by improper throttle usage, throttle-pitch coordination, or throttle pedal coordination.

The learning student will often be confronted with a low engine RPM and should learn how to properly cope with and recover from a low RPM condition. The instructor will demonstrate the proper methods of recovery. A review of the procedures are listed below.

Hovering - A low engine RPM while hovering can be the result of improper throttle usage, throttle-pedal coordination, hovering in a strong cross-wind (or downwind), hovering in turbulence created by other helicopters, etc. Your first reaction should be to increase throttle to regain proper RPM. If it is apparent you are against the stop (full throttle)then you should reduce or lower collective pitch. This should be done cautiously so you do not make hard or drifting contact with the ground. If by reducing collective pitch and hovering closer to the ground, you are still unable to regain operating RPM, then land the helicopter, being sure you are level and straight, and reduce collective pitch. With the collective pitch down, regain operating RPM with the throttle and proceed to pick up to a hover in the normal manner.

In Flight - A low engine RPM in flight can be the result of improper throttle usage or throttle-pitch coordination. It can occur in cruise, climbs or descents (approaches). The position of your collective pitch should be your guide as to the recovery method. If you were in cruise or descents (approaches), the low RPM was probably caused by improper throttle usage. Your first reaction should be to increase throttle, followed by relaxing any up collective pitch pressure you may be holding. If you were in a climb, the low RPM was probably caused by improper throttle-pitch coordination. Your first reaction should be to relax or reduce collective pitch, followed by increasing throttle as necessary.

A thorough knowledge of the above techniques are necessary before solo and any questions should be clarified by your instructor prior to that time.

MAX PERFORMANCE TAKE OFF

(1) Get the aircraft light on its skids,
3200 RPM,
Cyclic centered,
Nose straight with the take off path.

(2) Smoothly apply pitch and full throttle maintaining RPM with pitch.

Apply sufficient left pedal to hold nose straight with the lane (necessitated by additional power therefore causing additional torque).
With cyclic obtain and maintain a 30 K. attitude.

(3) Recover at 100'.
Lower nose to a 40K attitude, then slowly reduce throttle to 23" (24" Dual) and ease the throttle and pitch down to maintain 3200 engine RPM. Properly executed you should reach 40K indicated airspeed about the same time you arrive at your normal climb power.

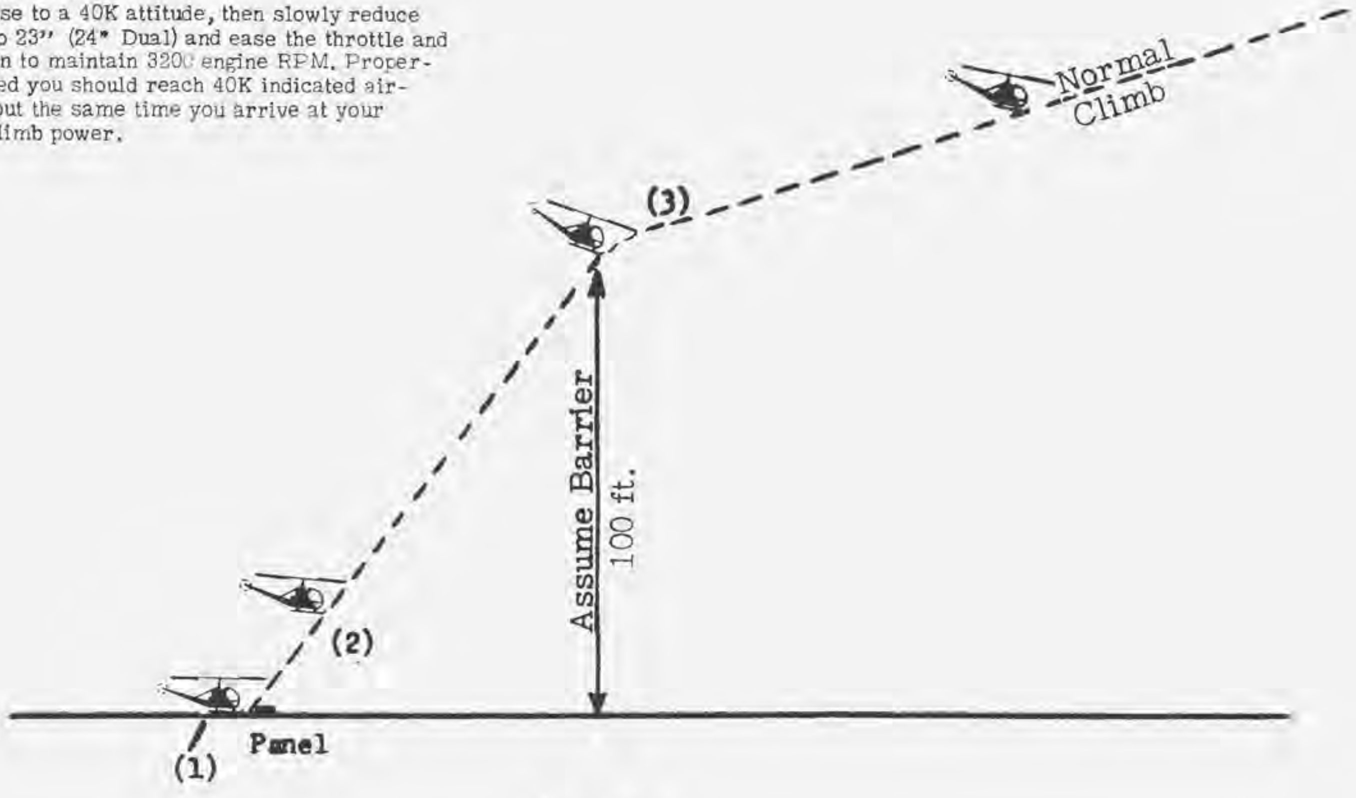


Figure 7

STEEP APPROACH

(1) Fly final at 300', 3200 RPM, 40 K., on lane center line.

(2) Using a 20° angle sight picture, (leading sight picture about 1/2"), enter by lowering sufficient pitch to start a descent. Hold 40 K. attitude initially. Maintain 3200 RPM by squeezing off throttle as pitch is lowered. Hold nose straight with lane using pedals. Note ground speed and apparent movement speed.

(3) Begin constant deceleration to panel. Keeping the same apparent speed noted at entry. (apparent brisk walk).

(4) When sufficiently slow to cause loss of translational lift start applying pitch to maintain angle of descent. The last 1/3 of the approach is a decelerating hover to the panel. Squeeze on the throttle to maintain 3200 RPM adding sufficient pedal to keep the nose straight with the lane.

(5) Terminate 3' above and 3' behind the approach panel (a normal hover). Maintain 3200 RPM, Hold nose straight with pedals.

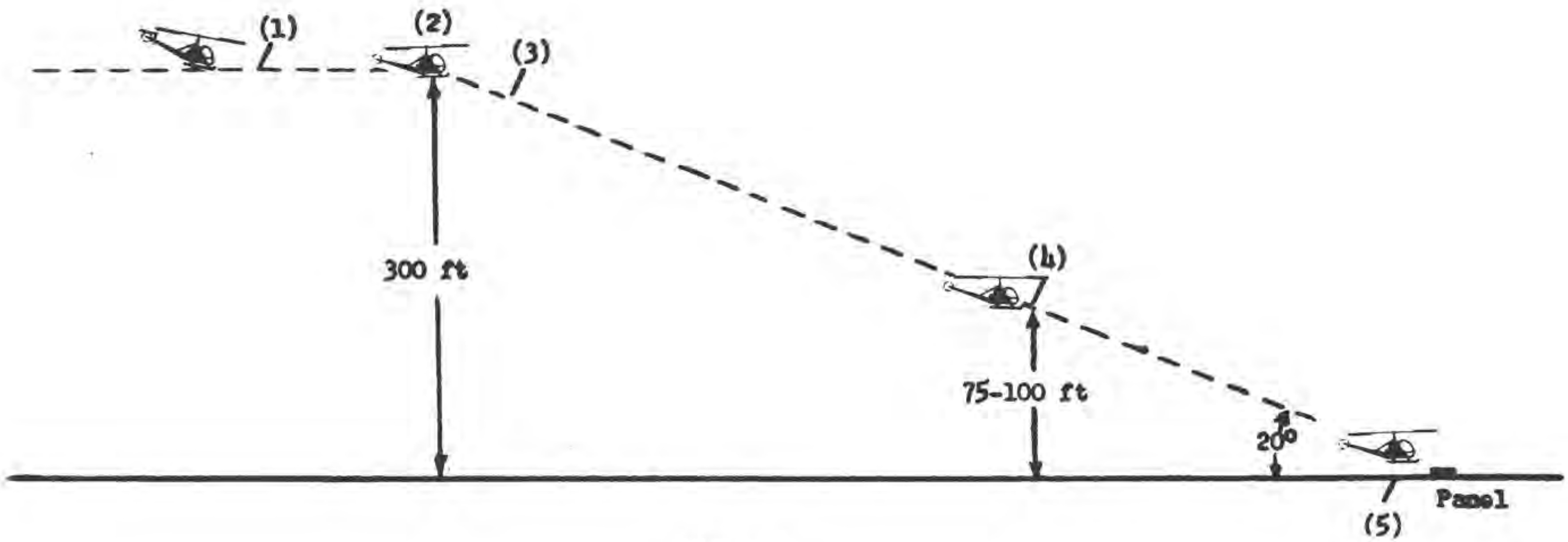


Figure 8

PRACTICE DEVELOPS PRECISION

CHAPTER V

PRIMARY STAGE FIELD MANEUVERS

Maximum Performance Take-off:

Purpose:

The maximum performance take-off is used when you need a steep angle of climb to clear barriers in your flight path. During your primary stage of training full power will be used so you can become proficient in the steepest possible take-off within safe limits.

Preparatory:

The maximum performance take-off is started by executing a clearing turn at the take-off panel, trim cyclic to hovering position, and then landing slightly behind the take-off panel in your lane. With the RPM reduced below 3200 clear again, overhead, to each side, and the rear; then pick out objects in front of the aircraft to line up with during take-off.

Entry:

Next, with the cyclic in the trimmed hovering position, apply a slight amount of left pedal. Increase RPM to 3200 and apply upward pressure on the collective pitch, increasing it slowly and smoothly until the aircraft is light on the skids. Hesitate momentarily, neutralize the cyclic to compensate for the load distribution of your aircraft and stop any ground movement, also make necessary pedal adjustments to maintain proper alignment of the aircraft. Continue now to apply collective pitch and as the helicopter breaks ground simultaneously apply a slight pressure forward on the cyclic to pivot into a 30-knot attitude, increase the throttle to the open or full power position, and apply the maximum amount of collective pitch that can be used without reducing the RPM below 3200. Adjust pedals as necessary to maintain heading. After full throttle is added, you maintain proper RPM by adding collective pitch if you overrev, or decreasing collective pitch, if you underrev. Your indicated airspeed at the entry of the take-off will be erratic, so you will not be able to judge your attitude from your airspeed indicator. You will have to learn to recognize proper attitude under other flying conditions and apply that knowledge to your maximum performance take-off. (It is easy to slip into a nose-low attitude.)

Maintaining:

Continue your climb at maximum performance, maintain a straight ground track, and use the pedals to keep the aircraft headed straight. If you have a cross-wind, the helicopter is flown in a slip; that is, you keep your heading straight along the take-off path with pedals, and hold the cyclic into the wind the amount necessary to make good your ground track over your guide points.

Recovery:

Continue the maximum climb to about 100 feet, then establish a normal climb by lowering the nose to a 40-knot attitude then slowly reducing throttle to decrease manifold pressure to 23 (24" dual) inches. As the manifold pressure starts decreasing, ease the collective pitch down to maintain 3200 RPM. Properly executed you should reach 40K indicated airspeed about the same time you arrive at your normal climb power. Students, at first, tend to reduce throttle too rapidly and, as a result, cannot properly coordinate collective pitch with the throttle movement. At this point if you have a cross-wind, establish a crab to maintain a straight ground track.

(See Fig. 7)

Things to Remember:

The maximum performance take-off is a smooth coordinated maneuver and should never be executed in an abrupt manner. Over-controlling causes a loss of lift, which decreases the aircraft's performance.

Do not sacrifice RPM in order to obtain additional pitch on the rotor blades. If, with full throttle applied, you are losing RPM, it can only be regained by reducing collective pitch.

Do not allow the aircraft to have any ground movement while preparing to take-off or as the aircraft breaks ground.

Steep Approach:

Purpose:

The steep approach is used primarily when there are obstacles in your approach path that are too high to allow a normal approach. It is sometimes used to avoid areas of turbulence around a pinnacle. The steep approach will permit entry into most confined areas.

Preparatory:

The steep approach is set up in the same way as the other approaches, 40 knots airspeed and 300 feet altitude (increase RPM to 3200 turning on base.)

Entry:

As you come in on your approach lane, the panel will appear at the top of the bubble and move downward to the steep approach sight picture position. The angle you will use for this approach will be about twenty degrees. Just before you reach the steep approach sight picture, apply a smooth positive downward pressure on the collective pitch. A greater reduction of collective pitch is usually required at the beginning of the approach to start the descent, than for a normal approach, since this approach is steeper than the normal approach. Be sure to lead your entry, as you will not have as much time to lower the collective pitch as you do in the normal approach. When you lower the collective, add right pedal to maintain heading.

Maintaining:

The same principles of "power glide control" apply in maintaining position on the proper angle of descent, as in the normal approach. You want to maintain an approach ground speed of a brisk walk all the way to the panel. When you notice an increase in your apparent ground speed, apply a slight amount of aft cyclic to begin your deceleration. Because of the steeper angle of descent, you will not have as much time for your deceleration as you do in your normal approach. The pilot must exercise caution during the final part, lest he "fall through." This is more likely to occur at the termination of a steep approach than at the end of a normal approach. Apply full power if necessary to stop the descent at hovering altitude.

Termination:

At about 75-100 feet from the ground,begin a smooth upward pressure on the collective pitch to slow your rate of descent. As you apply pitch, the nose of the aircraft will tend to come up and you will have to apply a slight amount of forward cyclic to keep the aircraft level. There is a tendency in this part of the approach to let the rate of descent increase. While the application of collective pitch is not abrupt, it must be applied more positively than in the normal approach. You should build up your power so that when you reach the hovering position you can hover with little additional application of pitch and power.

Corrections for a cross-wind are accomplished in the same manner as for the normal approach.

(See Fig. 8)

Things to Remember:

If you over-arc or let the angle of descent become too steep, either make a go-around or land beyond the original point of intended landing.

Maintain proper RPM in the final part of the descent.

A proportionate increase of airspeed on final should be made for winds of higher velocity than normal, in the same manner as outlined for a normal approach.

TAKEOFF FROM THE GROUND

Preparatory:

Execute a clearing turn and then land slightly behind the takeoff panel. Reduce RPM below 3200 and clear behind, overhead, and to each side. Pick out objects in front of the aircraft to line up on during the takeoff.

Entry:

Increase RPM to 3200 and apply upward pressure on the collective pitch, increasing slowly and smoothly until the aircraft is light on the skids. Hesitate momentarily and adjust cyclic and pedals to prevent any ground movement. Continue now to apply collective pitch and as the aircraft breaks ground, use cyclic as necessary to assure forward movement as altitude is gained to 3 feet. Continue moving forward and accelerating, using power as necessary to maintain 3 feet. As you accelerate to translational lift, the helicopter will begin to climb. Continue the rest of the takeoff, gaining airspeed and altitude in the same manner as a Normal Takeoff.

APPROACH TO THE GROUND

Preparatory:

Note - Same as Normal Approach (12° angle)

Entry:

Note - Same as for Normal Approach

Maintaining:

Note - Same as for Normal Approach

Termination:

The termination will be same as the Normal Approach except you will not terminate at a hover but continue the approach directly to the ground. Contact with the ground should be in a level attitude, skids straight and with no forward movement.

Things to Remember:

Note - Same as for Normal Approach

QUICK STOPS (RAPID DECELERATIONS)

Purpose:

This maneuver requires the use of all the controls simultaneously. It is designed to bring the helicopter to a stationary position from forward flight.

Preparatory:

Before starting the maneuver, the wind direction and velocity should be evaluated as these will have a bearing on the distance required to stop the helicopter once the deceleration is initiated.

Technique:

Begin the maneuver from a 3 foot hover, Start in the same manner as if you were making a normal takeoff. As the helicopter starts to climb, continue to accelerate to 40 knots. Climb to an altitude not to exceed 25 feet. Maintain 25 feet and 40 knots and initiate the quick stop by making a smooth but positive reduction of collective pitch, followed closely by a rearward pressure on the cyclic. The desired technique is to slow down your forward motion as the helicopter slowly starts to descend. If cyclic is applied too fast, the helicopter will start to climb; if you apply cyclic too slow, you will descend prematurely. When you lower the collective pitch you will have to apply right pedal to maintain heading and adjust throttle to maintain proper RPM.

Continue to hold aft cyclic until the helicopter has decelerated almost to a stop. Maintain a slight nose high attitude and as the helicopter starts to descend, start applying positive upward pressure on the collective pitch. Continue to apply pitch and power to the point where you can stop the descent, level the aircraft and terminate at a stationary hover.

NOTE:

(Airspeed may be increased 45 to 50 knots if increased wind velocity dictates.)

Deceleration Exercises:

Purpose:

Deceleration exercises require the use of all the controls almost simultaneously. They are designed to develop your timing and coordination and to teach you a method of dissipating your airspeed quickly in an emergency. Although the maneuver is sometimes called a rapid deceleration, this does not mean the maneuver should or can be rushed to completion.

Preparatory:

You begin the exercise headed into the wind at an altitude of approximately 50 feet and an airspeed of 50 knots. Deceleration exercises are usually performed over open terrain in case a forced landing is required. You maintain 3200 RPM throughout the maneuver.

Entry:

To start maneuver, make a slight reduction in collective pitch, followed closely by a slight rearward pressure on the cyclic. The idea is to slow down your airspeed and at the same time retain the same altitude. The rearward movement of the cyclic must be exactly timed to the lowering of the collective pitch. If you apply rearward cyclic too fast, the aircraft will start to climb; if you apply cyclic too slowly, you will lose altitude. When you lower the collective pitch you will have to apply right pedal to maintain your heading. You adjust the throttle to maintain proper RPM.

Maintaining:

Continue to hold rearward cyclic until you decelerate to an airspeed of approximately 25 knots. Do not let your ground speed fall below 10 knots.

Recovery:

To begin the recovery, apply a slight upward pressure on the collective pitch and apply forward pressure on the cyclic until the aircraft starts to accelerate. Maintain this attitude until the aircraft is at cruising speed. Do not let the nose get more than a few degrees below a level attitude; otherwise you may have to use excessive power to keep the aircraft from settling. Maintain altitude and RPM by upward pressure on the collective pitch and by squeezing on throttle. The increase in power will require the use of left pedal to maintain your heading. Continue to accelerate up to cruising airspeed, slowly applying right pedal as airspeed increases.

180-Degree Autorotation

Preparatory:

You practice 180-degree autorotations to increase your skill in performing autorotations, in that you must maneuver the helicopter more than you do while making straight-in autorotations. To properly execute a 180-degree autorotation, you must maneuver the helicopter through 180 degree change of direction and land on the proper lane, while maintaining proper trim on the pedals, proper aircraft attitude, and proper RPM. You must also evaluate accurately the existing wind conditions to determine where the downwind leg should be relative to the landing lane.

To practice 180-degree autorotations, fly the downwind leg close to the area at an altitude of 500 feet and an airspeed of 50 knots. Maintain 3200 RPM on downwind leg. If you have a cross-wind correct for drift by crabbing.

Entry:

You begin your 180-degree autorotation when your helicopter is approximately opposite the area you intend to land. Lower the collective pitch to the full down position, simultaneously decrease throttle to split needles and apply right pedal to maintain heading, establishing an engine RPM between 2500-2700. Begin your turn by applying cyclic in the direction you wish to turn and establishing an approximate 45 to 50 knot attitude. Do not use your pedals to assist your turn.

Maintaining:

It is best to make the first half of the turn as soon as possible. This allows you time on the last half of the turn to vary your airspeed, or degree of bank in order to make a good approach to your intended landing area. You must cross-check the rotor RPM, attitude of the aircraft, and the airspeed in the turn. It is advisable to rotate the throttle into the full closed position at the 90 degree point of the turn. In autorotative turns the rotor RPM may tend to overspeed and it will be necessary to increase the collective pitch slightly so as not to exceed 395 rotor RPM. When collective pitch is used to avoid an overspeed, you must return it to the full down position before the RPM has decreased below the safe operating range. The attitude during an autorotative turn is very important, for a nose low attitude will cause a high rate of descent. An attitude comparable to the attitude of a straight in autorotation should be maintained in the turn as the air speed indicator is subject to some error in autorotative turns. Usually the turn should be completed at about 75 to 100 feet above the ground. The termination will be the same as in all modified flare autorotations.

(See Figure 9)

Things to Remember:

A cross-wind condition will effect the angle of bank in an autorotative turn, in that you will vary the angle of bank to compensate for drift in the turn, i.e. a wind blowing you toward the landing area will cause you (1) to set up the downwind leg slightly farther from the landing area than you normally would; and (2) you should make a steeper angle of bank than normal to compensate for drift and to be aligned prop-

(1) Entry preparation is downwind paralleling the area.
500' altitude,
3200 RPM
50 K airspeed.

(2) Enter about opposite touchdown spot. Lower pitch positively and split needles. Apply right pedal to hold nose straight. Roll into turn holding 45 to 50 knot attitude. Maintain initial pedal required to trim.

(3) RPM in the green, 45-50 K attitude, Play turn to roll out with a steep approach angle to the area.

(4) Roll out holding 45-50 K attitude, RPM in the green, alligned with area, using cyclic, nose straight with pedals.

(5) At approximately 35 to 50 feet of altitude, execute a modified flare to slow the rate of closure. The amount of flare will vary, but should be sufficient and positive enough so that you can definitely feel and see the aircraft slowing as far as the rate of closure, rate of descent and ground speed are concerned.

(6) At about 10-15 feet from the ground, apply sufficient collective pitch to check and slow rate of descent. As the aircraft descends closer to the ground, apply additional collective pitch as necessary to cushion the landing, and at the same time coordinate forward cyclic to level the aircraft.

(7) As a touchdown is made, hold the collective pitch stationary. If breaking action is desired, collective pitch may be lowered as required.

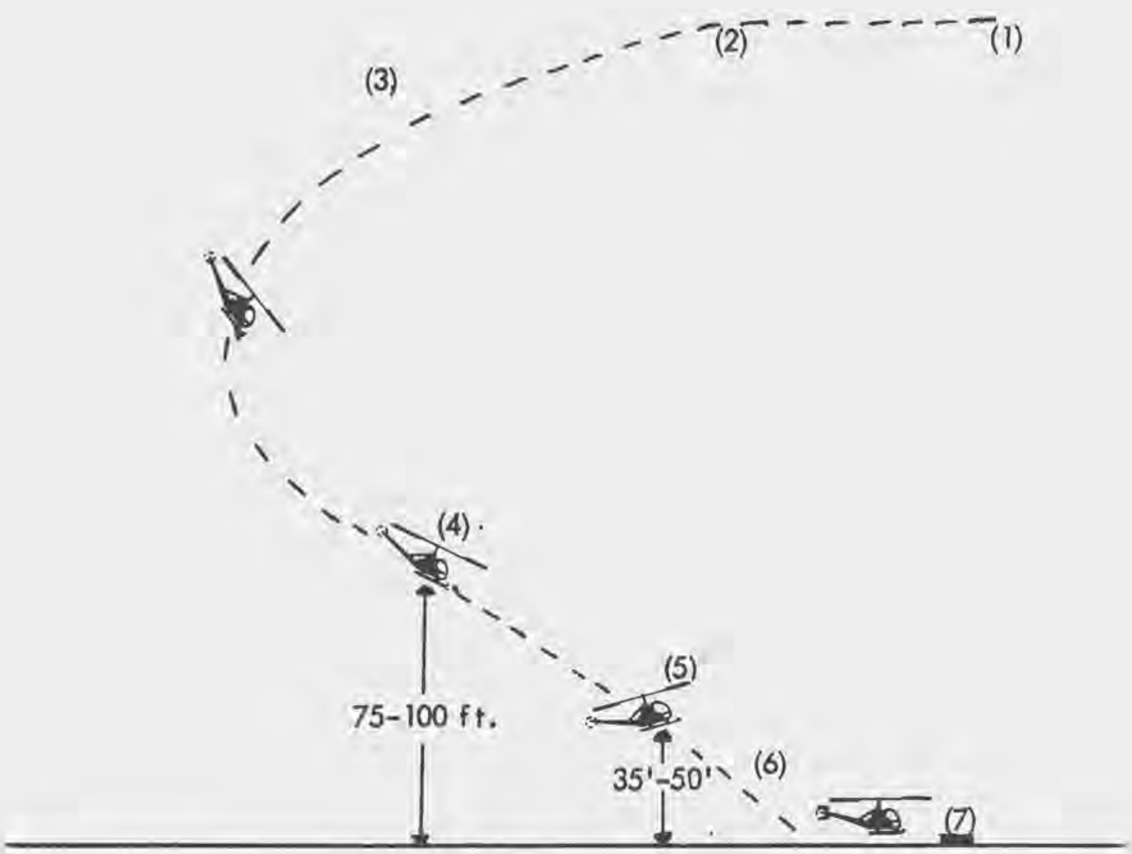


Figure 9

erly with the area as the turn is completed. (Avoid the tendency to use aft cyclic in the turn to compensate for wind drift.) If you have a cross-wind blowing you away from the field, the opposite will apply, i.e. (1) set up the downwind leg closer than normal; and (2) the angle of bank is shallower than normal to compensate for wind drift and make good the proper ground track to be aligned with the area as you complete the turn. The velocity and direction of the cross-wind will determine the degree of variance from a normal wind straight down the area.

Since a steep angle of bank will produce a high rate of descent in autorotation, you should avoid executing a steep turn at a low altitude.

Keep your pedals properly trimmed in the turn; if they are not properly trimmed the fuselage will not be streamlined and excessive drag will be created, causing a loss of airspeed, which causes the rate of descent to increase and also the angle of descent will be steeper than normal. For landing in a cross-wind establish a slip after the turn is completed.

Precision Autorotation:

(All 180-degree and sod touchdown autorotations considered precision autorotations.)

Purpose:

A precision autorotation is a variation of the modified flare autorotation, and is not a distinctively different maneuver. The primary difference between is variance of airspeed to aid in landing at a desired point.

Since the variance of airspeed from 50 knots will increase the rate of descent the landing will require very good technique to cope with the increased rate of descent. Extreme variances of airspeed should be avoided at low altitude to preclude the possibility of encountering rates of descents that are too high for safe landings. If the approach is properly controlled, you can pinpoint your landing while maintaining a safe autorotative descent. It is important that you develop accuracy so that you can advantageously use a small area, if necessary, in event of an engine failure in flight.

Preparatory:

Precision autorotation to an area will be set up in the same way as the 180-degree autorotation: Entry is approximately opposite the area at which you intend to land, 500 feet and 50 knots airspeed.

Entry:

Lower the collective pitch to the full down position, simultaneously closing the throttle and splitting the needles and apply sufficient amount of right pedal to maintain heading. Establish 2500 to 2700 engine rpm. Begin your turn by applying cyclic in the direction you wish to turn and at the same time establishing a 45-50 knot attitude. Do not use pedals to assist your turn.

Maintaining:

Make the first half of turn as soon as possible to allow you time on the last half of the turn to vary your airspeed, degree of bank, or whatever is necessary for a good approach to your intended landing spot. The most difficult part of this maneuver is controlling airspeed to maintain constant line of descent. If the landing spot appears to move down the bubble, you will overshoot and need less airspeed. At approximately 200 feet, it may appear to many students that they are going to overshoot even though they are on the correct line of descent. Avoid the tendency to slow your airspeed excessively; never allow the airspeed to get below 45 knots, below 150 feet and prior to flaring. Any variation in airspeed should be done while altitude is still available. If overshooting, (altitude is too high and airspeed too low), you should dismiss the idea of hitting the spot and initiate a go-around.

Termination:

At approximately 100 feet of altitude, roll throttle into closed position and check rotor RPM again. Termination will be the same as in all modified flare autorotations.

Things to Remember:

Avoid an unusually high rate of descent during last 100 feet. Do not attempt to flare aircraft prior to landing with a slow airspeed (less than 45 knots). To get a good flare, you must have a minimum airspeed of 45 knots.

To consistently perform successful autorotative landings, you must be aware of existing rate of descent, forward speed, and atmospheric conditions. Stay alert; react according to existing conditions to each individual autorotation and do not be lulled into complacency by past performance.

Frozen Throttle Emergency Procedure:

A frozen throttle in flight is an emergency condition where the pilot must evaluate the conditions and decide on the type emergency procedure to follow. The throttle may freeze under any power setting from full throttle (i.e. maximum performance take-off) to reduced power as in a normal descent. An evaluation of the power being applied as the throttle freezes will be best guide to the pilot as to emergency procedure to follow.

The first step, upon recognition of a frozen throttle, is to contact the controlling radio and declare an emergency. Decide upon emergency procedure to be followed and advise your controller of the plan. If at all possible, execute the landing at a stagefield or the Heliport.

A frozen throttle under full throttle condition will require some experimentation to determine if collective pitch can be reduced sufficiently to get a descent while not getting an excessive engine over-rev condition. If the collective pitch cannot be reduced without getting an excessive engine over-rev, fly to a stagefield, Heliport or other suitable landing area and turn off the magneto switch and execute an autorotation.

A frozen throttle under other than full throttle condition will also require experimentation to determine if a descent can be established and executed without getting an excessive engine over-rev. If the descent can be established, the shallow approach to a running landing should be used. The descent should be kept at a slow rate, controlling rpm with use of collective pitch and touchdown made at a stagefield. Continue to maintain engine rpm with collective pitch after touchdown and shut off magneto switch to stop the engine.

NOTE: In the case of a low-time student who feels he is not proficient enough to make an autorotation, he should experiment until he finds the shallowest angle of approach that will give him the minimum amount of over-rev during a run-on landing.

DON'T BE MECHANICAL - DEVELOP JUDGMENT

CHAPTER VI

ADVANCED MANEUVERS

As a helicopter pilot, you have at your disposal an aircraft well suited for operation into and out of small confined areas, pinnacles, roads, and other unprepared landing areas. It is therefore, essential that you be taught the fundamentals of such operation and develop your proficiency to a point where you will be able to take advantage of the helicopter's characteristics. You have spent considerable time in learning the primary maneuvers. Those maneuvers you have learned form the basis for execution of the advanced maneuvers, though they will be somewhat modified as you will soon discover. Your proficiency should be good enough so that making an approach will be second-nature to you and you will not have to concentrate too much on items within the cockpit. In the advanced stage the majority of your attention will need to be directed to things outside of the cockpit, i. e. other aircraft, forced landing areas, etc. You will also find that your planning and judgment assume a much more dominant role than they did in the primary stage.

When we mention operation in confined areas, we are immediately faced with the problem of a definition for confined area, so for all practical purposes, we will say that a confined area is any location where the movement of a helicopter is restricted in any direction by terrain features or by the presence of natural or man-made obstructions. You can see that this simple definition covers a very wide field and a list of confined areas would be almost without end. As a start, we might list a clearing in a woods, either large or small, a city street, a building roof, or perhaps the deck of a ship. Practically any area from which you might operate could, with perhaps a slight stretch of the imagination, be classified as a confined area.

There is no prescribed method of performance that must always be followed in advanced maneuvers, instead, you must consider many factors that are impossible to obtain from any book or lesson plan. Now let us consider some general aspects of some of the factors affecting these maneuvers.

Wind is an important factor that affects the flight and operation of all aircraft. It probably reaches the height of importance when we consider its effect in connection with helicopter operation in confined areas and pinnacles, so a review of wind effect follows.

If wind velocity would remain constant and turbulence did not exist in any form, we could make a general statement and say that take-offs and landings should be made into the wind in order to obtain maximum airspeed with minimum ground speed. We know, however, that the smooth flow of air is constantly being interrupted and that the pilot must make allowance for up-drafts and down-drafts in order to fly safely. Gusts are variations in velocity of the wind; obstructions on the ground and even the ground itself may interfere with the smooth flow of air. Therefore, the closer the ground the more vicious the turbulence. A specific gust or its exact location cannot be readily anticipated or planned for, but turbulence can, in most instances, be predicted.

It is possible to predict with accuracy that turbulence will be found in the following places when the wind reaches a velocity of 10 knots or greater:

It will be present on the ground downwind of trees, buildings, hills or other obstructions. This area of turbulence is always relative in size to that of the obstructions, and its intensity varies with the velocity of the wind.

Turbulence may also be found near the ground on the up-wind side of solid obstructions such as trees in leaf, buildings, or perhaps a cliff. Turbulence in this position is not generally dangerous until the wind reaches a velocity of 20 knots or greater.

The air above and just slightly down-wind of any sizeable obstruction will contain turbulence. A hill mass or mountain range will cause this type of turbulence and the size of the mass and the velocity of the wind will govern the height of the turbulence and also its severity.

We have mentioned turbulence near obstructions, which is probably the most hazardous, but we also encounter turbulence near the ground on bright sunny days when flying over dissimilar types of terrain. This type of turbulence is caused by the upward and downward passage of heated or cooled air, and though it is annoying, it is not, in most cases, dangerous.

Extreme turbulence should be avoided if at all possible, but if it is necessary to operate under such conditions, you should exercise care and take every precaution to prevent the operation of the helicopter beyond its capabilities.

Some general rules can be stated that apply to helicopter operation in any type of confined area. The following are some of the most important ones to consider regardless of whether such areas are enclosed, slopes or pinnacles.

Know the direction and approximate velocity of the wind at all times and plan your landings and take-offs with this wind condition in mind. This does not necessarily mean that your take-off and landing will always be made into the wind, but wind must be considered, and its velocity will many times determine proper avenues of approach and take-off.

If possible, plan your flight path over areas suitable for forced landings in case of engine failure. It may be necessary to choose between an approach which is cross-wind but over an open area and one directly into the wind but over heavily wooded or extremely rough terrain where a safe forced landing would be impossible. Perhaps the initial phase of the approach can be made over the open area and cross-wind and then it would be possible to execute a turn into the wind for the final portion of the approach.

Always operate the helicopter as closely to its normal capabilities as possible considering the situation at hand. In all confined area operation, with the exception of the pinnacle operation which will be covered later, the angle of descent should be any angle from a normal (12°) to a steep (20°), but in any event should be no steeper than is necessary to clear any barrier in the avenue of approach and still land on the selected spot.

Always make your landing to a specific point and not to just some general area. The more confined the area, the more essential it is that the helicopter be landed precisely at a definite point. This spot must be kept in sight during the entire final approach.

Any material increase in elevation between the point of take-off and the point of intended landing must be given due consideration as sufficient power must be available to bring the helicopter to a hover at the point of the intended landing. You should also allow for a decrease in wind velocity which may result from the presence of obstructions.

While flying a helicopter near obstructions you must be continually conscious of the tail rotor. You will usually consider diameter of the main rotor blades while operating in a restricted area as they are readily seen from your position in the cockpit and, as a result, you devote most of your attention to safeguarding them and entirely forget the tail rotor which is normally out of sight. You must establish a safe angle of descent over a barrier to insure tail rotor clearance of all obstructions, and after you come to a hover, you must avoid swinging the tail into obstructions. A good, safe rule to follow is never, unless absolutely necessary, swing the tail to either side in a confined area until after you have made a ground reconnaissance and are sure it will miss all obstructions. Even after a successful landing has been accomplished in the area; the pilot must be conscious of the tail rotor and keep a safe distance while afoot inspecting the area, as this small insignificant-looking little propeller is extremely dangerous anytime it is in motion.

Keeping in mind the general precautions that will apply to any advanced maneuver we will now consider the specific operation of a confined area, a pinnacle, and a slope landing. You must use your judgment on the execution of any of these maneuvers as it is impossible to establish any exact rules or regulations covering every circumstance. We can, however, set forth some general rules.

CONFINED AREA OPERATION

(See Fig. 10)

High Reconnaissance:

Purpose:

The primary purpose of the high reconnaissance is to determine the suitibility of the area for a landing. A high reconnaissance is needed for most of the maneuvers in the advanced stage confined area and pinnacle operations. In a high reconnaissance it is necessary to accomplish the following:

(1) Determine wind direction and velocity.

(2) Locate and determine the size of the barrier immediately around the area.

(3) Select the most suitable flight paths into and out of the area, particularly considering forced landing areas, and the long axis of the area.

(4) Plan the approach and select a point for touchdown.

Technique:

Ideally, the high reconnaissance is flown at 500 feet. If the terrain and obstacles around the area force you to fly at a higher altitude, your reconnaissance will be less helpful and you will need to be more careful in sizing up the area. In general, students have a tendency to carry out their high reconnaissance at too high an altitude. It is permissible to fly lower than the recommended 500 feet but you should never fly downwind at less than this altitude.

If possible, you fly in a complete circle around the area in order to observe it from all sides. However, you are not always able to do this and may have to fly back and forth on one or possibly two sides of it. You should observe the area from approximately a 30-45-degree angle. Avoid the tendency to fly too close in. The 30-45-degree angle will allow you to make the best estimate of the height of barriers, the presence of obstacles, the size of the area, and the slope of the terrain.

You must be careful to divide your attention between flying the aircraft and your observation of the area. Be especially alert for other aircraft. Don't become so absorbed in your high reconnaissance that you forget about altitude and airspeed. Keep a forced landing area within reach at all times if possible.

Selecting an Approach Path:

The approach path should be generally into the wind and over terrain that minimizes the time that you are not in reach of forced landing area. If, by flying at an angle to the wind you can keep a forced landing area in reach, you should do so. It is more important to have an available forced landing area than to fly directly into the wind, especially if the wind is not too strong. You should also decide the type of approach you will make. If at all possible, you should make a normal approach. When there are fairly high barriers, however, you will have to make a steeper approach.

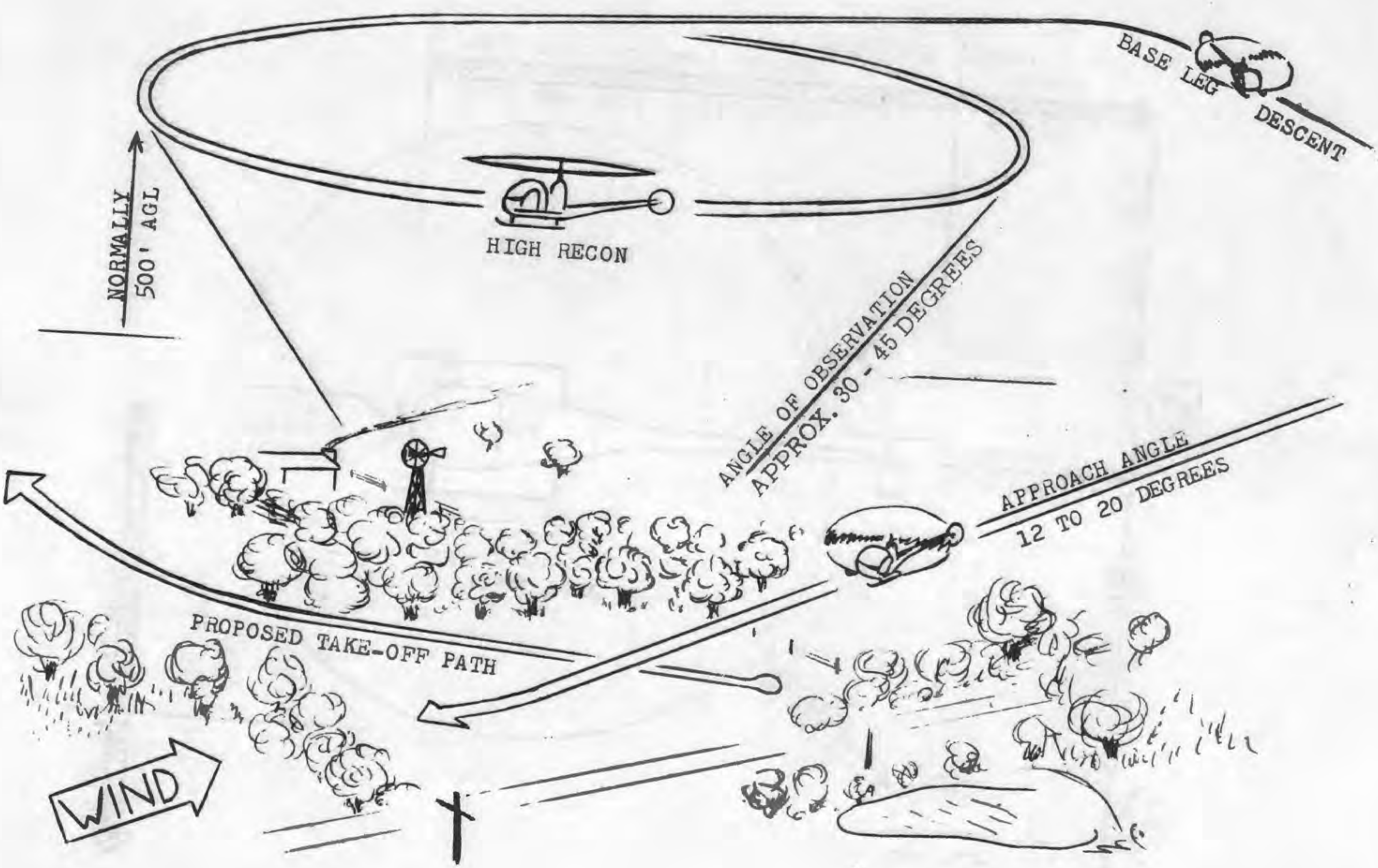
Selecting a Touchdown Point:

This point will normally be in the upper third of your area. This means that your approach will have to be sufficiently steep to clear the barrier and at the same time allow you to hit your landing spot.

Selecting a Take-off Path:

The take-off path should be into the wind. But again it is better to fly at an angle to the wind and have a forced landing area available than to fly directly into the wind without such an area. Another thing to be considered in selecting a take-off path is orientation. While you are in the air, you should

FIGURE 10 CONFINED AREA OPERATION



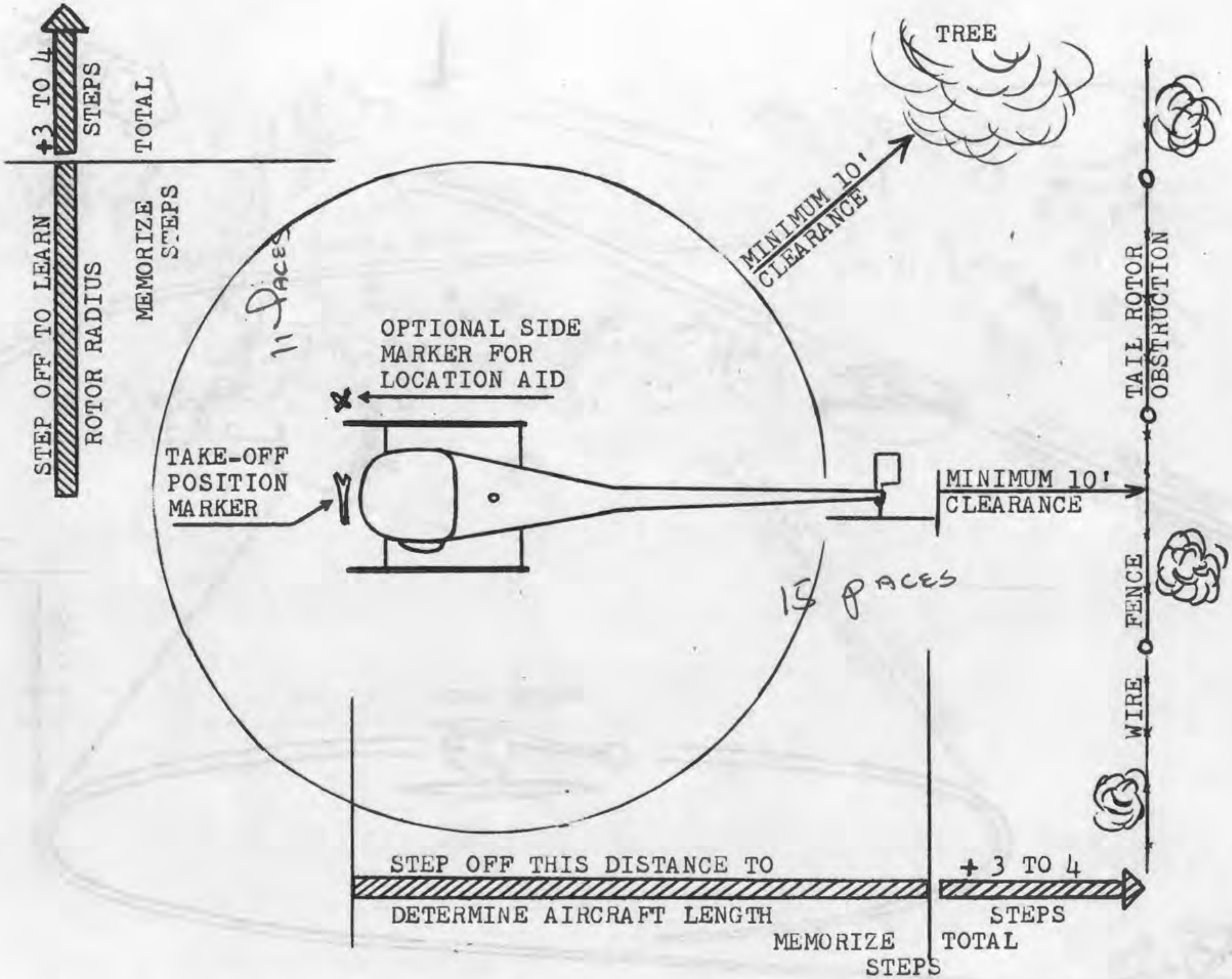


FIGURE 11 AIRCRAFT POSITION MEASUREMENTS

pick out check points to keep you well oriented when youare on the ground. On the ground you want to be able to find the exact take-off path that you selected in the air.

Low Reconnaissance:

Entry:

A low reconnaissance begins shortly after you have entered your approach into a confined area or pinnacle and ends at touchdown. At this point, objects on the ground can be better identified and the height of barriers better estimated.

Your view of the approach path is greatly improved. Even though you made a decision in your high recon on the approach angle, you are not bound by that decision. Anytime on the approach that you decide to alter your flight path you are permitted to do so. However, if there is a major change in angle of descent, make a go-around.

Technique:

In the low recon, you want to verify what you saw in the high recon and pick up anything you may have missed. Check especially for wires, slopes, and small crevices because they are especially hard to see from higher altitude. The low recon of the touchdown area should be done thoroughly and quickly.

Touchdown Area:

We want to make sure that our landing spot is unobstructed. If it is not clear select another spot and proceed to it.

Approach to a Confined Area:

Preparatory:

The preparation and plan for an approach to a confined area is accomplished in the high reconnaissance. A flight pattern should be established prior to the approach, that should approximate the stage field traffic pattern. Direct your flight path to a point where you can establish a simulated base leg. On this leg descend to an altitude of 200 feet and slow airspeed to 40 knots. Increase RPM to 3200 upon leaving your hi-recon altitude. Turn on final and follow your pre-determined approach path. The approach path should be generally into the wind and at the same time you are over terrain that minimizes the time you are out of reach of a forced landing area.

Entry:

The approach should be as close to a normal approach as possible. The angle of descent should be no steeper than a steep approach. If the approach requires a steeper angle, it is best to forget about landing in that area. In general, if a steep approach will get you into an area, a maximum performance take-off will get you out. Never go into an area when you are not sure you can get out of it.

Maintaining:

The low recon is carried out during your approach. If you decide to make a go-around, do so prior to losing effective translational lift. It is permissible to change your approach path at any time to avoid turbulence, obstruction, or to select a better point of touchdown.

Termination:

Ordinarily the approach will be terminated at a normal hover. In some instances, high grass or uneven ground may require hovering at a lower altitude to conserve the effect of ground cushion; however, extreme caution should be exercised. Keep hovering turns to a minimum. Do not turn unless you know your tail rotor is clear. You can never really be sure of the amount of obstruction in the area until you have made a ground reconnaissance. Select a suitable area and land. After you land slowly lower the collective pitch. Maintain 3200 RPM until you get your pitch to the full down position. Then move the cyclic control in various directions to determine the stability of the helicopter on that particular terrain. If the helicopter moves or begins to slide, taxi or hover the helicopter a few feet to obtain a secure and safe position. Check the cyclic again; if the helicopter remains steady, level the rotor disc with the horizon.

Ground Reconnaissance: (See Fig. 11)

Preparatory:

After your touchdown in a confined area or pinnacle, you begin the ground reconnaissance. This reconnaissance is never made from inside the aircraft. Before getting outside the aircraft, reduce engine RPM to 2200, place the carburetor air in cold position, and apply friction to the throttle and collective pitch.

Technique:

When you get out of the aircraft be very careful not to walk upslope under the main rotor. The first thing to check is the direction of the wind. A good way to do this is to walk well in front of the aircraft and throw dust or grass into the air and observe the direction in which they are blown. Next walk back to the barrier or tree line on the downwind end of your area, observing all barriers or obstructions in the area. You will want to use a maximum amount of available area for take-off even though you have a large area. Pace off one helicopter length plus 3 or 4 paces (9 to 10 feet) from the downwind barriers or obstructions. This is the point the nose of the aircraft will be over on take-off with the tail or main rotor 3 or 4 paces (9 to 10 feet) from the barrier. Place a sturdy marker, such as a heavy stone or log, at your take-off point. Make sure your marker will not blow away.

Hovering Plan:

Hover at normal hovering altitude unless a lower hover is required to conserve the effect of ground cushion. If the area is wide enough, turn around and hover downwind to the take-off point. There should be about 10 feet of clearance on either side of the main rotor blades. If the margin is close, do not trust your own judgment. Pace off the distance!

When backward hovering is required, markers are used. In backward hovering you can't look back or guess what is behind you. You need markers to maintain ground track. Never use markers set up by other people who have been in the area ahead of you. It is possible that their markers have been moved or were incorrect in the first place.

Under light and varible wind conditions, recheck wind direction just prior to returning to the helicopter to be sure that the wind has not shifted.

Take-Off from a Confined Area:

Preparatory:

After completing your ground reconnaissance, you will be ready for take-off. You will have to release the friction on the collective pitch and throttle, adjust carb heat and make a high speed magneto check to be sure the engine is running properly and the plugs did not foul while the engine was idling. Then hover to your take-off point as the situation requires. Keep the tail rotor at least ten feet from any obstacle. You want to use all the available area for the take-off. At the same time you must maintain approximately 10-foot clearance between the tail and the down-wind barrier. If you do not keep this clearance, poor technique, rough control touch, or turbulence could drive the tail back into the barrier. The addition of a few feet to the take-off path would add only a few inches to the amount of clearance over your up-wind barrier.

Just prior to take off it is especially important to look behind and overhead for approaching aircraft.

Entry:

Take offs are started from the ground holding approximately a 30 knot attitude and using full power. Your flight path should be over the lowest barrier and generally along the long axis of the area that allows you to take advantage of the wind and terrain. The angle of ascent will be the same as the maximum performance take off made at the stage field. It is better to clear the barrier by a few feet at normal RPM (3200) than to sacrifice RPM by attempting to clear the barrier by a greater margin. As soon as the barrier has been cleared or you reach an altitude that will safely clear the barrier, resume a normal climb in the same manner as you did at the Stage Field.

Maintaining:

Wind conditions need to be considered seriously during your take-off. In general, flying over good terrain is preferable to heading directly into the wind. This is true only up to a point depending on the velocity of the wind and relative height of the barrier. If, to avoid unsuitable terrain you flew at a 90-degree angle to the wind, you would lose all the additional lift the wind provides. Your take-off angle could not be as steep and you might run out of pedal control.

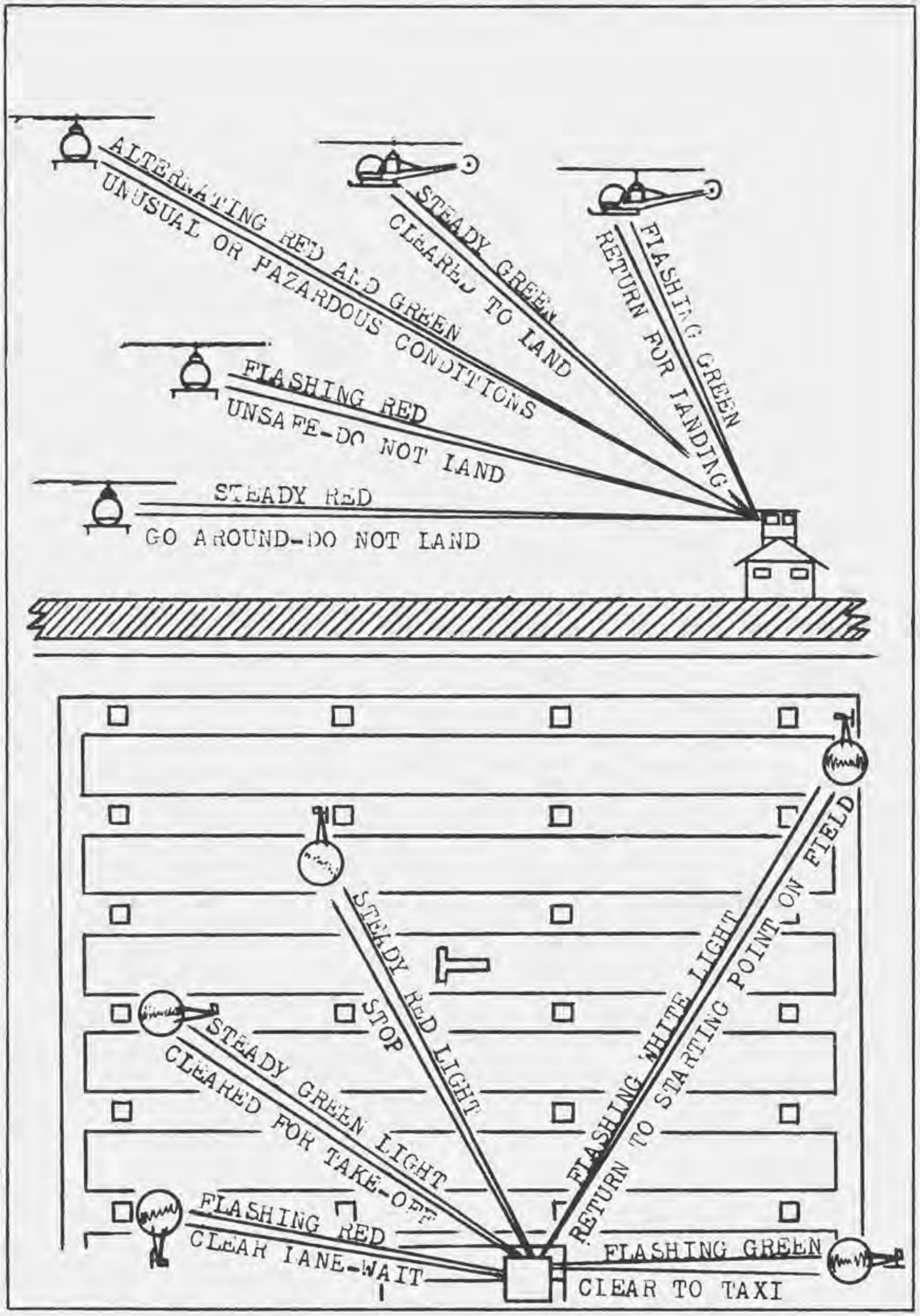


FIGURE 12 VISUAL SIGNALS

Pinnacle Operations:

Preparatory:

The operation is begun with a high reconnaissance. If it is necessary to climb to a high altitude to reach a pinnacle, it should be kept in mind that the helicopter will not perform as well at high altitudes as at low altitudes. Whenever possible, climb to altitude on the windward side of the pinnacle to take advantage of upward air currents.

Approach:

Establish a flight pattern in the same manner as for a confined area. The approach should be made as nearly into the wind as possible. However, during the high reconnaissance a "terrain evaluation" must be included. The "terrain evaluation" will determine the directions of approach to the pinnacle. The direction chosen should be generally into the wind but may be varied so as to allow a "break away" from the approach or execute a "go-around".

There is usually a lot of turbulence around a pinnacle, updrafts on the upwind side and down drafts on the downwind side. When turbulence is suspected on the downwind side of a pinnacle, a low reconnaissance is performed to check turbulence severity and available power for the aircraft. The low reconnaissance is terminated when winds, turbulence, and power have been evaluated. At that time a "go-around" or "break away" is executed.

The final approach should be as near to a normal approach as possible, dependent on barriers, turbulence, and power available. If turbulence was encountered, the approach should be steepened to avoid the turbulent area. If sufficient power is not available to perform a normal or steep approach without danger of "falling through" the approach must be shallower. During the shallow approach the airspeed will be carried longer in the approach with a slight deceleration executed prior to touchdown.

Low Re-con:

NOTE: Same as for a confined area.

Termination:

NOTE: Same as for a confined area.

Ground Re-con:

NOTE: Same as for a confined area.

NOTE:

A steep approach is used to a pinnacle only when an excessive downdraft is determined or when a barrier exists in the landing path that would necessitate a steepening of the approach.

NOTE:

A shallower than normal approach is used when the A/C and load cannot be hovered out of ground effect.

NOTE:

On the approach to the pinnacle, up to 90 degrees of the wind may be sacrificed to afford a better approach route. i.e., forced landing areas, low barriers, break away path, etc.

Take-off From A Pinnacle:

Release the friction from the collective and throttle, adjust carb heat and make a high speed magneto check. Clear yourself prior to pick up, then hover to the pre-determined take-off point as the situation requires. Use all the available area for take-off, and at the same time maintain approximately a 10-foot clearance between the tail and/or main rotor and any barriers. Ordinarily the take-off will be made from a hover. Since you will have plenty of altitude as soon as the aircraft clears the edge of the pinnacle, the main concern on take-off is to gain airspeed. The airspeed gained will cause a more rapid departure from the slope of the pinnacle. In addition to covering unsafe ground quickly, a higher airspeed affords a more favorable glide angle and thus contributes to the chances of reaching a safe area in the event of forced landing. If no suitable area is available, a higher airspeed will permit the pilot to execute a flare and decrease forward speed prior to autorotative landing. Do not dive the aircraft off the edge of the pinnacle. Merely make the take-off without gaining altitude, adjusting to normal climb power setting as effective translational lift is reached and accelerate to the normal climb airspeed.

If the aircraft must take-off over a barrier or a difference in terrain, the following types of take-offs will be used.

1. Take-offs from pinnacles, when the direction of take-off is over terrain of the approximate same level, will be made in the same manner as a confined area take-off.

2. When the take-off is from a true pinnacle with barriers and there is sufficient area to gain translational lift prior to reaching the barrier, the take-off will be made from a hover. After clearing the barrier change the altitude over airspeed back to airspeed over altitude.

3. When the take-off is from a true pinnacle with barriers and there is any doubt about having sufficient area to gain translational lift prior to reaching the barrier, the take-off will be made from the ground, in the same manner as a confined area take-off. After clearing the barrier, change the attitude back to airspeed over altitude.

Slope Operation:

Entry:

At the termination of your approach, hover toward the slope taking care not to turn the tail of the aircraft upslope. It is usually best to land the aircraft sideward rather than upslope. As you come into position over the slope, hover the aircraft to a stop. Do not stare at the skids. If you stare at the skids, a slight movement will cause you to overcontrol and throw you out of position for a slope landing. So hover into position and then focus your vision out front again. (8^0 is the maximum angle you can make a normal slope landing with the OH-23D.)

Landing:

Put a slight downward pressure on the collective pitch to start the aircraft descending slowly. As your upslope skid touches the ground, apply cyclic pressure in the direction of the slope; this will hold the aircraft against the slope while you let the aircraft down with your collective pitch. As you reduce the pitch, continue to move the cyclic toward the slope to maintain your position. If the hub hits the mast you should not land. The slope must be shallow enough to allow you to hold the aircraft against it with the cyclic during the entire landing.

After the downslope skid is on the ground, continue to lower your collective pitch all the way to the bottom. Maintain 3200 RPM while you trim your cyclic in the upslope position and assure yourself that the full weight of the aircraft is on the skids. In this way you make sure that you have adequate RPM for take-off in case the aircraft should start to slide down the slope.

Slope Take-off:

The procedure for take-off is almost the exact reverse of that for landing. Adjust your engine RPM to 3200 and move the cyclic in the direction of the slope. Then begin to apply collective pitch as smoothly as you can. As the aircraft gets light on the skids, apply whatever pedal you need to maintain your heading. When the downslope skid has risen and the aircraft approaches a level attitude, move the cyclic back to the neutral position. Continue to apply collective pitch and pick the aircraft straight up to a hover before moving away from the slope.

Things to Remember:

If your selected touchdown point contains a slope greater than eight degrees, DO NOT attempt a landing with the OH-23D.

Divide your attention between flying the aircraft, looking at the area, and remaining clear of other aircraft. Do not fly through traffic patterns during a reconnaissance or when taking off and landing in any area. Maintain a constant airspeed and altitude except when you change it for a valid purpose.

When approaching a confined area or pinnacle you should select a landing point in the upper third of the landing area in order to eliminate the necessity for a very steep approach. Care should be taken, however, so the the final stage of the approach will not be conducted in turbulence which may be present at the far side of the area, (in small areas you have no choice in avoiding turbulence.)

If the wind is favorable, try to plan to approach and take-off over the lowest obstructions. Also try tl utilize the length of the area for the take-off and approach.

The angle of descent on an approach to a confined area should be kept as near normal as possible and still safely clear obstructions.

Use your own judgment when working a confined area, or pinnacle, and do not try to outguess your instructor or check pilot. There is normally more than one solution in working any area, so learn to use your judgment in evaluating the existing factors, and profit from your instructor's experience when he suggests a better method for working a particular area. Of course, conditions change and you cannot stereotype the approach or take-off at any area.

CHAPTER VII

NIGHT FLYING

Introduction to Night Flying:

Night flying is a very important phase of your pilot training. It is another step toward making you an all-around Army pilot. This phase is designed to make you as proficient a flyer 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 fly an aircraft at night in the same manner as in the daytime. Moreover, night flying is smoother than day flying because of the absence of thermal or convection currents. As with an automobile, even the engine of your aircraft will sound smoother than it does in the daytime. Generally speaking, any apprehension that you might have about night flying will result from the restictions placed on your visibility. Once you overcome the feeling of strangeness because of the visual limitations, you should have very little difficulty in flying at night.

Night Vision:

Many persons do not know the facts about night vision; others do not even know anything can be learned about it. You will never see as well as an owl, but you can learn to do a better job of seeing at night.

There are three reasons why it takes training and practice to improve your night vision. Your mind and your eyes are a team. To see well, both members of this team must be used effectively. Your eyes are formed in such a fashion that you must learn to use them differently at night than you do during the day. Your eyes do not automatically tell you what you see as they do in the daytime, and familiar things appear differently. Therefore, it takes practice to recognize objects which your eyes see at night.

It is important that you understand how your eyes are constructed and how they are affected at night.

The light-sensitive nerves ending at the back of your eyes are of two types - rods and cones. Cones are located in the center of your eye or rather in the center of the retina, the layer upon which all images are focused. This layer may be compared to the film in a camera. Surrounding the cones, then, are the rods. These rods and cones are innumerable. The cones, in the center of the eye, are used to see color, details, and far-away objects; the rods, on the other hand, located around the cones, do not see color but only shades of gray. Neither do they pick up any details. Rods are working when you see something out of the corner of your eyes. These rods pick up objects, particularly those which are moving, but do not give you a detailed picture of these objects. Both rods and cones are used in daytime vision.

Although there is no rigid division of functions, the rods, generally speaking, make night vision possible. The rods and cones function in daylight and in moonlight, but in anything darker than moonlight, the process of vision is placed on the rods. In other words, as the cones lose their efficiency the rods take over; the rods are sensitive to 1/5000th of the intensity at which the cones lost their effectiveness. You may recall that the last time you walked into a darkened theater you had difficulty in finding a seat and seeing people for the first few minutes. You could not see anything until your eyes became adjusted.

As you go from a well-lighted room into a dimly-lighted or darkened room, your pupils first enlarge to let in any light that may be present. After the first five to ten munutes your cones become adjusted to the dim light, and your eyes become 100 times more sensitive than they were when you first entered the room. It takes much longer for your rods to become adjusted; but when they do, your eyes are 100,000 times more sensitive than they were before you entered, and you can see a great deal if you know how. This adjustment of the rods takes at least 30 minutes.

Now, take just the opposite of this process. As you walk out of a theater or darkened room into bright light, your eyes are dazzled by the brightness, but in a very few minutes they become completely adjusted. This reaction is so rapid that only seconds in bright light will result in your eyes losing all of the adaption to the dark. If you now re-entered a darkened room, your eyes would have to go through the long process of adapting to the darkness again.

Since you cannot see in the dark unless your eyes are adapted, and since it takes 30 minutes for this process to take place, the first rule is to adapt your eyes and keep them adapted.

Obviously, you could sit in the dark for 30 minutes before every night flight. There is however, a better method of night adaption. It has been found that you can see with the cones in red light while the rods are still not sensitive to red light and, for all practical purposes, are "in the dark." This means that if you sit in a red-lighted room or, when available, wear red adaptation goggles in ordinary light, the rods will adapt themselves while you use the cones to read or play cards. After 30 minutes in this light your eyes are ready for the real experience.

Incidently, red light is harmless and will not injure your eyes. It has only one disadvantage - you will not be able to see red markings on maps and charts.

Now that you know how to develop your night vision, you must learn the precautions or rules to keep your night eyes. Ideally, this would be to avoid all but red light. However, it is not as easy as that; you must learn the practical way as well as the ideal. You can avoid many things injurious to your night eyes. Even the flare of a match or brief flash from your flashlight will seriously interfere with their adaptation to darkness. Use only as much light in your aircraft as is essential. Practice blindfold drills. Pilots should train themselves to do all manual operations without light. The pilot who does not need a light to find his way around a cockpit is well on his way to becoming an effective night pilot.

Of course, you cannot read instructions or charts without lights, but you can use as little light as possible. Always study your charts thoroughly before a flight so that you will not have to pore over them during flight. Staring at instruments tires the eyes and may reduce effective vision as much as 50 percent. While flying with lighted instruments, look at them as briefly as possible and keep all lights turned low.

When you use white light, slip on your adaptation goggles. If they are not available, preserve the adaptation in one eye by covering or shutting it. When you open it again in darkness you will be able to see with it while the other eye is re-adapting.

Searchlights can blind pilots instantly and, during the war, often caused the pilots to crash or to be thrown off the target. Protect yourself from these harmful effects and learn a discipline to follow while flying at night. It will benefit you on any flight and may save your life in combat flying.

After you have adapted your eyes and learned to keep them adapted, your night-seeing problems have just begun. When something catches your attention out of the corner of your eyes, ordinarily your eyes turn toward the object to get a better look at it. This is the right way to look in daylight when the point of sharpest vision is at the center of your eye. It is all wrong at night. When you look directly at an object, you are trying to see through your night blind spot in the center of your eyes. Night vision is impossible at the center of the eyes. To take advantage of the rods at night, always look slightly to one side of the object you want to see.

When you catch an object out of the corner of your eyes, try to hold your eyes just a bit off center so that you will have the object at the point of maximum sensitivity. If your eyes move irresistibly toward the object, let them swing through so that you can pick it up again at the other corner of your eyes.

If you see an aircraft or object and then lose it, do not try to bore the darkness to find it again. Instead of staring at the spot where you lost it, move your eyes around the spot in a circle, focusing always slightly away from that point. If the aircraft or object is there, you will spot it again by looking to one side of it, or over or under it. It takes practice, but it works.

Learn to move your eyes frequently in dim light. The rods tire quickly and are at their best only for short periods. As you search, do not sweep the sky or sea at random; scan by searching a small area carefully and then jumping your eyes to the next area. You can see very little while your eyes are in rapid motion, but they are sensitive just after moving. Move them in short jumps so that you see all parts of the search area in succession. Move your eyes more slowly than you would move them in daylight. Blink your eyes if an image becomes blurred.

Since this type of seeing is not second nature, you will have to practice it until it becomes automatic. Remember that every bit of training and practice you give night seeing will repay you in better seeing.

Night Recognition:

In daylight you see the color and detail of an object as well as its size and the contrast it makes against its background. From a lifetime of experience and practice you interpret what your eyes pick out and thus identify the things you see. You use your night eyes in the same way, except that your rods, when adapted to darkness, are insensitive to color and do not see detail. Therefore, you depend entirely on the size of an object and the contrast between the object and its background to see it. This means that at night, familiar things look quite different from the way they look in daylight. Since you have not had as much practice in night seeing, as in day seeing, objects are also harder to identify.

Your eyes furnish you with so little information at night that you must be able to interpret the smallest clues in order to identify the objects your eyes pick out. Night conditions are so varied that it is impossible here to go into detail on night recognition. The important thing is for you to use every night flight to learn more about night seeing.

A common experience in night flying is vertigo, dizziness, special dis-orientation, or whatever you want to call it. It is sometimes worse just after a take-off from a lighted runway. The sharp change from bright light to utter darkness brings on an eerie feeling that everything is going awry.

At night, even more than in daylight, it is important for you to keep your windshield and windows clean and unscratched. Tests prove that a thin film of oil or dust on a windshield will reduce visibility by more than 50 percent. Haze, fog, dirt, scratches--anything that absorbes or scatters light--reduce contrast and make things harder to see. You cannot do much about haze or fog, but you can keep your windshield clean.

At night, vision is the first thing affected by the lack of oxygen. If your job in the air calls for sharpness of night vision, and if oxygen is available, use it from ground level on up. Your night-seeing margin is so small that the slightest lack of oxygen affects your seeing. At altitudes over 5000 feet, instrument markings seem dimmer. You begin to turn up the panel lights to see better. The more you turn up your lights in order to see inside your aircraft, the less you can see outside. You impair your night adaptation at the same time the lack of oxygen is making your eyes less efficient.

CAUTION: At 12,000 feet without oxygen, you cannot see nearly as well as on the ground. At 16,000 feet your sight is seriously impaired. Even though you do not realize how much it is affected, you cannot see as far and your vision becomes fuzzy around the edges. If you wait until you reach 16,000 feet before using oxygen, your eyes will not reach full efficiency again for several minutes. Do not wait until you reach 16,000 feet. If you need your night eyes, use oxygen from ground level up.

If you are a victim of vitamin shortage, this deficiency will impair your night vision. However, if you eat a well-rounded diet, extra doses of vitamins will not increase your night-seeing ability.

COMPENSATE FOR REDUCED VISION

Smoking and drinking heavily, as well as the use of many drugs, may reduce your night vision; so avoid these harmful habits. Since fatigue also impairs your vision, get plenty of rest.

Although your first night flights while in pilot training will not necessitate the best night vision, it may help you to get out of a difficult situation. Night vision will also be useful later on in your career; take heed, therefore, of the facts presented here; practice night seeing and increase your effectiveness as a pilot.

Things to Remember:

Adapt your eyes and discipline yourself to keep them adapted.

Concentrate on seeing.

Learn to look off-center.

Learn and use the techniques that give your eyes a break.

Practice blindfold drills.

Watch your physical condition and keep in training.

Later on in your flying career, when going to high altitude, use oxygen from ground up.

Night Flights:

Although you may be somewhat tense and apprehensive during your first night flight, you will find that the same techniques and procedures used in day flying will apply. This apprehension is quite normal, since flying an aircraft at night will be a new and different sensation to you. You may notice a series of lights being reflected from your canopy which could be glare from your instrument or cockpit lights; however, do not confuse these with lights of other aircraft. Once you realize that many things which appear strange at night are really quite normal, you will have overcome the biggest obstacle in successful night flying.

Night flying will demand more of you than day flying. You must be constantly alert for other aircraft in the area. 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 able to distinguish objects, as you look out of the cockpit, until your eyes become accustomed to the change. To eliminate confusion and the need for turning up the cockpit light unnecessarily, you should have a thorough knowledge of all flight and taxi cockpit procedures before flight.

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, because you will have to make most changes by feel alone.

Check-out:

Dual instruction will be comparatively brief. Your instructor, however, will show you the local flying area, any prominent landmarks, cities or towns, and any points of interest that may help to keep you orientated.

Normally, a regular day-traffic entry will be used in the traffic pattern with the exception of radio calls. The instructor will usually demonstrate the first landing to you. You will then take over the aircraft and 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. Generally, traffic at night will be controlled by radio from the control supervisor; and you will be required to have a thorough knowledge of all light signals. These light signals will be covered in the local flying regulations, and you will receive a thorough briefing prior to night flying.

Solo:

Turn up your radio volume before take-off. Adjust your instrument lights as low as practical.

When flying in the traffic pattern or other congested areas, be especially vigilant for other aircraft. Look around constantly for aircraft identification lights. You may also see aircraft exhaust flames. Any time you see two closely positioned lights, a red and a green light, an aircraft is flying toward you because then you see the left "red" navigation light, and the right "green" navigation light.

Any time you are in the traffic pattern, be careful not to overtake another aircraft. Look for the "white" tail light.

CAUTION: If your engine should fail on take-off, there is only one thing to do--land straight ahead or you may make a slight turn, but only to avoid obstructions. Don't ever try to turn back to the field.

Landings:

The same techniques and procedures used in day landings will be used at night.

Things to Remember:

Make time allowances for the additional procedures and checks to be made prior to any night flight.

Because of the increased load on the aircraft's electrical system, while it is stopped on the ground, you may have to idle the engine slightly faster than in the daytime to assure operation of the generator.

Keep your instrument and cockpit lights turned down to a minimum.

Because of restrictions on visibility at night, the aircraft should be hovered at a slower rate.

When taxiing at night, do not shine your landing lights where they may "blind" another aircraft.

Night Flying Procedures:

Restricted vision present in night flying requires that all aircraft, operating in the confines of a traffic pattern, conform strictly to prescribed procedures. Preceding night flying all students will be briefed thoroughly on night flying procedures, however, the following should be studied to aid in retaining these procedures.

1. PREFLIGHT:

(a) Aircraft to be used in night flying will be preflighted prior to darkness so that a close visual inspection may be accomplished.

(b) In addition to the normal prescribed preflight the navigation lights, landing light, and instrument lights will be checked for proper operation.

(c) All students will assist in accomplishing the initial preflight inspection on the aircraft they are assigned to fly.

(d) No aircraft shall be used for night flying that does not have a properly operating radio (transmitter and receiver). Be sure to check the radio during warmup.

2. CALL SIGNS:

(a) Call signs will be assigned preceding night flying, and are to be used at the stage field for radio calls instead of the aircraft number.

(b) The call signs will indicate the traffic that will be used at the stage field. Echo aircraft will operate in east traffic and Whiskey aircraft will operate in west traffic.

3. TAKE-OFF (HELIPORT):

(a) Obtain take-off instructions as in normal day flying.

(b) Use landing light while hovering at the Main Heliport during darkness and proceed with extreme caution.

4. STAGE FIELD ENTRY AND PATTERN:

(a) Tune the radio to the stage field frequency after departing the heliport traffic and well in advance of entering stage field traffic.

(b) Aircraft, when turning onto 45 degree entry leg, will turn on landing light, and call the Stage Field Control as follows: "Control, Echo Two entry." Control will acknowledge and issue instructions.

(c) When you are well established on the downwind leg turn off the landing light.

(d) Airspeeds in the traffic pattern will conform to day operation airspeeds.

(e) Aircraft, when turning base leg, will call the Stage Field Control for the desired lane as follows: "Whiskey Two base Two." Stage Field Control will acknowledge and issue instructions, and you should acknowledge Control's instructions. Note: Use lanes 1 and 2 for normal approaches and lane 3 for autorotations in West Traffic. Use lanes 5 and 6 for normal approaches and lane 4 for autorotations in East Traffic.

5. APPROACHES (STAGE FIELD):

(a) Approaches will be made to the downwind light. Students will make no approaches solo without the landing light, except in an emergency (electrical failure).

(b) Do not turn the landing light on until just before initiating the approach.

(c) Exercise caution in maintaining alignment with the lane on final and during the approach.

(d) Go-around procedure will be as follows: The pilot will establish a normal climb then turn on the landing light and call Control, "Whiskey three on go-around lane three." Control will acknowledge. The pilot will climb straight ahead to traffic altitude and then to a point where the normal cross-wind leg is. At this point Control will advise him to either remain in closed traffic or leave traffic and reenter. He will then turn off his landing light and continue as advised.

6. TAKE-OFF (STAGE FIELD):

(a) Navigation lights will be checked as follows: The Control Supervisor, in clearing aircraft for take-off, will visually check all lights on the aircraft. This will be done when aircraft are making clearing turns. All pilots are required to report any burned out lights noted on other aircraft. Aircraft with a burned out light will turn on landing light and contact Control for instructions to proceed to the parking area.

(b) All take-offs will be rigidly controlled by radio from the Stage Field Control. Only one aircraft will be cleared for take-off at a time in the traffic pattern.

(c) To insure lateral spacing of aircraft for take-offs in different traffic patterns, at least one lane clearance will be maintained.

(d) Aircraft at the take-off panel will make a clearing turn. Control will clear aircraft for takeoff.

NOTE:

Aircraft in the same pattern will not be cleared for takeoff until aircraft on take-off has turned crosswind.

(e) Clearance to proceed to the parking area will be received from Control as follows: "Echo Two Lane Four clearance to parking area."

Control will issue instructions. Clearance to cross lanes must be received from Control.

(f) Clearance to proceed from parking area will be received from Control as follows: "Echo Two parking area clearance to east traffic." Control will issue instructions.

(g) Aircraft that has radio failure (either transmitter or receiver) will proceed as follows: Aircraft at the takeoff panel will turn on landing light and turn towards the tower for signal light clearance to proceed to the parking area. Aircraft in traffic will continue and after completing the approach proceed as outlined above. Aircraft not established in traffic will return to the heliport.

(h) Aircraft that has a complete electrical failure will proceed as follows: Aircraft at the take-off panel will proceed, using extreme caution, to the parking area. If in traffic, break out and return to Fort Wolters Heliport. The pilot will then notify the tower operator of his arrival and have the message relayed to the Stage Field Control.

7. AUTOROTATIONS (DUAL ONLY):

Upon completion of an autorotation, the pilot will clear and move to a position parallel to the take-off position of an adjacent lane. Control will issue instructions. Control may request that an aircraft take-off prior to reaching a point parallel to the take-off position in an adjacent lane to clear the lane for another aircraft on final, in the event this happens the pilot should take-off immediately.

8. DEPARTING STAGE FIELD AND ENTERING HELIPORT TRAFFIC:

(a) Aircraft departing the stage field will break the traffic 45 degrees to crosswind leg and the pilot will call the Stage Field Control as follows: "Whiskey Two departing traffic to return Heliport." Control will acknowledge.

(b) After clearing stage field traffic tune the receiver to the Heliport frequency and call the Heliport, usbg the aircraft's number, to establish contact and request landing instructions.

(c) When crossing the I. P. for landing at the main heliport the landing light will be turned on and will remain on until the aircraft is parked. The radio call over the I. P. will be as follows: "Wolters Tower, A/C Number, on entry."

(d) After completing the approach leave the landing light on and hover, using extreme caution, to the aircraft's parking spot. Be sure to leave the navigation lights on until the main rotor is secured.

9. LIGHT SIGNALS (See Fig. 12)

Color and Type	On the Ground	In Flight
STEADY GREEN	Clear for Take Off	Cleared to Land
FLASHING GREEN	Cleared to Taxi	Return for Landing
STEADY RED	Stop	Give way to other A/C. Continue circling
FLASHING RED	Taxi clear of landing area in use.	Airport unsafe. Do not land.
FLASHING WHITE	Return to starting point	Not Used
ALTERNATING RED AND GREEN	General warning signal	Exercise extreme caution.

CHAPTER VIII

NAVIGATION

During this phase of training you will encounter low level types of navigation. The knowledge gained here will be used on most navigation missions.

Aerial navigation is the art of flying an aircraft from one point to another and determining its position at any time 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 School flying will be valuable training 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 your first solo day navigation flight, you will be given a dual familiarization ride. 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 so that he can check your proficiency prior to your first solo navigation flight.

Preparation for a Navigation Flight:

There are many factors to consider in preparation for a navigation flight. These factors will vary, moreover, 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, range, landing and fueling facilities, and frequency 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 pre-flight 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. These are chart preparation, route survey, and flight log preparation.

Chart Preparation:

The very first step in preparing the chart is to select one which includes the area over which you will fly. As you learned in the classroom, there are many types of charts, each having its advantages and disadvantages. In your primary flying training, the Sectional Chart will be used because of the relatively short distances you will be flying and also because the main supporting type of navigation will be pilotage. The large scale of the Section Chart makes it more appropriate for pilotage techniques. Since a given area of the chart represents a relatively small portion of the ground, considerably more detail is shown on the chart.

After you have selected the proper chart, the next step is to draw the course line from the point of departure to the point of destination on the chart and determine the true course and distance. The course line can be drawn with either black or colored pencil (no red pencil). The important thing is to make sure that it can be easily seen. True course as you know is the angular distance from the true north to the course line, measured in a clockwise direction. It is determined by measuring the angle between the mid-meridian (the meridian lying closest to the mid-point of your course) and the course line. The mid-meridian is used because each meridian converges toward true north on the Lambert Conformal Chart and consequently will form a different angle with the course line. To fly an exact true course you would have to change heading constantly. Since this would be inconvenient, you can fly an average true course measured from the mid-meridian and any errors involved will tend to cancel out. Now you should apply variation to the true course to fly magnetic course. This is done by reading the various changes gradually as you fly from one place to another. To simplify matters, however, we can take the mid-variation line as long as the flight is in the same general area. Later on, when your flights extend over longer distances, the course will be broken into shorter "legs" and variation computed for each leg. As you learned in the classroom, if variation is west you should add it to the true course. This can easily be remembered by the saying "East is least and West is best." After you have applied this correction, write the magnetic course in large numbers on the right side of the course line and indicate the direction of the course by means of arrows. Now measure the length of the course. This can be done by using the appropriate scale on either the plotter or the bottom of the chart. You should be careful to use the statute-mile scale if you are using statute measurement and the nautical scale if you are using nautical measurement. At any rate, all facts used should be expressed in terms of common measurement. After you have determined the distance of the course line, you should write the distance directly below the magnetic course that you have just written on the chart. The next step is to place a small pencil mark to the right side and perpendicular to the course line at each ten-mile interval. At each twenty-mile interval you should write in the total distance to that point on the course line; that is, 20, 40, 60, and so forth.

You have now completed your chart for the first leg of your flight. Do the same for the remaining legs. Remember that the mileage should be begun anew at the beginning of each leg.

After you have prepared the chart for the entire flight, in the manner described above, start over, this time measuring and marking the courses in the opposite direction. Label the courses and mileages on the right side of the course line as before. Since you are now going in the opposite direction, however, the data will be on the opposite side of the course line. The reason for preparing a chart in both directions is that, in primary flying training, part of the students will fly the course in one direction and the remainder of the students will fly the course in the opposite direction. You may not know until the briefing just before the flight which direction you will be flying.

Route Survey:

After you have completed the chart examine the route very carefully. Note the following:

1. Elevation of terrain (with particular attention to hills or peaks).

2. Restricted, warning, and prohibited areas.

3. Emergency landing fields.

4. Location and frequency of check points.

A landmark used to establish the position of the aircraft is called a check point. It will also enable you, during flight, to compute ground speed and arrival time quickly and easily. A check point should be a unique feature or group of features along or close to your course. A landmark such as a large lake, although a very good reference in itself, would be a poor check point. A town at one corner of the lake, however, with an identifying highway or other feature would be an excellent check point.

The type of check point used will vary with the type of terrain over which you are flying. In open areas or farm country, almost any town or any combination of railroads or roads may be used. A railroad by itself, again, is a good reference point; but, to be a good check point, it would have to have some identifying feature to tell you at what position along the railroad you are. In more densely populated areas, such minor features as small towns close to similar towns, secondary highways, and so forth make poor check points. In such areas it is easier to identify principal highway junctions or large cities with distinct shapes.

A single large city or town itself would provide definite identification, and some prominent feature such as an airport or race track would indicate your exact position. Sometimes, when the only available check points are several towns approximately the the same size, they may be distinguished by comparing the pattern of roads and railroads leaving the towns.

There will be the possibility, however, that the check point you have chosen will be mistaken for some other group of similar features. Also, in arid regions or areas affected by drought, lakes and rivers may not appear as such on the ground. If this is the case, position identification may sometimes be made by continuing on course and checking another reference point that will positively identify the check point.

In forested areas the swaths cut for pipe lines or power lines can serve as good reference lines. In mountainous areas, mines, ranger station, peaks, and passes may be used. In deserts, where check points are few, such minor features as ranches or houses may be used.

The check points generally should not be more than fifteen minutes flying time apart. Sometimes the nature of the terrain will make the distance greater. The value of having check points close together is that corrections can be made before you fly too far off course.

After you have selected your check points, mark each one by drawing a circle around it so that it can be easily found on the chart during flight.

The Flight Log:

The next step in preparing for the flight is to fill out the flight log. The Flight Log is a record of all courses, headings, distances, speeds, check points, and other data important to the successful completion of the flight. It provides you with an organized record and schedule for the flight, thereby minimizing the possibility of forgetting important data and having to compute many problems in the air.

There are many forms of flight logs, each designed for a particular purpose. The Flight Log that you will use lists only information which is fundamental to a navigation flight.

Preparing the Flight Log:

First enter your name, the date, and the navigation flight to be flown. Then enter the total distance and true courses as measured on your chart. Now enter in the space provided the variation that you previously found for each leg. Remember that wind speed is usually given in knots.

The next step is to fill in all the data pertinent to the navigation flight. Write, in the spaces provided, the names of all of your check points in their proper order. Now fill in the column labeled "Distance from last Check Point." Notice, there is a horizontal line dividing each space into equal halves. In the top half you should write the distance of each check point from the previous check point. In the bottom half you should write the total distance from the beginning of the leg to the check point. Notice that the space for the first check point has no horizontal line. This is true because the distance from the last check point and the total distance will be the same. Now follow the same procedure for the remaining legs. Normally, this will be accomplished by the class as a group, so that all students will have the same check points in order to simplify the briefing before the flight. You have now completed as much of the log as you can prepare before the briefing for the flight.

On the day you are to make the navigation flight, additional data will be available to enable you to complete your pre-flight preparation of the flight log. Winds aloft, temperature aloft, flight altitudes, and cruise control data will be posted for your use. With the use of your computer, calculate true airspeed, true heading, ground speed and estimated time enroute to the check points. Now you can compute your magnetic heading by applying variation to the true heading. This correction is made in the same manner as you corrected true course for variation. Remember, east is least and west is best. Enter the magnetic headings in the space provided. After you have done this, you will be able to fill in the blanks labeled "Wind", "Drift Correction", "True Heading", "True Airspeed", "Ground Speed" and "Time from last Check Point". Notice that the blanks under "Time from last Check Point" have a line diagonally across them. In the top space opposite the first check point there is no diagonal line, since the time from the last check point and the total elapsed time would obviously be the same. After you have entered all this data, add the total time for each leg and enter this time in the blank labeled "Total ETE.". This is the total time you expect to fly on the navigation phase of the flight: that is, excluding take-off and landing.

Now check your log. The only blanks you should have are those for deviation, compass heading, departure time, and the columns labeled "ETA," "ATA". and "Notes." These will be filled out after you go to the aircraft and during flight.

Pre-flight Briefing:

Just prior to the flight there will be a briefing of all students. The purpose of the briefing is to tell you just what will be done and how it is to be done. The briefing will include all of the pertinent data necessary for the successful completion of the flight, and it will give you the opportunity to check your own computations. It will also include any information peculiar to your primary flying school. Not all of the data that will be contained in the briefing can be written down in a set of rules; however, all briefings will cover the following main points:

1. Aircraft assignment and take-off interval for each student:

Take-off interval will be expressed with reference to H hour. For example, the first aircraft will take off at H hour, the second aircraft at H plus two, the third aircraft at H plus four, and so on. Later on, either during the briefing or after the briefing, H hour will be announced. Suppose that H hour is 0930 hours. This means that the first aircraft will take off at 0930, the second at 0932, and the third at 0934.

2. Route briefing:

Check points and danger, caution and restricted areas.

3. Flight log data:

Cruise control, true airspeed, winds aloft, speeds, variation, magnetic headings, estimated time between check points.

4. Weather:

Forecast weather and weather along the route.

5. Communications and "lost" procedures.

After all the information has been covered, you will have an opportunity to ask questions. If there is anything that is not clear in your mind, now is the time to ask about it. Do not start cross-country with any unanswered questions in your mind.

When all questions have been answered, the briefing will be concluded. At this time your instructor will check your charts and log computations to make sure that you have properly completed all the details. He will also answer any last-minute questions you may have.

The Flight:

You are now ready to begin the navigation flight. Before you go out to your aircraft, make sure that you have the following items: charts, flight log, plotter, computer, and a pencil. When you get to aircraft, go through your regular inspection and checks, paying particular attention to the fuel tanks. If the fuel tanks are not full, ask one of the mechanics to "Top" the tanks. Never take off with tanks that are not completely full. In an emergency, that extra 5 gallons may mean the difference between landing safely and landing short of the runway. After you are in the cockpit and have completed the normal checks, note the correction necessary for deviation as recorded on the deviation card for each of your magnetic headings. Write these corrections in the proper blanks on your flight log. Now apply these corrections to the magnetic headings and write in the compass headings in the proper spaces. These are the headings that your magnetic compass should indicate when you are flying in the proper direction.

Setting Course:

You are now ready to hover out and take-off. You should allow plenty of time in your planning to enable you to take-off at your previously assigned take-off time. Needless to say, if any student took off whenever he pleased, there would be considerable confusion. Before take-off, be sure to set your altimeter at the field elevation. Later in your training you will put the altimeter setting in the Kollsman dial and check the hands for field elevation. When you do this, the maximum allowable error is 75 feet. The advantage of using this method is that when you call in for landing instructions, either on return to your home base or on arrival at another field, the tower will give you a new altimeter setting. This new altimeter setting will adjust your altimeter for the existing pressure at your destination. When you land, the altimeter will indicate field elevation.

After you have climbed to your flight altitude, fly over the field on your first heading. This is called "setting course". Note the time that you set course and write this time in the space labeled "D". Before setting course, you should have accomplished your cruise-control procedure and have attained the proper indicated airspeed. The reason for setting course directly over the field and at your proper altitude is that your time en route computations will be more accurate. Later on, when you are more familiar with navigation techniques, it will not be necessary for you to climb to your altitude before setting course: you will climb on course instead. The slower airspeed used for the climb will be computed on the log.

In-Flight Procedures:

Now that you are on course, it is very important for you to maintain your proper heading. By doing this you will get a fairly accurate check on both heading and ground speed when you reach the first check point.

STAY ALERT

As you continue on course, you will want to check your progress over the ground by referring to the chart. The easiest and most convenient way to use the chart is to have it folded neatly, with only the particular area over which you are flying exposed. Align the chart so that the course line on the chart lies in the same direction as your aircraft heading. In this manner your check points and other landmarks will appear on the ground in the same relative position as they do on the chart.

During the time it takes you to reach your first check point, you can bring your flight log up to date. Draw a diagonal line across the space in the column labeled "ETA" and "ATA" (estimated time of arrival and actual time of arrival). Now add the time under the column "Time from last check point" to the time of setting course and enter this in the top space of "ETA" space. When you arrive at the first check point, note the time of arrival and enter it in the bottom space of "ATA" space. If every factor has been accurate and your computations correct, these two figures will be the same. In actual practice, however, your winds aloft information may be in error, and a slight correction will be necessary. If the actual time of arrival is not the same as the estimated time of arrival, it will be necessary to recompute the ground speed with your computer, using the time, rate, and distance method which you learned in the classroom. Enter this new ground speed under the "Notes" column and use this speed to compute your next ETA. If you are off course, you should compute your correction to converge on the next check point. This is the practical application of "off-course correction" on your computer as learned in the classroom. Estimating how far you are off course will require some practice. The more altitude you have, of course, the smaller distances appear. It will be necessary, therefore, to take into consideration your altitude above the ground. Many times it will be impossible for you to compare the distance that you are off course with some known distance on the ground. This can easily be done by measuring the distance between two known landmarks on the ground by use of your chart and mileage scale. Care should be taken, however, that your time checks are accurate and that you have maintained your heading. If you fail to hold your heading or do not record your time correctly, you cannot expect your next correction and ground speed computation to be accurate. Now do the same thing at your next check point. If your latest off-course correction and ground speed computation have been accurate, you will arrive at the next check point on your ETA: and you will be on course when you get there. The only thing you will have to do then is take up your new heading or heading to parallel.

The same method is to be followed for the rest of the flight. This procedure will be covered more thoroughly in the classroom and by your flying instructor.

One word of caution: Do not keep your head in the cockpit for too long a period of time. Remember to look around just as you did on your local flights.

Strange Field Landings:

On one of your navigation flights you will make a landing at a field other than your home base. This is called a strange field landing. Before landing at a strange field, you should be thoroughly familiar with all the pertinent information regarding the field. You will be concerned with direction of runways, elevation of field, landing hazards, and obstacles in the vicinity of the field. After you are graduated from flying training, you will have to find all of this information for yourself from the appropriate publications. During primary training, however, all of this will be done for you. You will be told all the necessary information during the briefing just before the flight.

When you arrive at the field, make a normal traffic pattern and landing. Be alert for hazards. Remember, however, that the elevation of this field will probably be different from that of your home base. For this reason your traffic pattern attitude will vary accordingly. After your landing, you will hover to a gasing area, refuel and take-off and continue on your flight.

You have just completed your first day navigation flight. Remember that although each flight will be different in specific details, in the future the same fundamentals that you have just learned will apply to each navigational flight you will make.

FORMATION FLYING

General:

Two or more aircraft, holding positions relative to each other and under the command of a designated aviator, constitute a formation.

Formation flying is required to move groups of aircraft with minimum confusion in the shortest length of time in order to facilitate the element of surprise and allow mutual support. Formation flying is not dangerous when flown correctly. It becomes dangerous only when the basic principles involved are violated.

Purpose:

In a tactical situation, the great majority of flying will be in formation. Because formation flying requires the pilot's undivided attention and skill, it is imperative that every pilot become familiar with flying, the duties and responsibilities of the pilot as well as co-pilot and most important, the necessity for flying discipline.

Types:

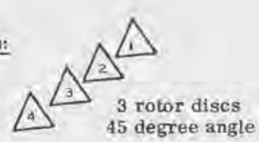
There are basically three types of formations:

a. Echelon (right or left)

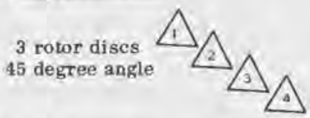
b. V - Formation

c. Trail Formation

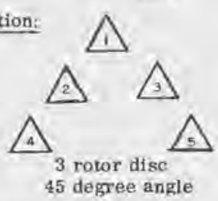
(Fig. No. 1) Left Echelon:



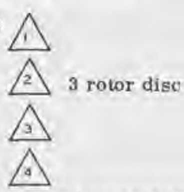
(Fig. No. 2) Right Echelon:



(Fig. No. 3) V - Formation:



(Fig. No. 4) Trail Formation:



There is lateral as well as vertical separation in all of the formations. Lateral separation is normally three (3) rotor discs at a 45 degree angle. Vertical separation is normally one to three (1-3) feet stepped up from front to rear of the formation.

Take-offs:

Formation flights are normally started on the ground. It is desirable to have an area large enough to accomodate all of the A/C in the formation. This allows each pilot to get into the correct position and space himself laterally. When signaled by the formation leader, roll the throttle to 3200 RPM. Be alert for the lead A/C or the A/C in front of you getting light on the skids.

During take-off in formation, constant power settings may be disregarded. Apply necessary collective pitch and power maintaining 3200 RPM to retain lateral separation as well as climb with the formation. Maintain directional control with pedals until approximately 50' above the ground at which time the A/C should be allowed to go into a normal crab.

In Flight:

Upon reaching the point where a turn is initiated, the aircraft's position in the flight will dictate the necessary maneuvers. For example, in a turn, A/C on the inside will have to lower collective pitch and slowly roll off throttle in order to dissipate airspeed. A/C on the outside will have to increase pitch and airspeed so that when the turn is completed, all aircraft will be in their original positions, properly spaced.

When in straight and level flight, learn to judge the distance from the lead A/C in number of rotor discs. The instructor will point out reference points on the lead A/C to be used to maintain a 45 degree angle. The vertical separation of 1-3 feet will be automatic after a little practical experience.

In order to become more proficient in formation flying, anticipate all turns, climbs, and descents. Make every move that the lead aircraft makes and always close on the lead A/C slowly and cautiously. Keep a constant separation in the flight both vertically and horizontally. The slightest deviation constitutes an accordian action throughout the remainder of the formation. This holds true for take-offs, in flight, and landings.

Landings:

The formation leader shall normally plan all landings to avoid turbulence and rotor wash if possible. For example, if there is a right crosswind, the formation leader alters the formation to right echelon in an effort to avoid turbulence from rotor wash from other A/C. Landings will normally be started at 300' and 40 knots. Increase RPM to 3200 and use whatever power is necessary to complete a normal approach. Maintain separation as stated in take-offs and in flight maneuvers.

Preparatory:

During preparations for a formation, the first important point to acknowledge is the fact that each number of the flight is a team member and should be prepared to take the lead and know what is expected of each member and each position. Know the hand signals and radio frequencies to be used. The designated flight leader should plan all climbs, turns and descents so that there are no abrupt movements and whenever possible, hold a constant airspeed and altitude.

The flight leader in determining the type of formation to be used, considers the following items:

a. Objectives of the mission.

b. Simplicity to permit easy control, facilitated flight discipline and afford reconnaissance capability.

c. Flexibility to meet different situations and ability to quickly close up to fill vacancies.

d. Mutual support and maximum protection.

e. Maneuverability for evasive tactics.

f. Provisions for rapid development of combined offensive and defensive power.

Pertinent Points:

a. The co-pilot should monitor instruments and navigate.

b. Be sure to receive or give a thorough briefing prior to each formation flight.

c. If staging area does not allow a line up for takeoff, A/C may link up after they are airborne.

d. If the landing zone cannot accomodate all of the formation, A/C may land as prescribed by the flight leader.

e. Proficiency in determining lateral and vertical separation comes with flying experience.

NOTE:

Combat attack formations will be introduced to you during your advanced phase.

CHAPTER X

Rotary-Wing Aerodynamics

Since this manual is intended primarily for pilots making the transition from fixed-wing to rotary-wing aircraft, this chapter will contain no extended discussion of the basic principles involved in the aerodynamics of flight. Instead, there will be but brief mention of the principles themselves, with the major emphasis on their application to the helicopter.

Although in many respects the helicopter differs radically from the conventional aircraft, rotary-wing aerodynamics is not something entirely new and different from fixed-wing aerodynamics. The same basic principles apply to both aircraft. During flight, the two types of aircraft are subjected to many of the same forces and affected by many of the same reactions. In short, the principles involved in rotary-wing aerodynamics are those basic principles with which the experienced fixed-wing pilot is familiar.

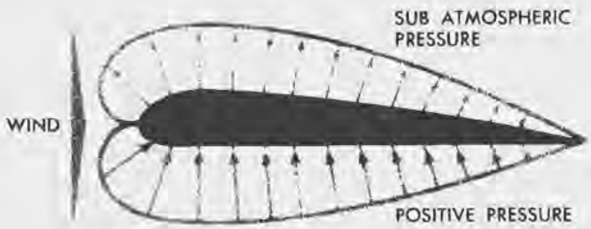
BASIC AERODYNAMICS

In flight, both the conventional aircraft and the helicopter are acted upon by four basic forces—*weight, lift, thrust,* and *drag.* In addition, both are affected by torque reaction.

Lift

Weight and lift are closely related in that weight tends to pull the aircraft—or helicopter—down, and lift holds it up. Right here is where the basic similarity between the helicopter and the airplane begins; both aircraft are heavier than air and both are supported by the reactions of airfoils to air passing over them. This reaction, or lift, is a result of pressure differential. The pressure on the upper surface is less than atmospheric, while the pressure on the lower surface is equal to, or greater than, atmospheric.

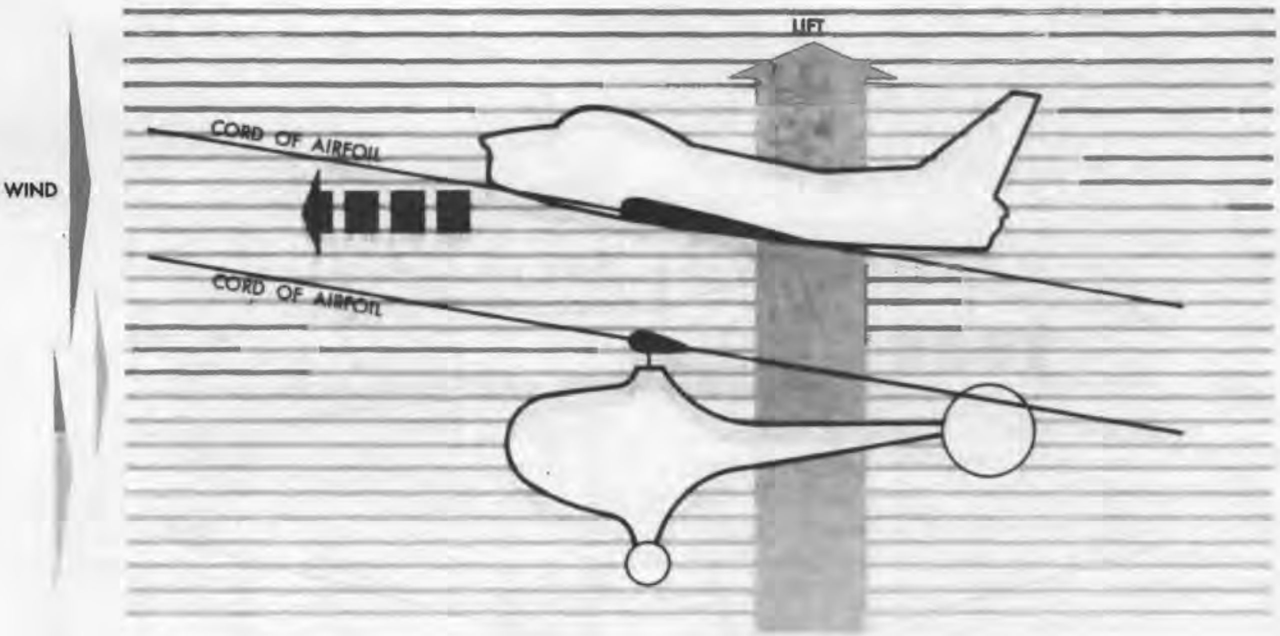
The conventional aircraft's airfoils are, of course, the wings. The helicopter's airfoils are the rotor blades. One aircraft has fixed wings and the other rotary wings, but the same basic principles of lift apply to both.



The length, width, and shape of an airfoil all affect its lifting capacity. However, for any one airfoil there are but two primary factors affecting the amount of lift the airfoil will develop. The relation between these two factors—velocity of airflow and angle of attack—and their effect on lift can be expressed as follows:

- For a given angle of attack, the greater the speed, the greater the lift.
- For a given speed, the greater the angle of attack (up to the stalling angle), the greater the lift.
- Thus, lift can be varied by varying either one of these two factors. Furthermore, increasing either speed or angle of attack, or both, (up to certain limits) increases lift.

VELOCITY OF AIRFLOW. Not only is velocity of airflow a primary factor affecting lift, but a certain minimum velocity is required in order that



Cords of an Airfoil

the airfoils may develop sufficient lift to get either an airplane or a helicopter into the air and keep it there. This means that, for either the airplane or the helicopter, the airfoils must be moved through the air at a relatively high speed.

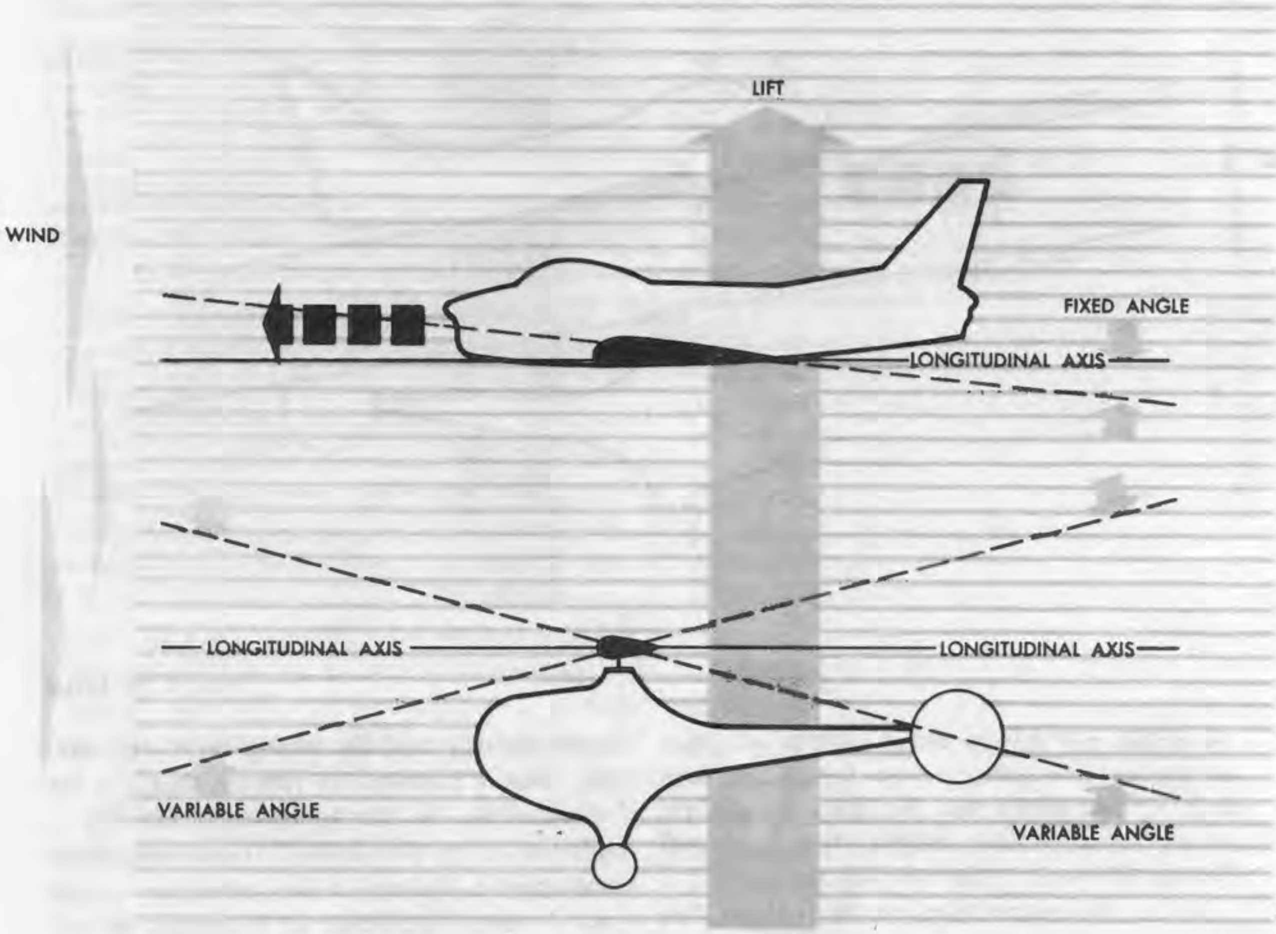
In the conventional airplane the required flow of air over the airfoils can be obtained only by moving the entire airplane forward. If the wings must move through the air at 100 knots to produce sufficient lift to support the airplane in flight, then the fuselage and all other parts of the airplane must move forward at that same speed. This means that the airplane must takeoff, fly, and land at relatively high speeds. Furthermore, it means that the airplane is limited to forward flight; it cannot fly backward or sideways.

The helicopter's airfoils must move through the air at comparatively high speed, too, to produce sufficient lift to raise the aircraft off the ground or keep it in the air. But here the required speed is obtained by rotating the airfoils. Furthermore, the rotor can turn at the required takeoff speed while the fuselage speed remains at zero.

Thus the speed of the airfoils (rotor blades), and the resultant velocity of airflow over them is independent of fuselage speed. As a result, the helicopter does not require high forward speeds of the entire aircraft for takeoff, flight, and landing. Nor is it limited to forward flight. It can rise vertically. It can fly forward, backward, or sideways as the pilot desires. It can even remain stationary in the air (hover) while the rotating airfoils develop sufficient lift to support the aircraft. In fact, all of these kinds of flight are normal for the helicopter.

ANGLE OF ATTACK. Velocity of airflow around an airfoil is but one of the factors affecting lift. The other factor is angle of attack. For either an airplane wing or a helicopter rotor blade, the angle of attack is the angle formed by the chord of the airfoil and the relative wind, as shown in the sketch.

With the conventional airplane, the angle of attack can be varied only by changing the attitude of the entire airplane. When, for example, the pilot wishes to climb, he pulls back on the control stick or column so that the airplane will take a nose-high attitude, thereby increasing angle of attack and lift. When he reaches the desired altitude, he levels off to decrease the angle of attack. When he wishes to descend, he pushes forward on the stick or column, causing the airplane to take a nose-low attitude.



Angles of Incidence

The pilot can increase or decrease the helicopter's angle of attack without changing the attitude of the fuselage. He does this by changing the pitch of the rotor blades by means of a cockpit control provided for this purpose. In fact, under certain flight conditions, the angle of attack continually changes as the rotor blade turns through 360°. This occurs whenever the rotor plane of rotation is tilted, as it is during forward, backward, and sideways flight. This tilting of the plane of rotation of the main rotor and the aerodynamics of the various kinds of flight will be discussed later.

ANGLE OF INCIDENCE. For the airplane, the final value of the angle of attack depends on the attitude of the airplane and one other factor—the angle of incidence. The angle of incidence, for either an airplane or a helicopter, is the angle formed by the chord of the airfoil and the longitudinal axis of the aircraft. The longitudinal axis of a helicopter is a line at right angles to the main rotor drive shaft.

The conventional airplane's angle of incidence is determined by the designer and is built into the aircraft. The angle of incidence cannot be changed by the pilot.

The helicopter's angle of incidence can be changed at will by the pilot—by changing the pitch of the rotor blades. Like the angle of attack, the angle of incidence continually changes as the rotor revolves whenever the control stick is moved from the neutral position and the rotor plane of rotation is tilted. Note the comparative angles of incidence, as sketched.

Airfoil Section

Airfoil sections used for airplane wings vary considerably—each being selected to meet specific requirements. The airfoil may be symmetrical or unsymmetrical, like the one shown here.

An unsymmetrical airfoil may be efficient for an airplane wing, but it has one disadvantage that makes it unsatisfactory for use as a rotor blade. The center of pressure "walks" forward and rearward as the angle of attack changes. The center of pressure is an imaginary point on the airfoil where all of the aerodynamic forces are considered as being concentrated. On an unsymmetrical airfoil the center of pressure is toward the rear of the wing at small angles of attack, and moves forward as the angle of attack is increased. This forward movement continues until the angle of attack is approximately the same as the angle of maximum lift coefficient.

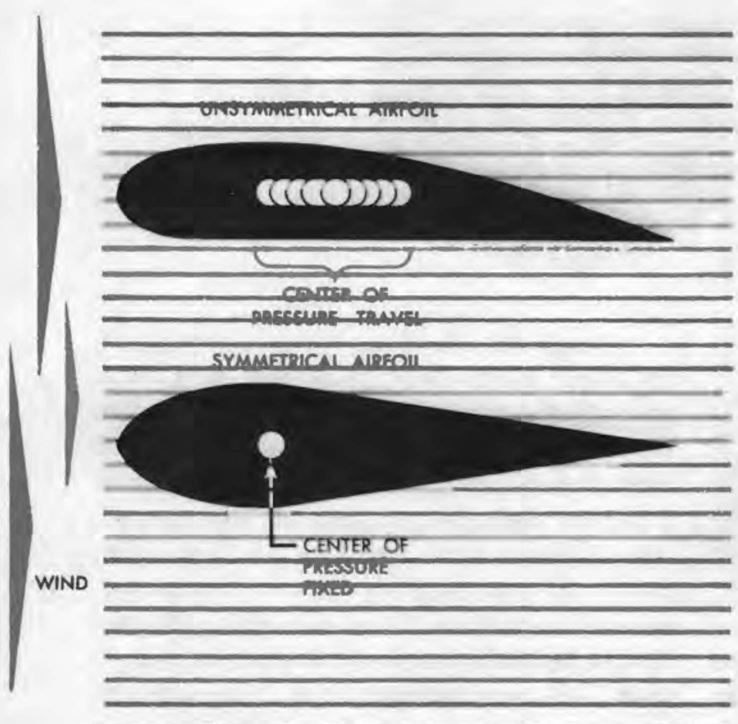
The center of pressure cannot be permitted to walk back and forth on a helicopter rotor blade, since shifting of the center of pressure would introduce pitch-changing forces. This would be undesirable—and dangerous. Therefore, the center of pressure travel is controlled by airfoil design and is usually at a point 25% back from the leading edge of the rotor blade. A symmetrical airfoil has the desirable characteristic of limiting center of pressure travel.

Thrust and Drag

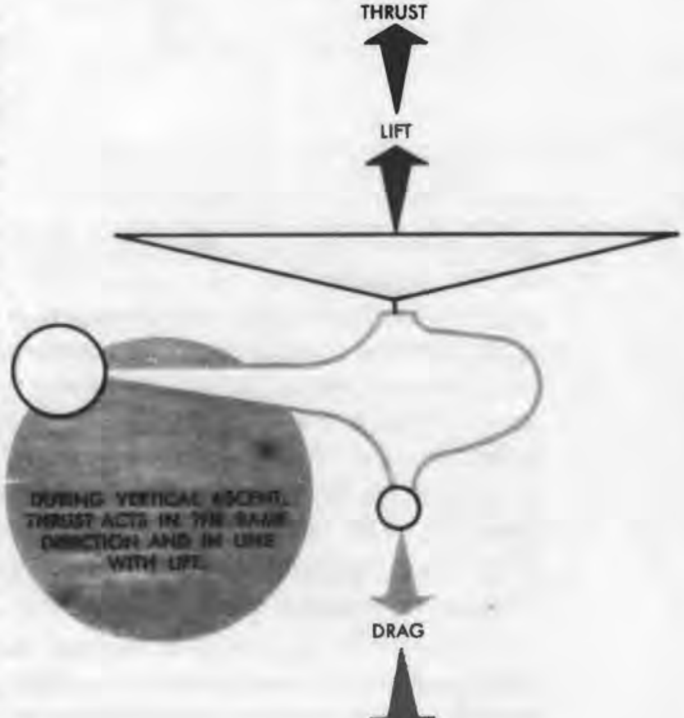
Like weight and lift, thrust and drag are closely related. Thrust moves the aircraft in the desired direction; drag tends to hold it back.

The conventional airplane's thrust is, in general, forward, and drag to the rear. These forces always act in opposite directions and are usually horizontal, or only slightly inclined from the horizontal. Seldom, if ever, do these forces approach the vertical. Furthermore, the conventional airplane's thrust can be separated and considered apart from lift. The propeller (or jet) is responsible for thrust; the wings are responsible for lift.

The helicopter gets both its lift and thrust from the main rotor. In vertical ascent, thrust acts upward in a vertical direction, while drag, the opposing force, acts vertically downward. In forward flight, thrust is forward and drag to the rear. In rearward flight, the two are reversed. In short, thrust acts in the direction of flight and drag acts in the opposite direction.

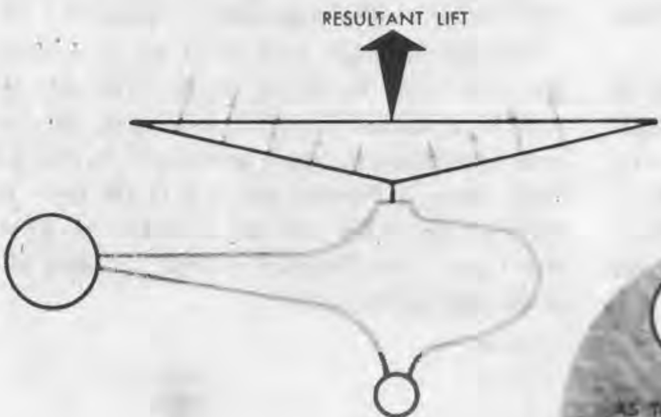


Center of Pressure



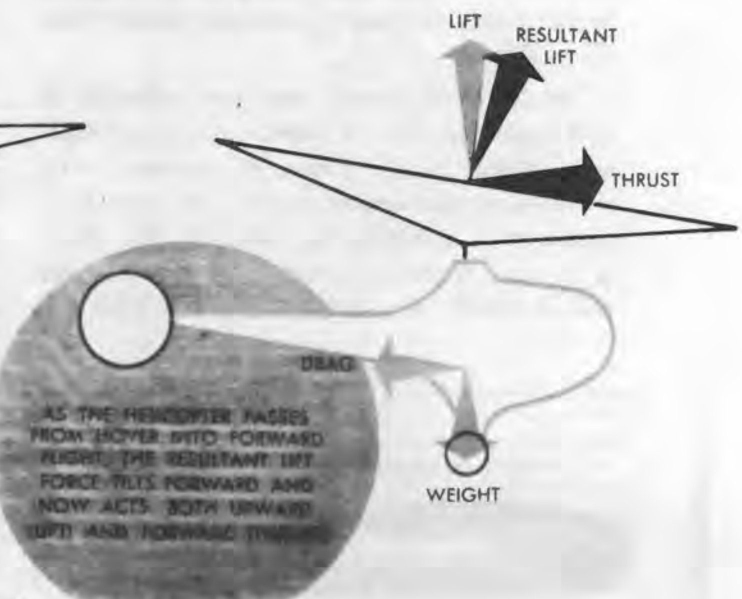
The thrust and drag forces are two of these conditions—vertical flight and forward flight—and are discussed in the following paragraphs. These discussions deal with the thrust and drag forces acting on the fuselage, not with the forces within the rotor system.

During vertical ascent, thrust acts vertically upward while drag acts vertically downward. Here the drag opposing the upward motion of the helicopter is increased by the downwash of air from the main rotor. Thrust must be sufficient to overcome both of these forces which make up the total drag. In the illustration, note that thrust acts in the same direction and in line with lift. Furthermore, the main rotor is responsible for both thrust and lift. Therefore, the force representing the total reaction of the airfoils to the air may be considered as being divided into two components. One component, lift, is the force required to support the weight of the helicopter. The other component, thrust, is the force required to overcome the drag on the fuselage. But drag is a separate force from weight, as is indicated in the sketch.



Now let us examine the thrust and drag forces acting on the fuselage during forward flight.

In any kind of flight—vertical, forward, backward, sideways, or hovering—the resultant lift forces of a rotor system are perpendicular to the tip path plane (plane or rotation). The tip path plane is the imaginary plane described by the tips of the blades in making a cycle of rotation. During vertical ascent or hovering, the tip path plane is horizontal and this resultant force acts vertically upward, as shown in the associated diagram. To accomplish forward flight, the pilot tilts the tip path plane forward. The resultant force tilts forward with the rotor as shown in the referenced illustration. The total force, now being inclined from the vertical, acts both upward and forward; therefore, it can be resolved into two components as shown in the illustration. One component is lift, which is equal to and opposite weight. The other component, thrust, acts in the direction of flight to move the helicopter forward.



Although this discussion covers only two flight conditions, it should point the way to a basic understanding of thrust and drag forces acting on the helicopter fuselage during flight. In rearward flight, the thrust and drag forces are similar to those in forward flight but are reversed. The tip path plane is tilted to the rear, the thrust component acts to the rear, and drag opposes the rearward motion of the aircraft. In sideways flight, the pilot tilts the tip path plane in the desired direction of flight, thrust is to the right or left in the direction of flight, and drag acts in the opposite direction.

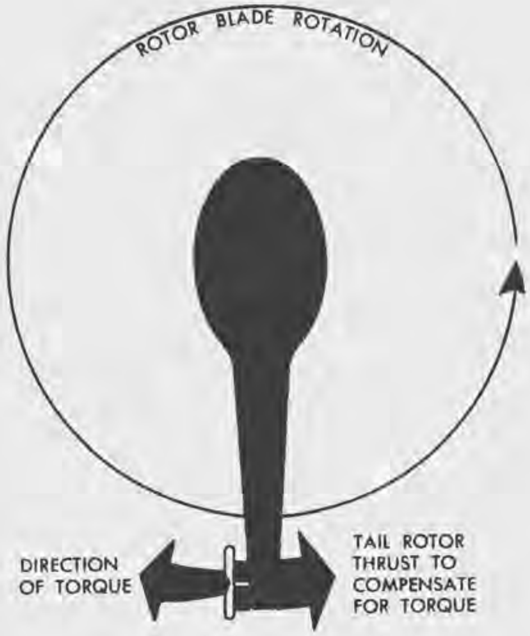
Torque

As a helicopter rotor turns in one direction, the fuselage tends to rotate in the opposite direction. This torque effect is in accord with Newton's third law of motion which states that, "To every action there is an opposite and equal reaction." In the helicopter, the reaction is in a direction opposite to that in which the rotor is driven by the engine and is proportional in magnitude to the power being delivered by the engine.

Torque is of real concern to both the designer and the pilot. There must be provisions for counteracting torque and for positive control over its effect during flight. On dual-rotor and coaxial-rotor helicopters, the rotors turn in opposite directions, thus "washing out" torque reaction. In jet helicopters with engines mounted on the main rotor blade tips, the power is initiated at the rotor blade; therefore, the reaction is between the blade and the air, with no torque reaction between the rotor and the fuselage. Therefore, it is in helicopters of the single main rotor configuration that torque presents a problem to the pilot during flight.

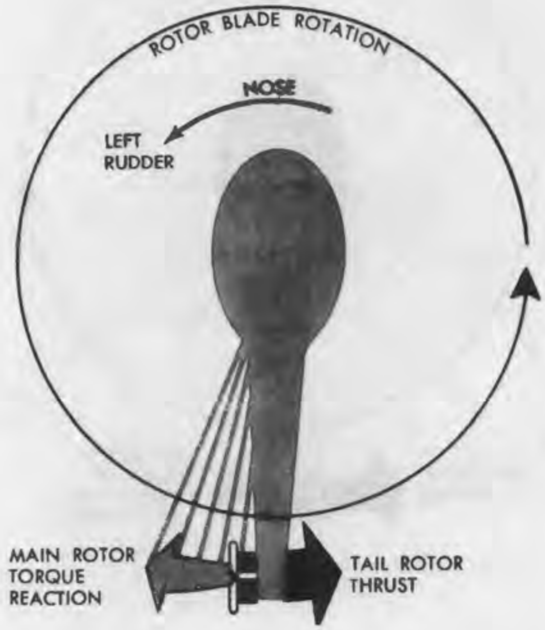
NOTE: In any helicopter—including the single main rotor type—there is no torque reaction when the engine is shut off. Therefore, there is no torque reaction during autorotation.

The usual way of counteracting torque in a single main rotor helicopter is by means of an antitorque rotor. This auxiliary rotor is mounted vertically on the outer portion of the tail boom. Turning at a constant rpm, usually slightly higher than one-half engine speed, the tail rotor produces thrust in a horizontal plane, opposite in direction to the torque reaction developed by the main rotor. The illustration shows the direction of the torque reaction and the direction of tail rotor thrust for a helicopter in which the main rotor turns from the pilot's right, to his front, to his left, and then to his rear. Most single rotor systems turn in this direction.



Since the torque effect on the fuselage is a result of the engine power supplied to the main rotor, any change in engine power brings about a corresponding change in the torque effect. Furthermore, power requirements vary with flight conditions. Therefore, the torque effect is not constant but varies during flight. This means that there must be some provision for varying tail rotor thrust. Usually, a variable-pitch tail rotor is employed and rudder pedals are linked by cables with the pitch change mechanism in the tail rotor gear box. This permits the pilot to increase or decrease tail rotor thrust, as required, to neutralize the torque effect.

The tail rotor and its controls serve as both a means of counteracting torque effect and a means of heading the helicopter in the desired direction of flight. Therefore, the tail rotor control pedals serve as rudder pedals. The effect of the tail rotor controls is shown in the illustration. Applying left rudder causes the nose of the helicopter to turn to the left; applying right rudder causes the nose to swing to the right. When the pilot wishes to maintain a consant heading, he keeps just enough pitch in the tail rotor to neutralize torque effect.

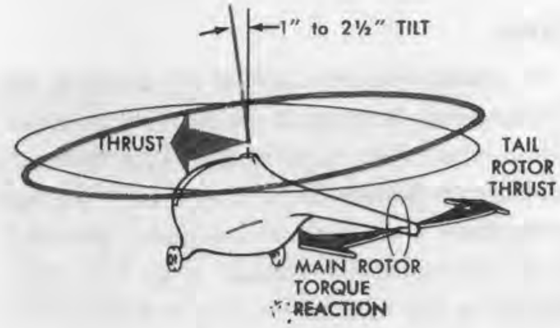


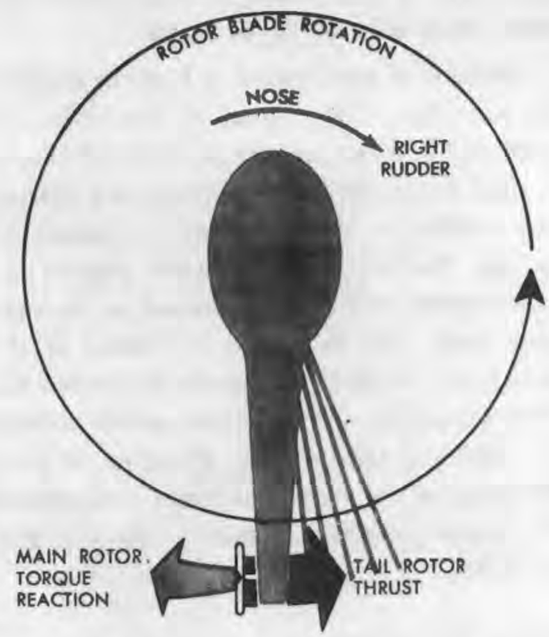
Although the tail rotor is the primary means of counteracting and controlling torque, the tail rotor alone doesn't quite do the job. This is true because torque cannot be compensated for by a single force. The tail rotor alone would prevent rotation of the fuselage, but would cause translation of the helicopter, during hovering, in the direction of tail rotor thrust.

Complete compensation for torque requires a *couple*—a pair of equal forces acting in opposite directions. Tail rotor thrust constitutes one of the forces. The second force is introduced by rigging the helicopter with the tip path plane tilted from 1 to 2½ degrees to the left, depending on the helicopter. The related illustration shows the balance of forces on a helicopter employing a single right-to-left main rotor. Note that the slight tilt of the tip path plane to the left results in a thrust force to the left. This force and tail rotor thrust form the couple required to completely compensate for torque.

Tail Rotor Failure

Tail rotor failure in a helicopter is the most difficult in-flight emergency with which a pilot will be required to cope. The first indication of





the tail rotor failure is a loss of directional control. When tail rotor failure is experienced, the main rotor torque will turn the helicopter to the right. The rate of turn will be governed by the amount of power being used at the time failure occurred. The only means of reducing this turning tendency is to establish an autorotative glide. (Autorotation will be discussed later.) This will be accomplished by reducing collective pitch and closing the throttle.

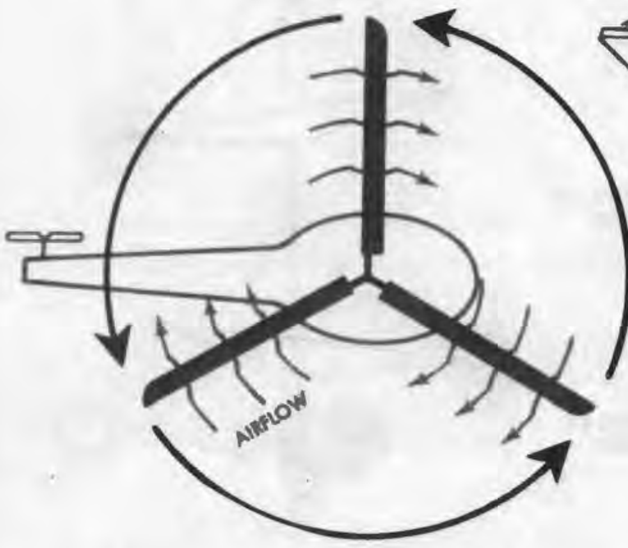
In autorotation the helicopter will turn to the left, due to bearing and gear friction in the transmission system. The friction drag induced by the main transmission system, however, is less than the torque induced by the engine and can be corrected for by maintaining adequate gliding air speed and making appropriate correction with the cyclic control stick.

Hovering

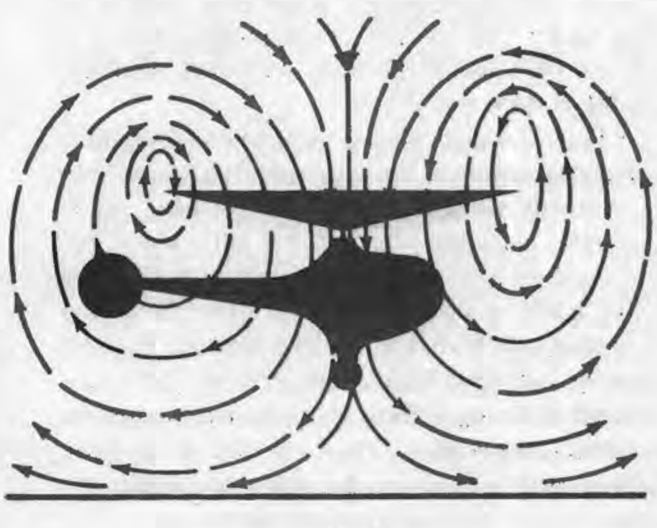
Hovering is the maintaining of a position above a fixed spot on the ground, usually at an altitude of about eight feet. Helicopters normally hover on takeoffs and landings.

For the helicopter to hover, its main rotor must supply lift equal to the helicopter's weight. Lift is controlled by controlling the pitch of the rotor blades.

As the blades rotate, air flows across the leading edge of each blade in the direction indicated in the accompanying illustration. The air flow crosses the leading edge of each blade throughout the complete rotational cycle of 360°. At the same time the blades have a tendency to screw upward into the air, and air flows down through the rotor system from above, as shown in the composite illustration.



Air Flow Across Blades



Air Flow

The pitch and rpm of the rotor blades is controlled by the collective pitch. The normal location of this control is shown in the related illustration. By raising or lowering the collective pitch stick you can change the *collective pitch*—the pitch on all of the main rotor blades. *Raising* the stick *increases* the pitch; *lowering* it *decreases* the pitch. If the rotor rpm remains constant, increasing or decreasing the blade pitch causes the helicopter to climb or descend.

To maintain constant rotor rpm during pitch change, a built-in synchronization unit is linked from the bottom of the collective pitch stick to the carburetor by a series of push-pull rods. As you increase blade pitch, calling for more engine power to maintain a constant rotor rpm, the synchronization unit opens the throttle. The opposite is also true, of course. If you decrease blade pitch, less engine power is required for the same rotor rpm so the synchronization unit acts to reduce engine power.

On the upper end of the collective pitch stick is a motorcycle-grip-type throttle, with which you can *roll on* or *roll off* throttle if the synchronization unit does not maintain exact engine rpm. This hand throttle permits you to override the synchronization unit in making the final adjustments to obtain the specified engine rpm.

DIRECTIONAL FLIGHT

Vertical Flight

Vertical flight is controlled exactly the same way as hovering, since hovering is an element of vertical flight. To climb, raise the collective pitch stick, using the throttle on the pitch stick to make any rpm adjustments not made automatically. At the same time, you hold the cyclic control (which we will consider next) in a vertical position, so that lift will be vertical. The flow of air is still over the leading edge of each blade, but the helicopter is now moving upward as shown in the illustration.

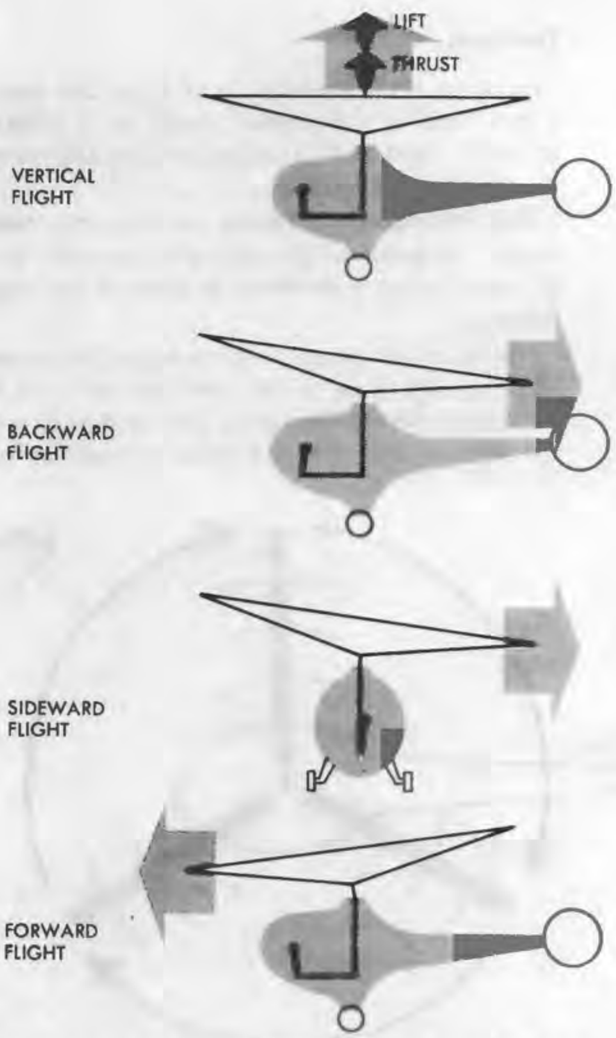
When the helicopter is climbing vertically the main rotor supplies not only the lift necessary to support the helicopter's weight, but also the thrust necessary to cause the helicopter to rise vertically. To descend, lower the collective pitch stick to decrease main rotor pitch and resultant lift.

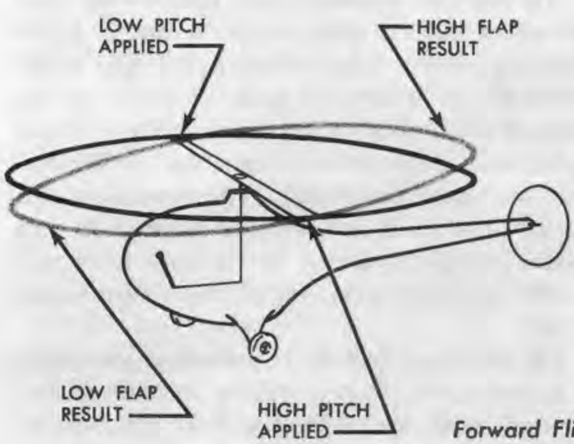
Horizontal Flight

Horizontal flight is controlled by tilting the tip path plane in the direction of desired flight—forward, backward, to the left, or to the right. As detailed in the associated illustration, the helicopter moves in the direction the cyclic control stick and tip path plane are tilted.

The pilot tilts the tip path plane by means of the cyclic pitch control. This control provides a mechanical means of changing the pitch of the main rotor blades throughout their cycle of rotation. Cyclic pitch change is equal and opposite, as the illustration shows. If the blade pitch is increased 3° on one side of the rotor system, at a point 180° around the cycle of rotation, the blade pitch is decreased 3°.

For every pitch change there will be a resulting flapping action of the individual blades, as they constantly change pitch during rotation. As is shown, maximum flapping will take place 90° around the cycle of rotation from the place where the pitch change was applied. The equal and opposite pitch change and the resulting flapping of the individual blades causes the tip path plane to tilt in the same direction as the pilot moves the cyclic control stick. Thus you can fly forward, backward, or sideways by tilting the cyclic control stick in the direction you want to go.





Forward Flight

Combination Changes of Direction

To climb or descend while moving forward, backward, or to either side is merely a matter of coordinating the movements of the collective pitch control, which governs vertical flight; and the cycle control, which governs horizontal flight.

Takeoffs

Helicopter takeoffs are similar to vertical climbs which, of course, they are. For normal takeoff, run the engine up to the stipulated takeoff rpm, then raise the collective pitch stick gradually to increase the rotor blade pitch until the helicopter rises into the air. Hold the cyclic control stick in a vertical position so that the helicopter will rise vertically.

At a height of about six feet, adjust the collective pitch stick to maintain this position, hovering above the takeoff spot in preparation for movement in the desired direction of travel.

Ground Cushion

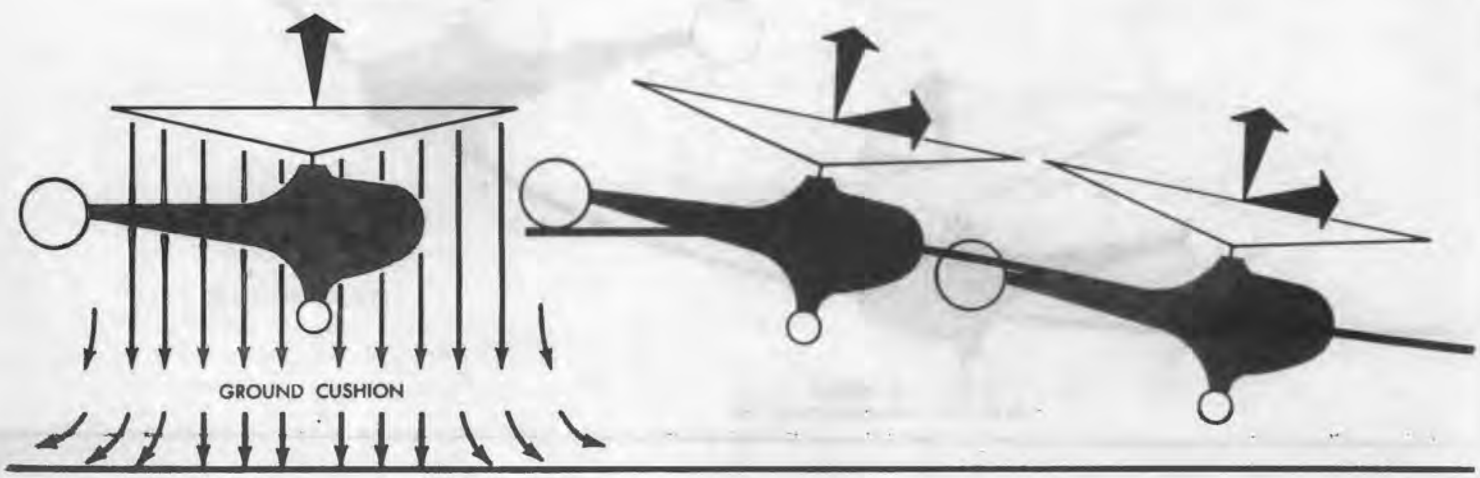
As the helicopter rises from the ground in a hovering attitude to a height of 6 or 8 feet, it may be noticed that a cushion effect is built up under the helicopter. This is commonly called *ground cushion* or *ground effect*. The ground cushion develops because air is packed between the main rotor blades and the ground. The downward flow of air strikes the ground and is partially trapped under the main rotor system which the sketch illustrates. The air packs because it cannot escape as rapidly as the downward flow of air which is established by the main rotor blades; therefore, a cushion of slightly compressed air is built up.

Boyle's Law states that the density of any gas varies directly as to its pressure. The greater the density of air, the greater the efficiency of both the engine and the rotor system. The ground cushion is established to a height equal to the rotor diameter, but it is effective only to a height of approximately one-half the rotor diameter. Correspondingly, there is more power available for hovering near the ground, that is, within a height of one-half rotor diameter. The ground cushion effect is lost at airspeeds in excess of 10 knots.

Translational Lift

Translational lift is the additional lift developed as the helicopter accelerates into forward flight. Translational lift becomes effective at an airspeed of approximately 15 knots, and it continues to increase with forward speed. However, at high values of forward speed parasite drag increases more rapidly than translational lift.

Since vertical lift increases and then decreases with changing values of forward speed, at some airspeed it must reach a point of maximum. This speed is known as *the most efficient airspeed*, and it will remain approximately constant for a partic-



ular type of helicopter. For example, the most efficient airspeed for the Sikorsky H–19 helicopter is 60 knots. At its most efficient airspeed a helicopter will have its best rate to climb, least rate of descent for a given power setting, and maximum endurance.

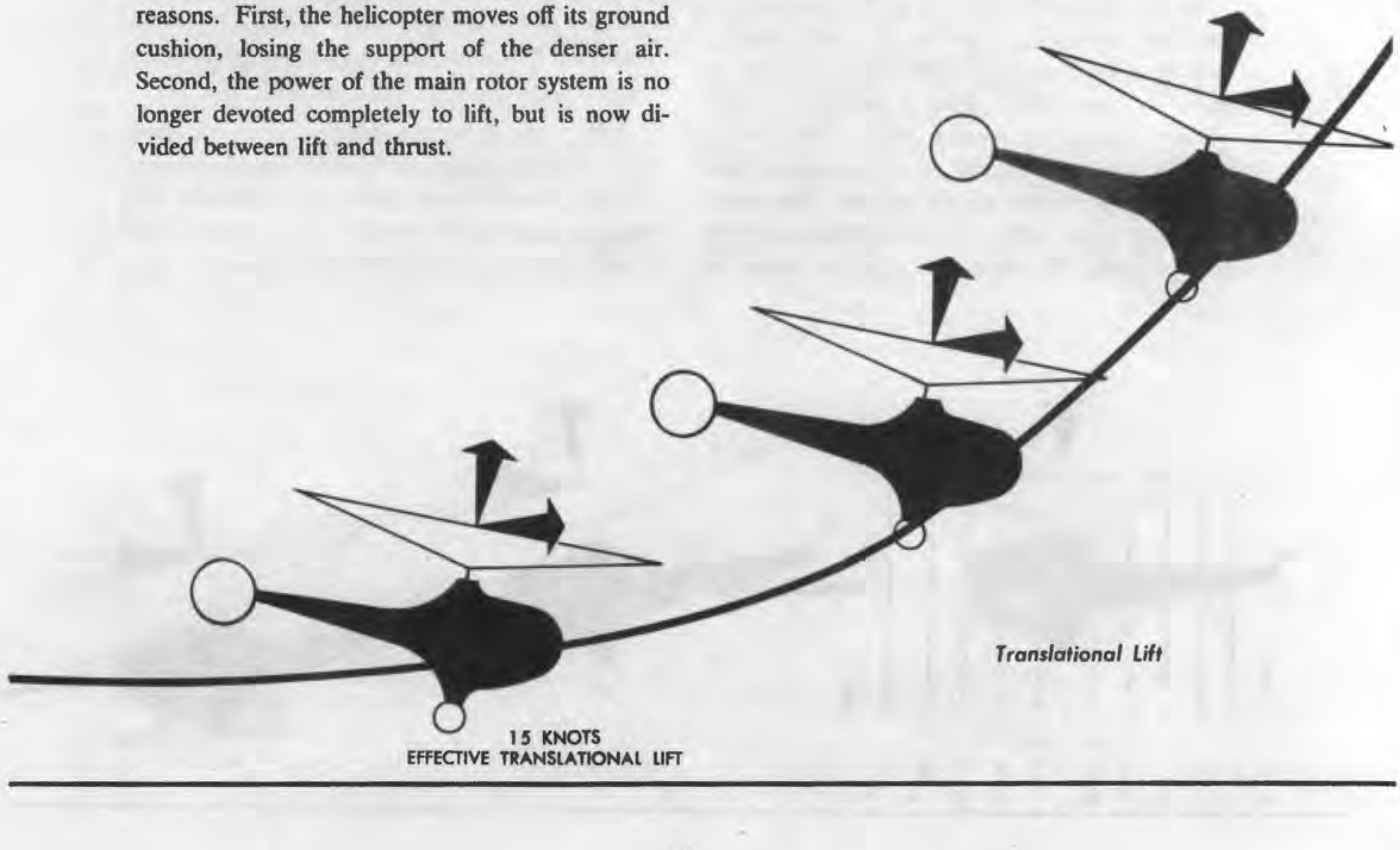
When hovering 6 to 8 feet above the ground in a no-wind condition, the helicopter is aided by the ground cushion effect. As the helicopter enters forward flight it slides off the ground cushion, and reduced lift will cause the craft to settle. The pilot increases pitch and power to prevent contact with the ground. However, when a forward speed of approximately 15 knots is reached, translational lift becomes effective and the helicopter will gradually climb. As forward speed is increased, lift is increased and less power will be required to maintain straight and level flight.

From the hovering position, 6 to 8 feet above the ground, the pilot prepares to move into forward flight. As he moves the cyclic stick slightly forward, causing the tip path plane to tilt forward, the helicopter settles toward the ground for two reasons. First, the helicopter moves off its ground cushion, losing the support of the denser air. Second, the power of the main rotor system is no longer devoted completely to lift, but is now divided between lift and thrust.

At 3 knots the helicopter has left its ground cushion and has a shorter lift vector, so it settles slightly toward the ground. At 10 knots it is still settling. But at 15 knots there is a noticeable increase in lift, which will continue as forward speed is increased. This additional lift, which becomes available at about 15 knots is called *translational lift.*

Many efforts have been made to explain translation lift. Perhaps the most plausible explanation is that a helicopter must travel about the distance covered in reaching a 15 knot speed to enter a clear air region. Whatever the explanation, a helicopter definitely will have greater efficiency and greater lift when it reaches a forward speed of 15 knots and beyond.

Helicopters usually takeoff into the wind; hence, the greater the velocity of the wind, the sooner a helicopter will enter into translational lift. In a 15 knot wind, for example, a helicopter will hover in translational lift following takeoff. It will not settle as it moves forward, providing the takeoff is into the wind.



Translational Lift

ROTARY-WING AERODYNAMIC EFFECTS

A helicopter is subject to several rotary-wing aerodynamic effects, which we will now consider.

Autorotation

Autorotation, often called "windmilling," is the process of producing lift with airfoils which rotate freely as the air passes from the bottom up through the rotor system. Under power-off conditions, the helicopter will descend, thus the airflow will be established from the bottom upward through the rotor system. The rotor is automatically disengaged from the engine, and the necessary power required to overcome parasite and induced drag of the rotor blades is obtained from the potential energy due to the helicopter's weight and height above the ground. This potential energy is converted into kinetic energy which is used to rotate the overhead rotor system during descent.

Autorotation is the principle used in the flight of the autogyro to provide lift. A helicopter uses autorotation for emergency landings in case of engine failure.

During autorotation, the rotor blades turn in the same direction as when engine-driven, but the air passes upward through the rotor system, causing a slightly greater upward flexing or *coning* of the rotor blades. Since the engine is not running, there is no torque effect on the fuselage during autorotation.

While in autorotation, it is essential that the pitch of the rotor blades be reduced materially to minimize drag thus permitting a high rotor rpm to build up. When the pitch angle of the main rotor blades is low (as shown in diagram A) the resultant lift force lies ahead of the axis of rotation, tending to keep the blade turning in its normal direction of rotation.

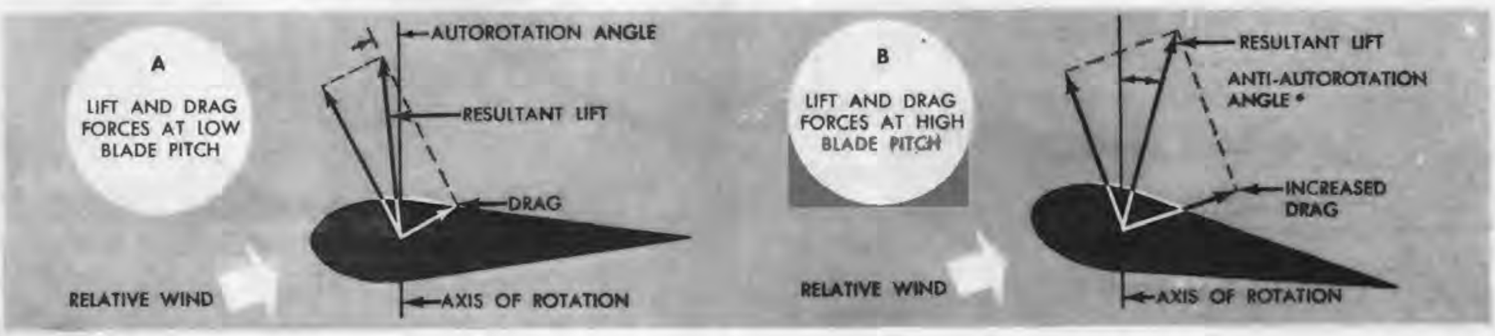
Diagram B shows a condition in which the blade pitch angle is too high for satisfactory autorotation. Note that drag is increased and the resultant lift force lies behind the axis of rotation, slowing the rotor.

The pilot must reduce the pitch in order to keep the rotor blades turning at sufficient speed to maintain the required centrifugal force. Otherwise, the blades will fold up and the helicopter will tumble out of control.

In the event of engine failure during flight, a safe autorotation can be accomplished, provided the helicopter is being flown at a safe altitude-airspeed combination and the inflight altitude is sufficient to permit selection of a suitable landing area. When altitude permits, an air restart should be attempted. If the engine fails to start, a normal power-off landing should be accomplished. Reduce collective pitch to autorotation and establish a glide at the most efficient airspeed (H–19 is 60 knots) with the stipulated autorotative rotor rpm. (The H–19 helicopter requires 210 to 225 rpm). At approximately 50 to 75 feet, execute a partial flare by moving the cyclic control stick back with no change in collective pitch. This will reduce airspeed and rate of descent, and will cause an increase in rotor rpm. Level the helicopter as it settles, and gradually increase collective pitch.

Dissymmetry of Lift

Dissymmetry of lift is the difference in lift which exists between the advancing half of the disk area and its retreating half when in horizontal flight. (The disk area is that swept by the rotating blades.)



When the helicopter is hovering motionless in still air, the lift created by the advancing and retreating halves of the disk area is equal. But when the helicopter is moving forward, the forward speed of the aircraft is added to the rotational speed of the advancing blade and subtracted from the rotational speed of the retreating blade.

To compare the lift of the advancing half of the disk area to the lift of the retreating half, let's analyze the basic formula for lift, which is:

$$L = C_L \times \frac{D}{2} \times V^2 \times A$$

In this formula:

- L equals lift
- C_L equals the coefficient of lift
- D equals density of the air
- V equals velocity
- A equals the blade area in square feet.

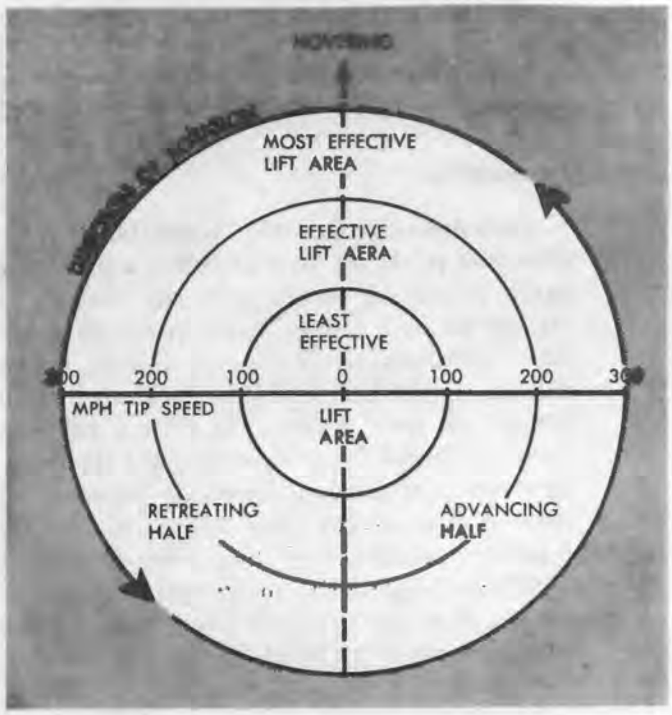
The coefficient of lift (C_L) is determined by airfoil shape. Most helicopters use symmetrical rotor blades, because symmetrical blades perform well whether the flow of air is from the top downward through the rotor system, as in powered flight—or from the bottom upward, as in autorotative flight. Also, a symmetrical airfoil limits the travel of the center of pressure, which is very important because center of pressure travel would introduce pitch-changing moments on the blades.

Density of the air depends, of course, on temperature, moisture, altitude, and so forth.

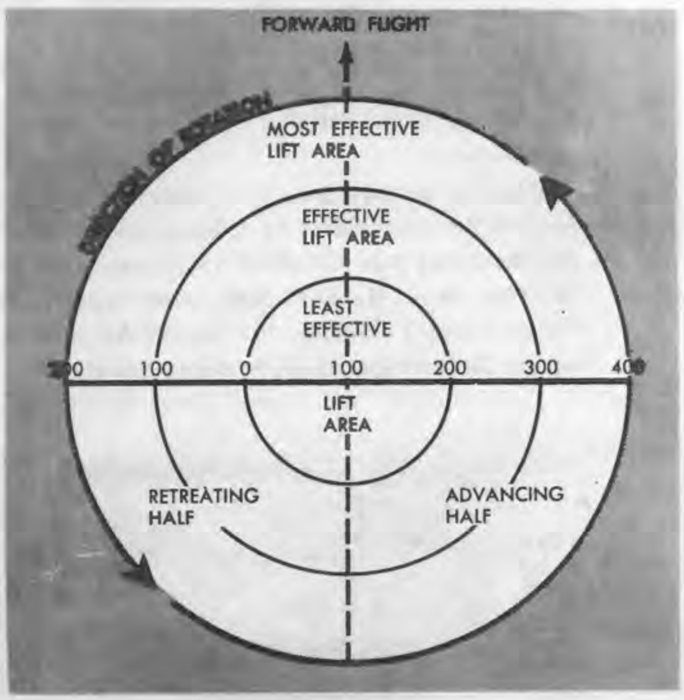
Velocity, as we have seen, is the product of two factors; the speed of the blades, and the speed of the helicopter itself.

It is obvious that three factors of the basic lift formula are the same for both advancing and retreating blades. These are C_L, D, and A. The only variable is V, velocity. Therefore, lift varies according to the square of the velocity.

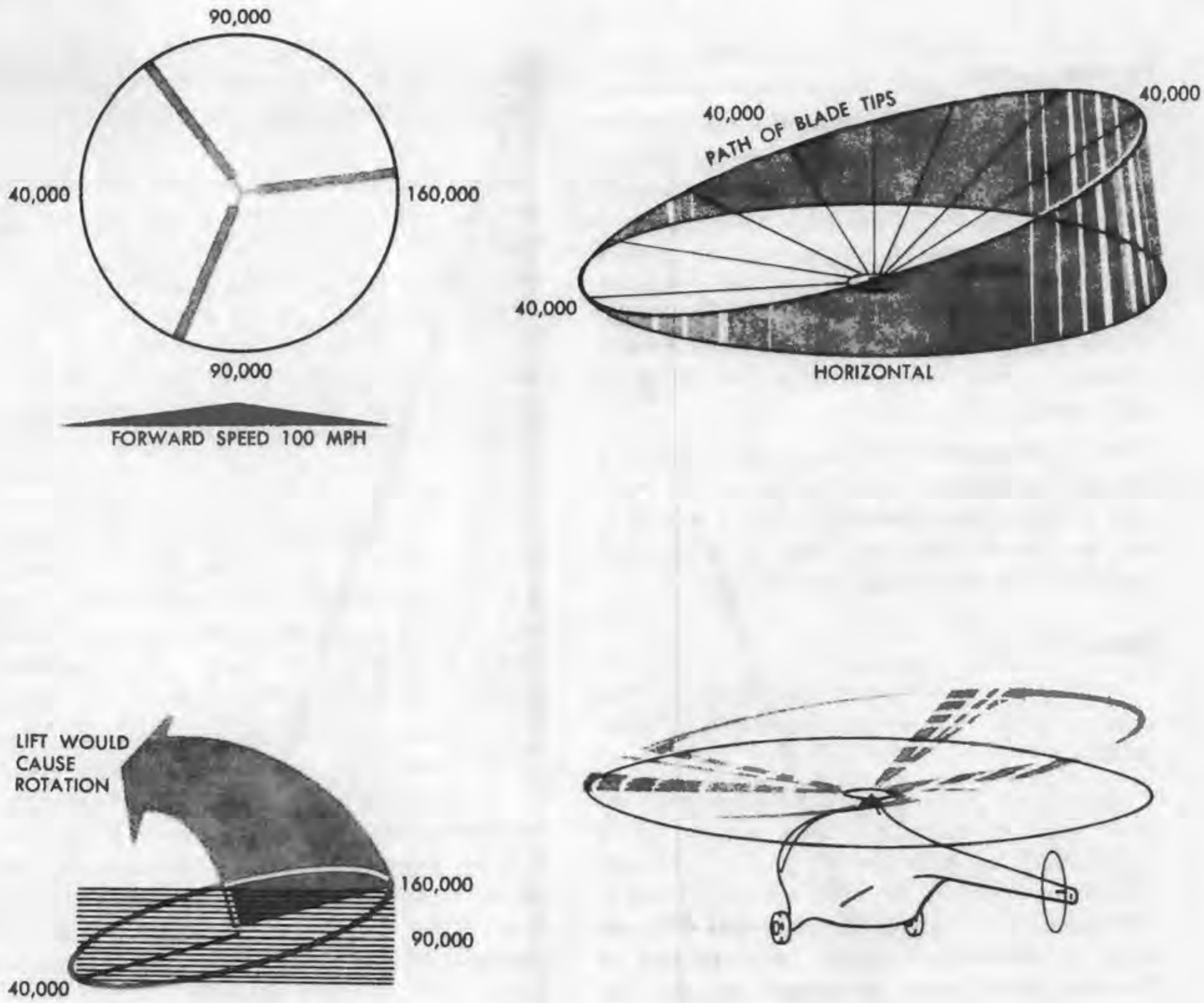
Now let us consider some specific values. The tip speed of most helicopter rotors is about 350 mph at normal takeoff rpm. In these examples, however, we will use a tip speed of 300 mph to simplify arithmetic. Also, we will consider only the tip speed although the rotational speed varies from about 350 mph at the tip of the blade to zero at the hub.



Zero Airspeed — Symmetry



Forward Speed — Dissymmetry



Effect of Flapping Hinges

When the helicopter is hovering, the velocity of the advancing blade is 300 mph. The velocity of the retreating blade is the same, 300 mph. Therefore, the lift created by the advancing blade is the same as that of the retreating blade.

Now consider the velocity of the blades when the helicopter is moving forward, as in the associated illustration, at a speed of 100 mph.

The advancing blade has a tip speed of 300 mph plus the helicopter speed of 100 mph, or 400 mph. V^2 is 160,000.

The retreating blade has a tip speed of 300 mph minus the helicopter speed of 100 mph, or 200 mph. V^2 is 40,000.

The lift created at the blade tip is in the ratio of 160,000/40,000, or four times as much for the advancing blade than for the retreating blade. If such dissymmetry of lift were allowed to go uncorrected, the helicopter would turn over.

The normal correction for dissymmetry of lift is to incorporate a *flapping hinge* in the rotor head. The diagram shows how this device equalizes lift on the advancing and retreating blades. As you can see, the hinge permits an advancing blade to rise, thus reducing its effective lift area. The hinge also allows a retreating blade to settle, increasing its effective lift area. Thus, the blades position themselves aerodynamically to equalize lift on the advancing and retreating halves of the disk area.

Pendular Action

It is normal for the fuselage of a helicopter to act like a pendulum, that is, to swing laterally and longitudinally. This pendular action can be exaggerated by over-controlling, therefore, control stick movements should be decidedly moderate. Also, because of this normal pendulous action, it is wise to keep the wheels of a helicopter at least five feet above the ground while hovering, especially during the early stages of helicopter flight training.

It is also normal for the helicopter to take a nose-low attitude in forward flight, and a nose-high attitude in rearward flight. This is caused by the fact that the drive shaft lines up in the same straight line as the resultant lift vector.

Resonance

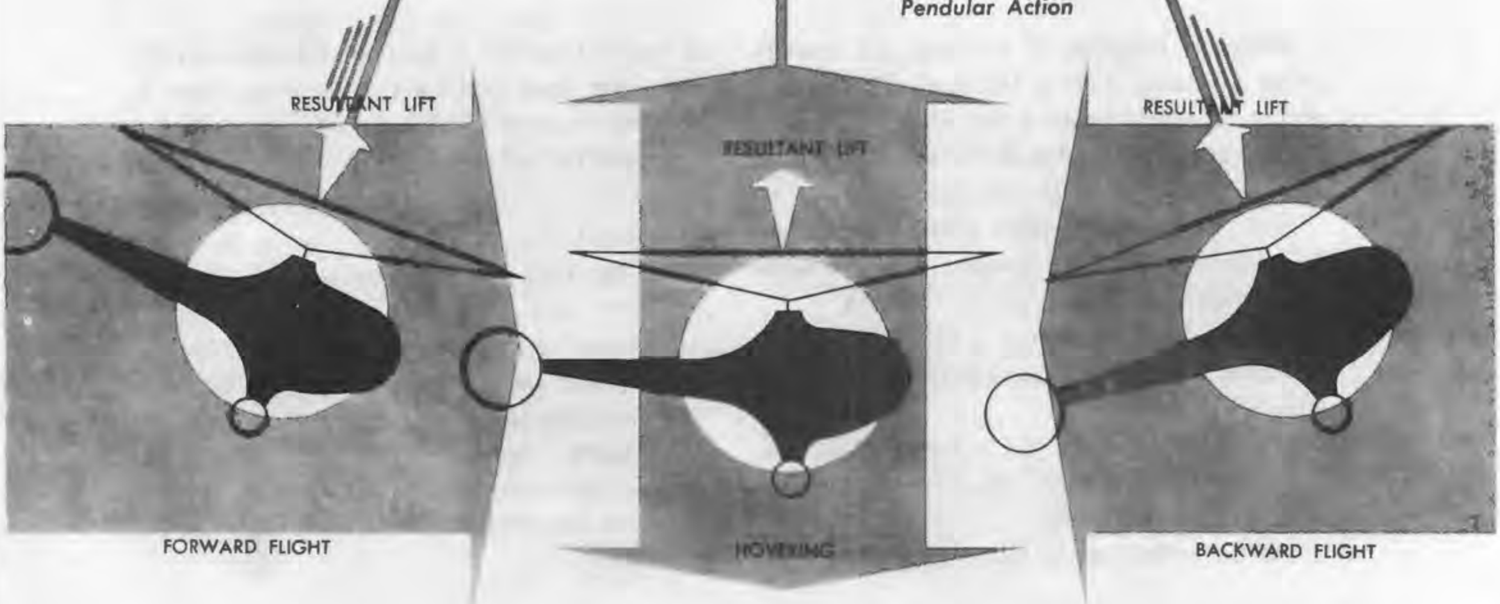
A helicopter is subject to two types of resonance—*sympathetic resonance* and *ground resonance.*

Sympathetic resonance is a harmonic beat between main rotor and tail rotor systems, which could shake the helicopter to pieces. This unsatisfactory condition has been engineered out of helicopters by designing the main and tail gear boxes in odd decimal ratios. Thus, the beat of the main rotor cannot harmonize with the beat of the tail rotor. There is no known case of helicopter destruction caused by sympathetic resonance.

Ground resonance may develop whenever the center of mass of the rotor system becomes unseated. This usually occurs during landings, when the helicopter is 87 to 95 per cent airborne. Ground resonance develops when the aircraft is light on its wheels, and one wheel of the main landing gear hits the ground and then the other wheel hits. Such successive shocks tend to cause the blades straddling the wheel hitting the ground to move down and to change their angular relationship. If a similar reaction takes place when the opposite wheel hits the ground, resonance may develop. This sets up a pendulum-like oscillation of the fuselage, which continues when once established until some force shocks the system sufficiently to interrupt the beat. This oscillation usually leads to structural failure.

If ground resonance should occur with high power, immediately increase power and takeoff. The resonance will stop when the helicopter becomes airborne. If ground resonance should occur with low power, immediately decrease rotor rpm further by decreasing throttle and apply both the rotor brake and the wheel brakes. If ground resonance should occur on a landing, increase throttle and collective pitch and hover. Seek a

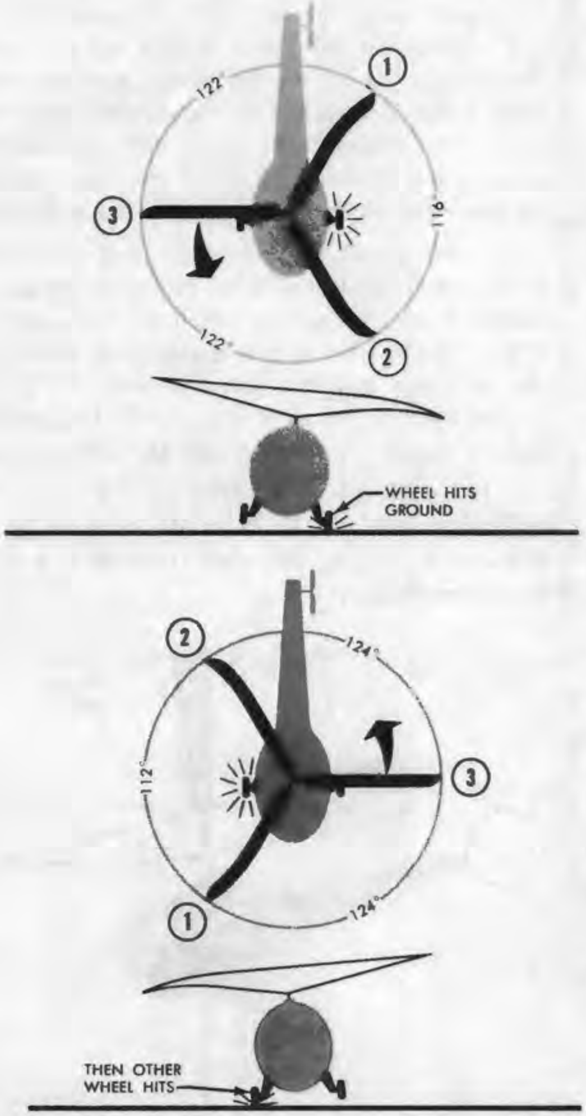
Pendular Action



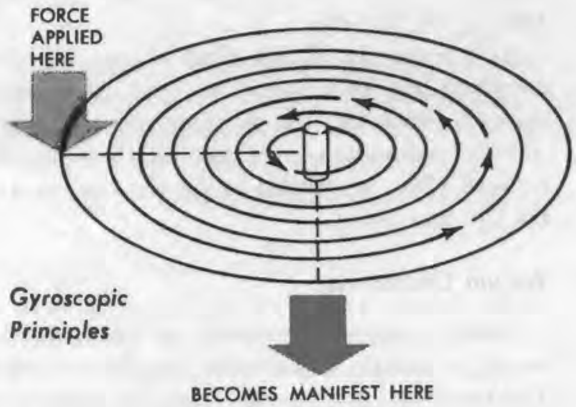
softer spot to make a landing because a shock strut or damper may be malfunctioning.

To prevent the possibility of ground resonance occurring during takeoff, steadily increase main rotor pitch until the wheels are clear of the ground.

Effect of Ground Resonance



During landings, steadily decrease collective pitch as the wheels contact the ground.



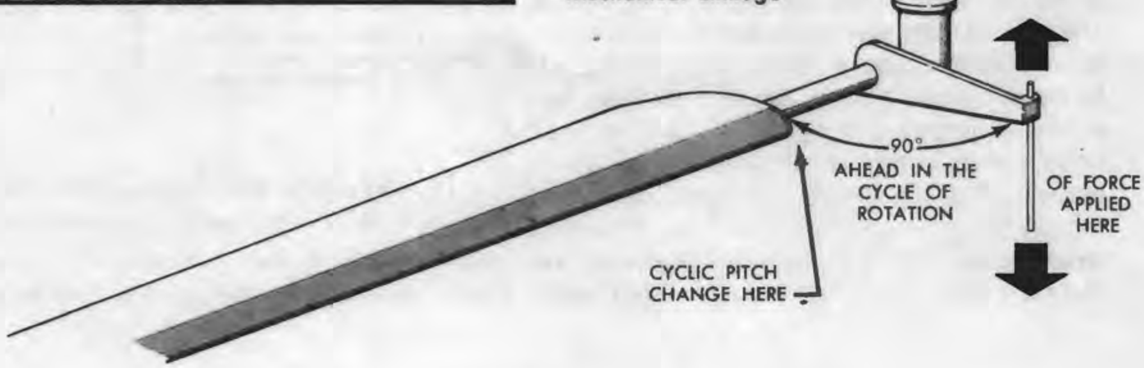
Gyroscopic Principles

Gyroscopic Precession

Gyroscopic precession is an innate quality of all rotating bodies, in which an applied force is manifested approximately 90° in the direction of rotation from the point where the force is applied. Thus, if a downward force is applied to the right of the disk area, gyroscopic precession will cause the disk area to tilt down in front, provided that the rotor system is turning from right to left. The applied force is pitch change on the main rotor blades, which is regulated by the cyclic control.

To simplify directional control, helicopters employ a mechanical linkage which actually places cyclic pitch change of the main rotor blades 90° ahead in the cyclic of rotation. Thus, if the cyclic control is moved forward (in case of a rotor system turning from right to left), high

Mechanical Linkage



pitch is applied to the blade on the pilot's left and low pitch is applied to the blade on his right. Since every pitch change causes a flap, reaching its maximum approximately 90° around in the cycle of rotation, this flapping will cause the disk area to tilt forward.

As you can see, if this offset linkage were not employed, the pilot would be required to move the cyclic stick 90° out of phase, or to the right when he wanted to tilt the disk area forward, and forward when he wanted to tilt the disk area to the left, and so on.

Weight Limitations

There is no single answer to the maximum weight at which a helicopter can be operated. The maximum permissible weight of a helicopter varies within broad limits, depending upon certain weight controlling criteria. The maximum weight of a helicopter becomes a variable quantity to produce optimums under different conditions. The weight limitation charts for a particular type helicopter provide flight personnel with operational gross weight information. However, it is readily understandable that as a structure is loaded to higher weights, its ability to withstand shocks or additional loads resulting from maneuvers becomes increasingly less.

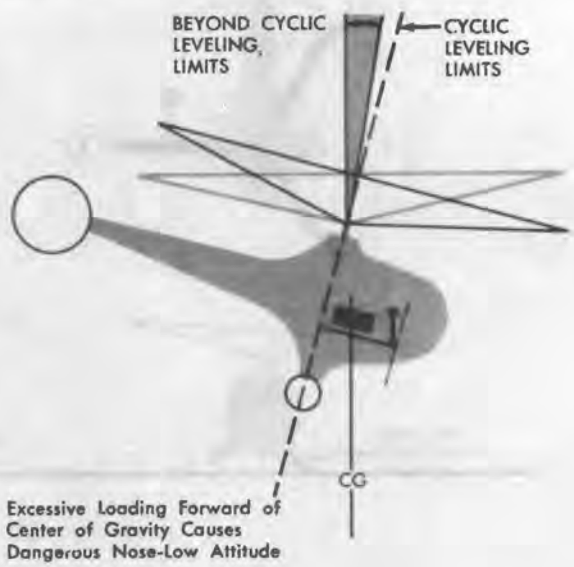
The margin of safety is the amount of shock or additional load that the structure will sustain before failure occurs. In planning any helicopter mission, the fact must be recognized that the *maximum* permissible weight may depend on the margin of safety desired for the various supporting structures, such as the main rotor, fuselage, landing gear, flooring, and so forth. Should the mission require excessive maneuvering or flight through turbulent air, it would be advisable to maintain a larger margin of safety than if smooth, level flight were contemplated.

In regard to helicopters, load factors are used as an indication of the margin of safety that is available. At any particular moment of operation the structural margin of safety, for example, will be equal to the difference between the load factor the helicopter is designed for, and the load factor the helicopter is sustaining at that given moment. For any specific helicopter, the weight limitations are based on the basic operating weight as determined by structural engineers and flight test data. The helicopter pilot should make certain that he thoroughly understands the weight limitations prior to flight. Just because a helicopter can takeoff with a heavy load is no assurance of a safe flight.

Weight and Balance

The permissible center of gravity (CG) travel is very critical in many helicopters. In fact, some helicopters have only a 4-inch maximum travel. If a helicopter is improperly loaded, not only does the fuselage tilt off the horizontal, but the rotor mast which is attached to the fuselage tilts the entire rotor system. The cyclic stick controls the amount and direction of tilt of the rotor system, but the travel on the cyclic control stick is limited.

The amount of back-stick the pilot can apply to the cyclic control to level the rotor system is limited by the manner in which the helicopter is rigged. If the helicopter is dangerously nose-low, the pilot may find that when he pulls the cyclic control back as far as it will go, the helicopter's attitude remains nose-low, and the rotor system still tilts forward. The pilot cannot slow the helicopter, nor can he raise the nose to land. Needless to say, he then finds himself in a dangerous predicament.



Excessive Loading Forward of Center of Gravity Causes Dangerous Nose-Low Attitude

In newer helicopter designs, efforts have been made to locate the loading compartment directly under the drive shaft to minimize CG travel. For the same reason, the gasoline supply may be located at or near the balance point, which is normally on the main drive shaft. However, the fact remains that the pilot must at all times balance his load so as to remain within CG travel limits. He should be well informed as to the CG travel limits of his particular helicopter and should exercise great care in taking on loads.

Stalls

Stalling, as applied to a fixed-wing aircraft, will not occur in a helicopter. However, a power settling may occur in low-speed flight, and blade stall may occur in high-speed flight.

Power Settling

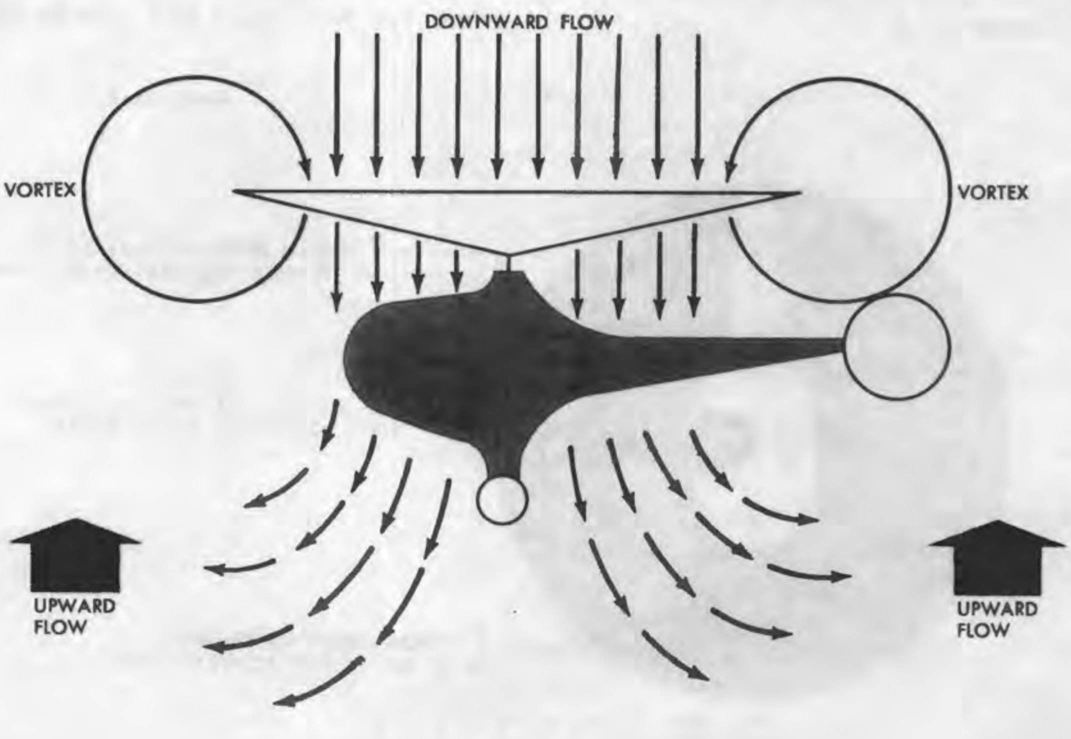
Power settling is the uncontrollable loss of altitude. This condition is aggravated by heavy gross weight, unfavorable density conditions, and low forward speed. When the rate of descent approaches 200 feet per minute with an air speed of 10–15 knots, roughness and partial loss of control may occur. At this high rate of descent and low airspeed, the downwash from the rotor begins to recirculate—up, around, and back down through the effective outer rim of the rotor disk. The velocity of this recirculating mass of air may become so high that full high-collective pitch will not produce sufficient lift to retard or control the rate of descent.

To recover from this condition, increase forward speed and reduce pitch. An altitude loss of 400 to 700 feet may occur before the condition is recognized and recovery is complete. During approach for landings, and descent or takeoff above congested areas, the pilot should avoid the conditions causing power settling.

Blade Stall

A flight characteristic that has caused a number of helicopter accidents is the blade stall or blade tip stall. The stall usually occurs at the tip of the retreating blade due to high angle of attack and slow airspeed of the retreating blade. The stalled blade sections are localized and exist throughout only a small portion of the rotor disk, as shown in the related sketch.

During flight conditions with high values of forward speed, gross weight, and altitude, the retreating blade has an excessive angle of attack and low airspeed. These conditions aggravate



Power Settling

blade stall. Mild blade stall will cause a roughness in both the helicopter and flight controls. Severe blade stall will cause an abrupt pitch-up of the nose of the helicopter. Although the retreating blades stall on the pilot's left the loss of lift is manifested at a point 90° later, thereby causing the tip-path plane to tilt downward toward the rear. The uncontrolled pitch-up will last only for a very short period as full control is restored automatically when airspeed decreases in the nose-high attitude and the excessively high angle of attack no longer exists.

When blade stall occurs, the controllability of the helicopter will diminish. If such vibrations and control kicks are noticed, the stall may easily be eliminated by accomplishing any one or a combination of the following:

1. Reduce collective pitch
2. Increase rotor rpm
3. Decrease severity of the maneuver
4. Gradually decrease air speed.

To stop the nose pitch-up, especially during turns at critical airspeeds and altitudes, gradually reduce collective pitch and/or rapidly increase rotor rpm, and gently ease the nose of the helicopter down with smooth, forward application of the cyclic control stick. Level off by use of bottom tail rotor pedal and lateral movement of the cyclic control stick.

Critical Weather

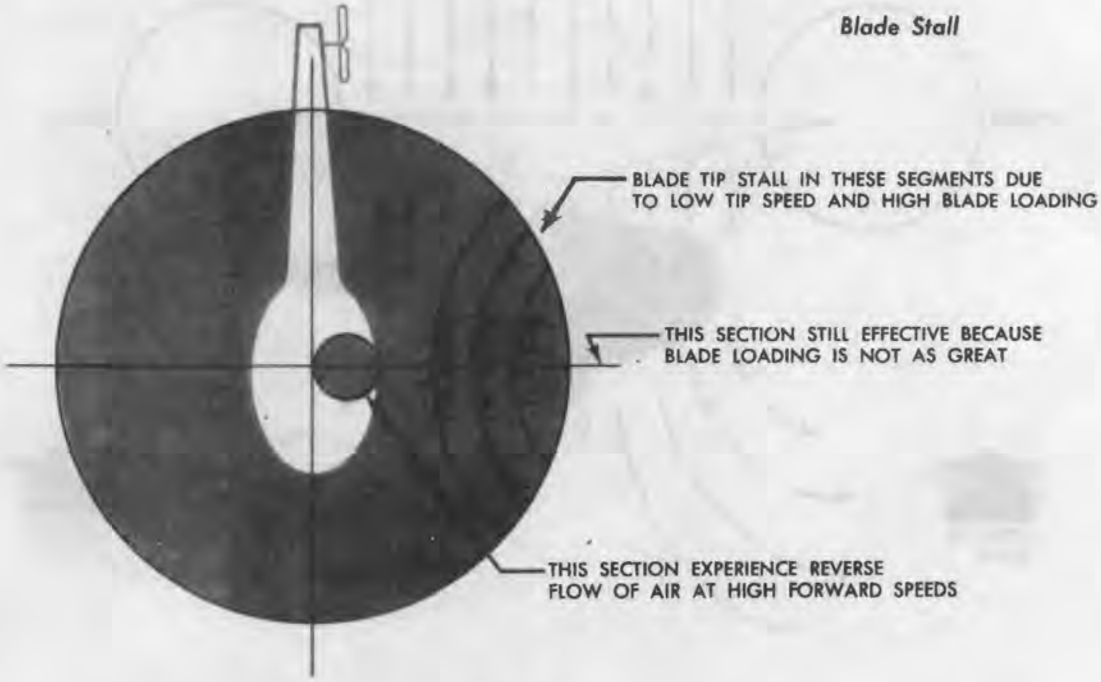
The flight characteristics of a helicopter are noticeably affected by the existing density conditions. For example, at sea level on a cool day the average helicopter demonstrates ample power and lift. However, on a very hot day at sea level the same helicopter is apt to be underpowered, and flight may become critical because of the less dense air conditions. The alert helicopter pilot shrewdly evaluates the existing density conditions, for experience has taught him to alter technique for landings, takeoffs, or autorotation, if such an emergency should arise.

Variation in density conditions will not only affect the efficiency of the main rotor blades as they bite into the air, but engine efficiency also will be altered. As the fuel-air ratio varies, so will the available engine power.

The air surrounding the earth extends upward for about 500 miles. The air at sea level is subject to pressure due to the weight of air above it. Air at sea level is subject to a pressure of 14.7 pounds per square inch and has a density corresponding to that pressure.

The air at an altitude of one mile above sea level has a pressure of 12.1 pounds per square inch, and the pressure at a two-mile altitude is

Blade Stall



9.9 pounds per square inch. The higher the altitude, the lower the pressure and, consequently, the less the density. Altitude is an important factor affecting density, but it is not the only factor.

Another major factor affecting density is temperature. Charles' law states that the density of any gas will vary inversely with the temperature. As air becomes warm, it expands; and as it expands, it becomes thinner because there are fewer particles (molecules) per cubic foot. Therefore, on a warm day the air will be less dense than on a cold day. A definite relationship exists between density and helicopter flight efficiency.

Standard air is designated as air at 59° F sea level conditions (29.92"Hg). In general, the density of air will decrease equivalent to 1,000 feet of altitude for each 15° rise in temperature. The presence of moisture in the air will also decrease density, as saturated moist air weighs approximately ⅝ as much as pure, dry air. However, the presence of moisture in the average climate is not too significant.

It should be remembered that wind is a great help in helicopter flight and may compensate for the loss of efficiency caused by density. The pilot should take into consideration all the factors affecting operation, as each has a direct bearing on the performance of the helicopter. Only by careful analysis can the pilot obtain the maximum functional capacity from his helicopter.

AIRFOIL Any surface that develops a useful dynamic reaction from the air.

AIRSPEED The speed of an airplane in relation to the air through which it is passing.

ALTIMETER An instrument for indicating the relative altitude of an airplane by measuring atmospheric pressure.

ALTITUDE The elevation of an airplane. This may be specified as above sea level, or above the ground over which it flies.

ANGLE OF ATTACK The acute angle formed by the chord line of the airfoil and the relative wind. The advancing and retreating main rotor blades of the helicopter vary their angle of attack in making a cycle of rotation during horizontal flight.

ANGLE OF INCIDENCE The acute angle formed by the chord of the airfoil and the longitudinal axis of the aircraft. In most helicopters, this angle continually changes while the helicopter is in horizontal flight, each blade varies its angle of incidence in making a complete cycle of rotation.

ARTICULATED ROTOR A rotor system whose individual or collective main rotor blades are free to flap, feather, and drag individually or collectively.

ATTITUDE The position of an airplane considering the inclination of its axes in relation to the horizon.

AUTOGYRO An aircraft having rotary airfoils which act only as a means of lift and support. Autogyro is a trade name for the Cierva type aircraft. The main rotor system of an autogyro is not engine driven while in flight. Lift is developed by the air passing up through the rotor blades causing them to rotate at a sufficiently high rpm to support the aircraft. Power is delivered to a conventional-type propeller, which is located on the nose of the autogyro, and provides forward thrust. Normally a minimum of a thirty miles an hour airspeed is required to sustain the aircraft in flight.

AUTOROTATION The process of producing lift with airfoils which rotate freely and are not engine driven. When a helicopter enters into autorotation, the flow of air is upward through the main rotor system, rather than downward, as in the case when the rotors are engine driven.

AXIS The theoretical line extending through the center of gravity of an airplane in each major plane: fore and aft, crosswise, and up and down. These are the longitudinal, lateral, and vertical axes.

BANK To tip, or roll about the longitudinal axis of the airplane. Banks are incident to all properly-executed turns.

BLADE One airfoil of a rotary-wing system used for lift, and directional control.

CEILING (meterology) The height of the base of the clouds above the ground.

CEILING (aircraft) The maximum altitude the airplane is capable of obtaining under standard conditions.

CENTER OF GRAVITY (CG) An imaginary point in a body where the resultant of all forces of gravity is considered to be concentrated.

CENTER OF PRESSURE An imaginary point where the resultant of all aerodynamics forces of an airfoil is considered to be concentrated.

CHECK LIST A list, usually carried in the pilot's compartment, of items requiring the airman's attention for various flight operations.

CHECK POINT In air navigation, a prominent landmark on the ground, either visual or radio, which is used to establish the position of an airplane in flight.

CENTRIFUGAL FORCE A force created by revolving a system which tends to pull away from the axis of rotation. More specifically, in a helicopter the rotating rotor system tends to pull the blades away from the rotor head, causing them to form a flat disc area.

CIRCUIT BREAKER A device which takes the place of a fuse in breaking an electrical circuit in case of an overload. Most aircraft circuit breakers can be reset by pushing a button, in case the overload was temporary.

COAXIAL CONFIGURATION Two rotor systems that are mounted on the same vertical drive shaft one above the other. These systems turn in opposite directions to compensate for torque.

COCKPIT An open space in the fuselage with seats for the pilot and passengers; also used to denote the pilot's compartment in a large airplane.

COLLECTIVE PITCH CHANGE A mechanical means of simultaneously increasing or decreasing the pitch of all main rotor blades. This angular change is equal on all main rotor blades.

COMPASS, MAGNETIC A device for determining the direction of the earth's magnetic field. Subject to local disturbances, the compass will indicate the direction to the north magnetic pole.

CONING The upward flexing of the rotor blades resulting from the vectorially combined effects of centrifugal force and lift.

CYCLIC PITCH CHANGE A mechanical means employed to change the pitch of the main rotor blades when the rotor system makes a cycle of rotation. The angular change of the main rotor blades is equal or opposite.

CRUISE CONTROL The procedure for the operation of an airplane, and its power plants, to obtain the maximum efficiency on extended flights.

DENSITY ALTITUDE The altitude under NACA standard air conditions. True altitude under field air conditions may be converted to the density altitude by correcting for barometric pressure and air temperature. Conversion of pressure altitude to density is based upon correcting for temperature only.

DEVIATION The error induced in a magnetic compass by steel structure, electrical equipment or similar disturbing factors in the airplane.

DISC AREA The area swept by the rotating blades, which is practically a circle, having a radius of one-half the rotor diameter.

DISC LOADING The ratio of gross weight to disc area (gross weight divided by disc area).

DISSYMMETRY OF LIFT The unequal lift across a rotor disc that occurs in horizontal flight as a result of the difference in velocity of the air over the advancing half of the disc area, and the air passing over the retreating half of disc area.

DRAG The force which tends to resist an airfoil's passage through the air. Drag is parallel to the relative wind and varies as the square of the velocity. In a helicopter, the term dragging is used to describe the movement of the rotor blade in a horizontal plane about a vertical axis.

DRIFT Deflection of an airplane from its intended course by action of the wind.

FLAPPING The movement of a blade vertically about the horizontal axis. There are several reasons for this action, one being the dissymmetry of lift that exists between the advancing and retreating halves of the disc area during horizontal flight.

FLIGHT PLAN A detailed outline of a proposed flight usually filed with an FAA Flight Service Station before a cross-country flight.

FUSELAGE The body to which the wings, landing gear, and tail are attached.

GASCOLATOR A type of fuel strainer incorporating a sediment bulb.

GLIDE Sustained forward flight in which speed is maintained only by the loss of altitude.

GROUND CUSHION OR GROUND EFFECT Additional lift obtained when the helicopter is hovering close to the ground caused by the packing of the air between the main rotor and the ground. Such air has greater density. It is effective to a height of one-half the rotor diameter.

GYROSCOPIC PRECESSION A characteristic of all rotating bodies. Such bodies will be uniformly displaced 90° in the direction of rotation from where a force is applied.

HORSE POWER A unit for measurement of power output of an engine. It is the power required to raise 550 pounds one foot in one second.

HOVERING Maintaining a fixed position in space over a spot on the ground. While hovering, lift equals gross weight.

HOVERING IN GROUND EFFECT The flight of a helicopter with zero ground speed near enough to the ground or water surface to compress a cushion of high density air between the main rotor and the ground or water surface, thereby increasing the lift produced by the main rotor.

HOVERING WITHOUT GROUND EFFECT The flight of a helicopter with zero ground speed not near enough to the ground or water surface to gain additional lift by compressing an air cushion between the main rotor and the ground or water surface.

LIFT The supporting force induced by the dynamic reaction of air against the wing.

LIFT COMPONENT The sum of the forces acting on a wing, perpendicular to the direction of its motion through the air.

LOAD FACTOR The sum of the loads on a structure, including the static and dynamic loads, expressed in units of F, or one gravity.

MANEUVER Any planned motion of an airplane in the air or on the ground.

OVERSHOOT To fly beyond a designated area or mark.

RIGID ROTOR A rotor whose blades and hub are rigid to the mast, and can feather only, but cannot flap or drag.

ROTATIONAL VELOCITY The velocity of any specified section of a rotor blade resulting from rotation of the blade.

SEMI-RIGID ROTOR A rotor system whose blades are fixed to a hub, but are free to flap and feather.

TACHOMETER An instrument which registers in revolutions per minute (RPM) the speed of the engine.

TAIL ROTOR All the blades and attachments which make up the torque compensating system.

TAXI To operate an airplane under its own power on the ground, except that movement incident to actual take-off and landing.

TIP PATH PLANE The imaginary circular surface formed by a plane passed through the average tip path cf the rotor blades.

TORQUE A force or combination of forces that produce a rotating or twisting motion. In a helicopter, the initiating force (engine)rotates the main rotor system in one direction, and the fuselage tends to rotate in the opposite direction. A helicopter with a single main rotor, driven by a conventional engine, employs a tail rotor to compensate for torque.

TRACKING A term denoting the satisfactory relationship of the rotor blades to each other under dynamic flight conditions. This relationship is established whenever the blade tips rotate in the same place. The word "tracking" has come to mean also the mechanical procedure used to bring the blades to the above satisfactory flight condition.

TRANSLATIONAL LIFT The additional lift obtained when leaving the ground cushion and entering horizontal flight.

USEFUL LOAD In airplanes, the difference, in pounds, between the empty weight and the maximum authorized gross weight.

VISIBILITY The greatest horizontal distance which prominent objects on the ground can be seen (used to denote weather conditions).

WIND SHIFT (OR WIND SHIFT LINE) An abrupt change in the direction or velocity, or both, of the wind. Usually associated with a front.

WIND SOCK A cloth sleeve, mounted aloft at an airport to use for estimating wind direction and velocity.

WIND TEE An indicator for wind or traffic direction at an airport.

YAW To turn about the vertical axis. An airplane is said to yaw as the nose turns without the accompanying appropriate bank.

OH-23D HELICOPTER PREFLIGHT INSPECTION

AND

COCKPIT PROCEDURE

(There will be less chance of forgetting something if a definite inspection procedure and sequence is learned and used.)

I. PREFLIGHT INSPECTION

A. Cockpit Check:

(1) UNTIE MAIN ROTOR BLADE, move in the direction of rotation to ascertain aft tail rotor drive shaft bearing movement and to position tail rotor blades horizontally. Visually check under surface and leading edge of main rotor blade for defects.

(2) Remove main rotor tie down block and secure in right cockpit seat belt.

(3) Check battery quick disconnect for attachment.

(4) Check magneto switch "OFF".

(5) Check parts 12, 13 and 14 of the form 2408. Insert date on parts 12 and 13.

(6) Turn fuel on. Turn master, fuel pump, anti-collision, and running lights switches on. Check for fuel leaks right side, operation of anti-collision and right running light. Walk around rear and check tail light operation. Check for fuel leaks left side and left running light for operation. Turn off all switches.

(7) Check level of fuel and oil, (Eng 8 qts. Txmn 4 1/2 qts.)

(8) Cockpit interior, left side, for security and condition of safety belts and shoulder harness, emergency door release, and electrical junction box for security of cover. Check adjustment of tail rotor control pedals and security of first aid kit. Check collective pitch friction lock off.

(9) Left door plexiglas for cracks, and security of attaching bolts.

(10) Left front skid leg for condition and security and forward spring tube for deflection (maximum allowable permanent set is 0.75 inch and locally deflected 0.15 inch maximum in any one foot length.) Left position light for security of mounting and condition of glass. Check left skid, attachment of forward spring tube to basic body, and under surface of basic body section.

(11) Landing light for condition, security. Remove pitot cover, if present.

(12) Bubble for appearance, cracks, and security of attaching bolts.

(13) Right door plexiglas for cracks, security of attaching bolts.

(14) Cockpit interior, right side, for security and condition of safety belts, emergency door release, security of radio equipment, adjustment of right tail rotor control pedal, installation of C.G. ballast plate, and fire extinguisher. Maximum cabin loading is limited to 600 lbs. Use ballast weight so that the center of gravity limitations are not exceeded.

(15) Right front skid leg for condition and security, right position light for security of mounting and condition of glass, attachment of forward spring tube to basic body, right skid, ground handling wheel, aft skid leg, drag strut, and aft spring tube for deflection.

B. Flight Controls and Engine Compartment (Right Side), CHECK:

(1) Underside of basic body check, right side for cuts, dents, popped rivets, etc. and fuel leaks.

(2) Lower and upper right hand tail boom fittings.

(3) Lower aft right hand engine mount frame fitting.

(4) Electrical junction box on right hand side of engine deck for security of cover, cannon plugs, and proper safetying, and general condition of electrical wiring.

(5) Battery for security, drain plugs, vents open and security of quick disconnect.

(6) Lower forward right hand engine mount frame fitting.

(7) Drain fuel strainer.

(8) Condition and security of ignition harness and evidence of oil leaks in lower engine case.

(9) Starter for security of attachment and condition of wiring.

(10) Right side of engine for general condition. Security and safetying of oil temperature bulb, oil filter, oil pressure adjustment cap. Check for oil leaks around engine case, cylinders and rocker box covers.

(11) Condition and security of engine cooling shroud assembly (right side) and engine cooling shroud access door assembly.

(12) Security of external power receptacle cover.

(13) Condition of lower cyclic bell crank cover.

(14) Cyclic push rods, bell cranks, vibration dampers, link assembly, isolation linkage, upper fire wall bell crank bracket, and transmission bell crank bracket for general condition, security and freedom of movement.

(15) Condition and security of cabin heat duct assembly.

(16) Condition and security of engine air intake duct assembly.

(17) Condition and security of inner gimbal lord mount, inner and outer engine mounting gimbal assemblies, and engine mount strut assembly (right side).

(18) Transmission and transmission oil lines for general condition.

(19) Security and condition of tail rotor drive forward slip joint assembly and slip joint cover.

(20) Carburetor for proper safetying, security of controls, security of attaching bolts, and visually check idle cut-off valve plunger for proper position (should extrude about one-half inch.)

(21) Drain carburetor float chamber and close valve when drained.

C. Tail Boom and Tail Rotor, CHECK:

(1) Tail rotor cable turnbuckles and engine deck pulleys for security.

(2) Aft snubber assembly for excessive wear and deterioration of land mount (maximum allowable separation is 1/16 inch in depth and extending 360 degrees).

(3) Forward tail rotor drive shaft for dents or scratches.

(4) Underside of transition section for skin condition.

(5) Frequency transmitter converter and keyer covers for security.

(6) Forward universal joint.

(7) Cardan joint for security of mounting, safeties, cracks, and excessive radial movement.

(8) Aft universal joint.

(9) Aft tail rotor drive shaft bearings, control cables, and guide bracket for excessive wear and safeties.

(10) Tail boom for skin condition.

(11) Security and condition of tail rotor drive aft slip joint assembly and slip joint cover.

(12) Tail rotor control cable terminal fitting bolts for condition and safety.

(13) Condition and security of tail rotor control aft pulleys, aft pulley bracket, and cable drum.

(14) Horizontal stabilizer, rear position light, and wiring for security.

(15) Tail rotor gear box parting surfaces for oil leaks.

(16) Security of tail rotor gear box to tail boom aft bulk head.

(17) Tail rotor gear box filler and drain plugs for safeties.

(18) General condition, security, and safetying of tail rotor blades, blade balance screws, balance weights, attachments of blade roots, and security of tail rotor hub assembly to tail rotor gear box output shaft.

(19) Outboard tail rotor stop and tail rotor drive shaft cap for safeties.

(20) Tail rotor yoke for freedom of movement and security. Blade balance screws for safetying.

(21) Safetying, wear, and radial freedom of control turnbarrels and rod ends.

(22) Security and safetying of pitch change arm to pitch change rod.

(23) Tail skid strut for security and antenna, if present.

(24) Tail boom for skin condition.

(25) Visually check under surface and leading edge of main rotor blade for defects.

D. Flight Controls and Engine Compartment (Left Side) CHECK:

(1) Upper left hand tail boom fitting.

(2) Lower aft left hand engine mount frame fitting.

(3) Left-hand snubber assembly for excessive wear and deterioration of lord mount (maximum allowable separation is 1/16 inch in depth and extending 360 degrees).

(4) Oil coolers and oil lines for general condition, security, and oil leaks. Oil drain valves closed position.

(5) Condition and security of ignition harness.

(6) Left side of engine for general condition, security, and peoper safetying. Check for oil leaks around engine case, cylinders and rocker box covers.

(7) Condition and security of carburetor heated air intake flex duct.

(8) Condition and security of inner gimbal, lord mount, inner and outer engine mounting gimbal, assemblies, and engine mount strut assembly (left side).

(9) Condition and security of generator air duct.

(10) Check oil breather for security. (back of transmission.) Check Txmn pressure warning switch and temp bulb.

(11) Condition, security, and safetying of collective pitch external push rods, push rod end bearings, upper fire wall bracket - link - bell crank assembly, transmission bell crank-bracket assembly.

(12) Condition, security and safetying of collective pitch yoke and ring assembly, upper and lower mast boots for lubricant. Check collective pitch yoke retaining pin for safetying and collective pitch yoke support bracket.

(13) General condition, security, and proper safetying of installation of wobble plate pylon assembly to transmission, wobble plate yoke to pylon, and wobble plate yoke to wobble plate. Check wobble plate bearing security and attachment of wobble plate shield.

(14) Security and safety of wobble plate gimbal sleeve to main rotor mast.

(15) Condition, security, and proper safetying of bolts attaching wobble plate gimbal ring to lower scissor, lower scissors to upper scissors, upper scissors to trunnion bearings, and trunnion bearings to control rotor cuff incidence bracket.

(16) Security of nuts securing base of the control rotor hub trunnion to the studs in main rotor hub.

(17) Radial freedom of control rotor cuff bearings to blade root cuff.

(18) Safetying of retaining bolts connecting control rotor cuff and blade assembly spar tube.

(19) General condition of fabric covering of both control rotor blades.

(20) Main rotor blades for condition and security of bonded areas and visible damage to spar or skin, and vent holes for obstructions.

(21) Safetying of main rotor tension-torsion bar retention pins.

(22) Main rotor blade incidence arms for security of installation, proper horizontal clearance and visually check paint on top surface of the incidence arms for evidence of contact with main rotor hub.

(23) Security and radial freedom of main rotor blade incidence arm push pull rods.

(24) Proper safetying of four bolts securing ballast assembly to the main rotor hub.

(25) Proper safetying and security of bolts of the ballast assembly and ballast tubes.

(26) Main rotor mast spanner nut for security and two safeties.

(27) Safeties and security of spline drive fitting thrusts nuts located in outboard side of main rotor gimbal ring.

(28) Security, safeties, and radial freedom of special bolts securing main rotor hub to gimbal ring (castellated nuts located on the inboard side

of main rotor gimbal ring). Clearance of ears on main rotor hub to gimbal ring should be noted by rocking the main rotor blades up and down.

(29) Condition and security of engine cooling shroud assembly (left side) and engine cooling shroud access door assembly.

(30) Security and safetying of cooling fan to cooling fan gear box fan drive shaft.

(31) Visually check condition of upper and lower cooling fan drive coupling assemblies and check coupling assembly snap rings for proper positioning.

(32) Security of snap rings on transmission fan drive shaft and cooling fan gear box drive shaft.

(33) Check transmission oil lines and filter for security.

(34) Lower forward left hand engine mount frame fitting.

(35) Check collective pitch dual throttle control cable assembly, bungee assembly, and collective pitch throttle linkage for safetying and security.

(36) Move collective pitch through full travel to ascertain freedom of system movement and proper operation of throttle override.

(37) Check aft skid leg, vertical strut, drag strut, and ground handling wheel.

(38) Underside of basic body section (left side for cuts, dents, popped rivets, and fuel leaks.

(39) Drain fuel sump.

(40) Fill out form 2408.

2. COCKPIT PROCEDURE

A. Starting and Warm-Up

(1) Check main rotor tie down strap and block for security.

(2) Fasten safety belt. (Caution: Excessive belt extending beyond the buckle may foul the controls. Whenever seats are unoccupied, fasten belts and shoulder harness to prevent fouling controls). Do not tie in knots.

(3) See that cabin heater is "OFF".

(4) Check all controls for full travel and freedom of movement.

(5) Collective pitch down, throttle closed.

(6) Carburetor heat cold, carburetor air filter in "carb air filter" position.

(7) Fuel Shut-off valve "On".

(8) Check circuit breakers "In". (Day-landing light breakers "out").

(9) Fuel pump, radio, master, position lights, magneto, and landing light switches "OFF".

(10) Set clock and altimeter.

(11) Instrument lights rheostat "OFF".

(12) Ascertain condition and static position of instruments.

(13) Check radio power and FM radio switches "OFF".

(14) Check magnetic compass.

(15) Master switch "ON", check generator warning light and other electrically operated instruments (Engine oil temperature, volt ammeter, fuel gauge, cylinder head temperature, carb air temperature, Txmn oil pressure warning light and Txmn oil temperature warning light. Check cockpit light "OFF".

(16) Auxiliary fuel pump "ON" (Fuel pressure gauge will fluctuate until carburetor float chamber and pump fuel strainer bowl have been refilled). After pressure stabilizes, prime engine as necessary by opening and closing throttle (use primer switch in extreme cold weather only).

(17) Ascertain that helicopter is clear of personnel or obstructions prior to starting, and shout, "CLEAR, ROTOR BLADES DISPLACED". (57 models: Pull fuel quantity gauge fuse).

(18) Keep throttle in the indent, depress starter and after engine has turned over 1 or 2 revolutions switch ignition to right magneto position. As soon as engine starts, release starter and switch ignition to "Both" position. Check Txmn oil pressure warning light out.

(19) Leave throttle in indent until tachometer needles are synchronized (needles should not join prior to 700 RPM or after 1600 RPM. If such a condition exists do not fly the helicopter: improper clutch action is indicated).

(20) Check oil pressure gauge for proper indication (If engine oil pressure is not indicated within 30 seconds after engine starts, stop engine).

(21) Warm up the engine at 1650 to 1700 RPM until oil temperature gauge indicates 15 degrees C. minimum. Then increase RPM 2200 and continue to warm up.

(22) Adjust cyclic trim to center rotor hub around mast.

(23) Turn auxiliary pump "OFF" and check fuel pressure gauge for proper indication (2-5 lbs. PSI) Turn fuel pump on. (57 models: Insert fuel quantity gauge fuse).

(24) Check carburetor heat operation and apply heat as required to maintain the carburetor air temperature between 32 degrees and 54 degrees C. (45 degrees C. desired, for in flight operation).

(25) Check ammeter for indication of current and generator warning light "OUT".

(26) While engine is warming up, turn on radio, and tune in tower. Put on APH-5.

(27) Press fuel gauge test switch to test the operation of the fuel quantity gauge. (When pressed, the switch causes the gauge pointer to drop toward zero. When switch is released, the pointer should return to its original position. A system malfunction is indicated if the pointer fails to return to its original position).

(28) Maintain 2200 RPM until cylinder head temperature reaches a minimum of 100 degrees C.

(29) Increase RPM to 3200, set manifold pressure approximately two inches above minimum pitch setting. Accomplish normal magneto check, a drop off of 200 RPM is permissible if there is no engine roughness. Return collective pitch to full down position maintaining 3200 RPM.

(30) Check tip path plane.

(31) Close throttle quickly to split tachometer needles, simultaneously apply right pedal. While needles are split, depress manifold pressure purge, momentarily to drain lines. (Caution: Do not depress in flight).

Accomplish low speed magneto check (with needles split) then switch to "OFF" position and back to "BOTH" position quickly to insure proper grounding of leads.

(32) Check engine idle speed (engine should idle with tachometer needles synchronized between 1650 and 1700 RPM). Return RPM to 2200.

(33) Press transmission warning light and check for proper operation. Check Txmn oil temp w/spring loaded toggle switch.

NOTE: Any discussion of helicopter starting procedure would be incomplete if it failed to deal with "quick starts". Quick starts occur when the helicopter is started at a throttle setting that would cause the transmission clutch to engage immediately, causing a sudden and very rapid acceleration of the entire driven mechanism of the helicopter. This can cause severe damage to both personnel and material. A quick start may cause misalignment of balanced surfaces, shear drive shafts, strip gears, distort the fuselage and otherwise damage the helicopter to such an extent it will require a complete overhaul. A quick start should be stopped by closing the throttle and shutting off the magneto switch immediately. A helicopter should not be flown after a quick start occurs until it has been thoroughly inspected.

B. Before Take-Off

(1) Fuel selector full "On".
(2) Carburetor heat as required.
(3) Anti-collision light on.
(4) Magneto switch on "Both".
(5) All engine instruments in green.
(6) Radio transmitter selector on position #2.
(7) Aircraft clear.
(8) Lock shoulder harness.

C. Before Landing

(1) Carburetor heat as required.
(2) Control friction "Off".
(3) Shoulder harness locked.

D. Shut-Down Procedure

(1) Adjust cyclic trim to center rotor hub around mast.

(2) Place carburetor heat lever to "COLD" position, Anti-collision light off. Auxiliary fuel pump off.

(3) Check magnetos at 3200 RPM. Return collective pitch to full down position maintaining 3200 RPM. Close throttle to split tachometer needles, simultaneously apply right pedal. Accomplish low speed check and grounding check, with needles split. Check engine idle speed.

(4) Maintain 2200 RPM and place fuel shut off valve in "OFF" position. When engine stops turn magneto switch off, refill carburetor and turn all other switches off.

(5) Place fuel shut-off valve in "OFF" position.

(6) Complete Form 2408, parts 12 and 13, and place in proper location to denote refueling is required.

(7) Let rotor coast to full stop making no attempt to stop it manually (Exception: When shutdown is to be made in high wind conditions, the cyclic control stick will be moved slightly forward. If it becomes apparent that the main rotor blade could strike the tail rotor shaft, the following procedure may be used to stop the main rotor. Grasp the 5 inch drive tube at either end and exert equal pressure with the hands. Do not push or pull the drive tube when attempting to stop the rotor. Avoid scratching the tube with rings. (Beware of catching clothing on rotating elements).

(8) Secure main rotor.

(9) Accomplish "walk around" post flight inspection.

3. EMERGENCY PROCEDURES AND ENGINE LIMITATIONS

A. Engine Fire During Starting:

(1) If fire breaks out during the engine starting procedure, immediately discontinue priming the engine but continue to engage the starter in an attempt to draw the fire through the engine.

(2) If the fire continues or spreads, release the starter and close the fuel shut-off valve.

(3) Signal fire guard to apply fire extinguisher to fire.

(4) Be sure all electrical switches are off before leaving the helicopter.

(5) Do not attempt to restart the engine without first determining the cause of the fire.

B. Tail Rotor Failure in Flight

(1) Immediately close the throttle to maintain directional control.

(2) After directional control is established, cautious application of power may be made if necessary to lengthen the glide.

(3) Maintain an airspeed of at least 40 knots.

(4) Correct the torque effect of the main rotor by applying cyclic control slightly away from the direction in which the helicopter tends to turn.

(5) Make a normal autorotative landing into the wind if possible, on a straight flight path.

(6) When making an autorotative landing because of tail rotor failure, forward speed at the time of ground contact is desirable if the landing surface is sufficiently smooth.

(7) NEVER apply power during the actual landing operation.

C. Electrical System Emergency Operation:

(1) A red warning light on the instrument panel will light up in the event of a generator failure. If the generator fails, immediately pull out the generator field circuit breaker located on the circuit breaker panel. This will disconnect the generator from the electrical system. To conserve battery power turn off all electrical equipment not immediately needed for flight. The radio equipment may be used later as required.

D. Gauge Indications:

(1) Airspeed Indicator:
83 Knots maximum
30 to 83 knots operation range
0 to 30 caution between 10 and 375 feet altitude

(2) Dual tachometer:
Engine RPM:
2900 RPM minimum for flight
2900 to 3200 RPM continuous power operation
3200 RPM maximum

Rotor RPM:
314 RPM minimum for flight
335 to 370 RPM continuous power operation
395 RPM maximum
200 to 225 cooling fan resonance. Avoid prolonged operation

(3) Carburetor air temperature gauge:
0 to 32 degrees C danger of icing
32 to 45 degrees C continuous operation (summer)
45 to 54 degrees C continuous operation (winter)
At all times within the green arc
54 degrees C maximum. 45° C desired

(4) Engine gauge unit:
Oil Temperature
40 degrees C minimum for flight
40 to 107 degrees C continuous operation
107 degrees C maximum

Oil Pressure
25 PSI minimum for flight
65 to 85 PSI continuous operation
85 PSI maximum

Fuel Pressure
2 PSI minimum for flight
2 to 5 PSI normal
5 PSI maximum

Cylinder Head Temperature Gauge
100 degrees C minimum
100 to 246 degrees C normal
246 degrees C maximum

(5) Engine overspeeds:

3520 RPM - land where nearest mechanic is available, write on part 13 of DA form 2408. Have engine checked before further flight.

In excess of 3600 RPM - land at nearest available clear area. A/C will be downed for engine change.

(6) Rotor overspeeds:

415 RPM - land at nearest available clear area. A/C will be downed for an extensive main rotor inspection.

(7) Oil Breather Procedures:

During periods of low outside air temperature, there exists a tendency for the oil breather tube to freeze. In this condition there could be enough back pressure created to dislodge oil seals in the engine and transmission.

The Hiller OH-23D has a modification that permits a quick change from the regular oil breather tube to a larger one mounted on the aft side of the oil cooler, that precludes building up of back pressure.

The following procedures should be adhered to:

Outside Air Temperature -
Above 20°F - Use regular oil breather installation.
Below 20°F - Use modification installation.

SECONDARY PRE-FLIGHT

(To be used only after initial Pre-Flight by the same pilot - same ~~aircraft~~).

UNTIE MAIN ROTOR BLADE

Magneto Switch OFF - 2408-13

Navigation and anti-collision light operation and fuel line leaks under pressure.

Fuel and Oil Quantity

Left Side of Cabin

Helicopter Exterior - Front

Right Side of Cabin

Flight Controls and Engine Compartment (Right Side)

Fuel Drains

Right Side of Tail Boom Structure

Flight Controls and Engine Compartment (Left Side)

Transmission

Main Rotor System

Cooling Fan

Drain Fuel Sump

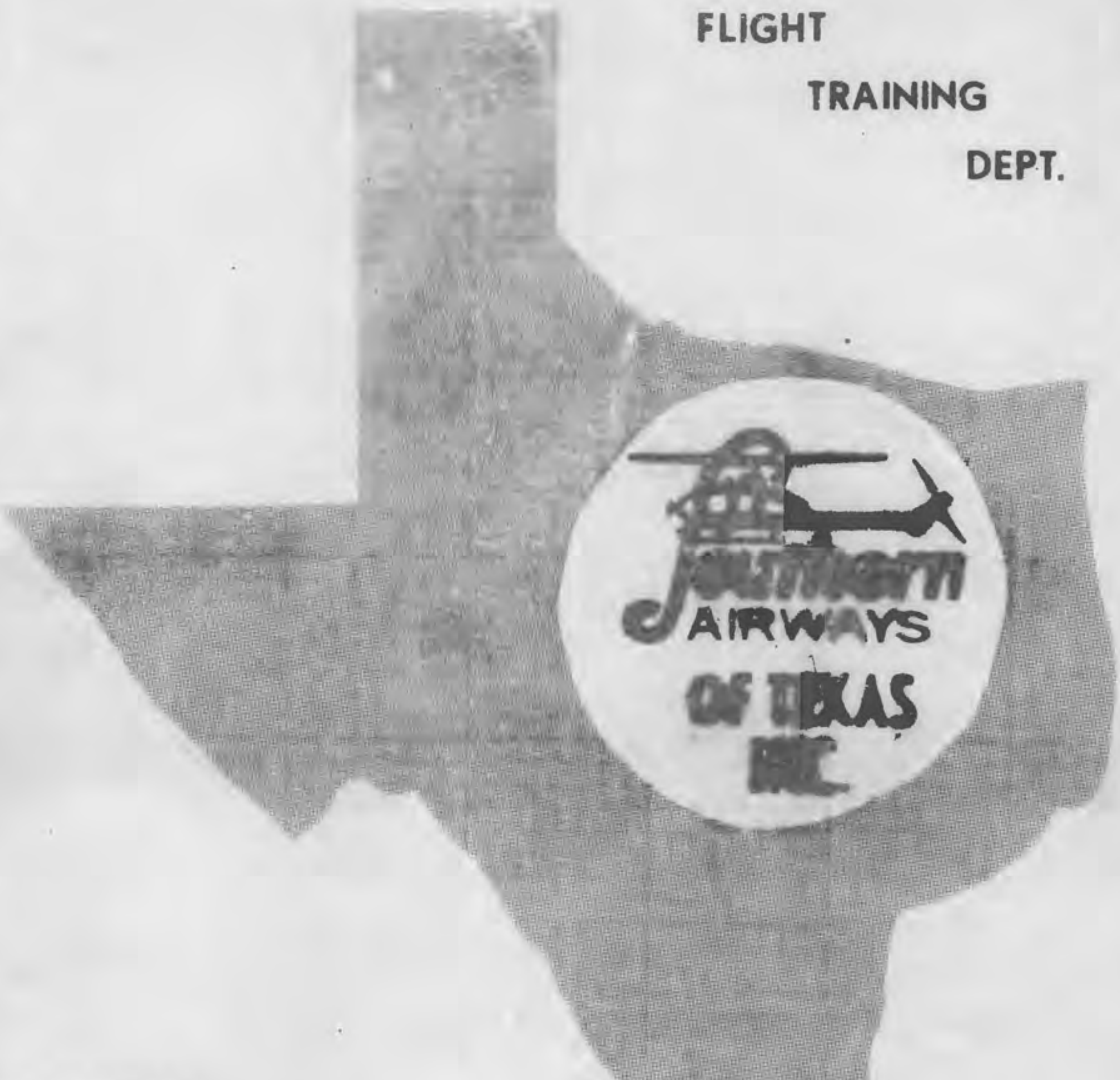
For more detailed information concerning component parts, tolerance and allowances, refer to Initial Pre-Flight.

SOUTHERN AIRWAYS OF TEXAS, INC.

FLIGHT

TRAINING

DEPT.



HELICOPTER INSTRUCTIONAL TECHNIQUE

APRIL

1967

PRE-SOLO HELICOPTER INSTRUCTIONAL TECHNIQUE

Ground Demonstration

1. Peripheral vision demonstration.

2. Function of anti-torque pedals.

    a. Explain proper method for adjusting.

    b. Explain utilization (position of feet on pedal).

3. Function of throttle and collective pitch controls.

    a. Explain and demonstrate use of the friction locks.

    b. Explain the function of each control and demonstrate proper method to make control changes.

    c. Explain necessity of correlating the controls.

4. Function of the cyclic control.

    a. Explain proper method utilize the control.

    b. Explain and demonstrate use of trim device.

Demonstration of Controls in Flight

1. Demonstrate effect of cyclic control.

    a. Demonstrate level attitude longitudinally and laterally using reference points in the cockpit.

    b. Demonstrate nose-high attitude and the resultant decrease of airspeed.

    c. Demonstrate nose-low attitude and the resultant increase of airspeed.

    d. Demonstrate left side low (left bank).

    e. Demonstrate right side low (right bank).

    f. Demonstrate common errors (over-controlling, tenseness, and improper trim on cyclic.

2. Demonstrate effect of collective pitch control.

    a. Increase collective pitch and note the resultant increase of altitude indicated by the altimeter.

b. Decrease collective pitch as required to stop the ascent and demonstrate the stabilization of the altimeter.

c. Decrease collective pitch and note the resultant decrease of altitude indicated by the altimeter.

d. Increase collective pitch as required to stop the descent and demonstrate the stabilization of the altimeter.

e. Demonstrate common errors.

3. Demonstrate effect of throttle control.

a. Increase throttle and note resultant increase of rpm.

b. Decrease throttle and note resultant decrease of rpm.

c. Slowly increase and decrease collective pitch to vary the manifold pressure from 20 to 23 inches without manually varying the throttle and note the synchronization of the throttle with the collective pitch to maintain engine rpm.

4. Demonstrate effect of pedal control.

a. Depress right pedal then left pedal to demonstrate yaw about the vertical axis.

b. Hold constant pedal position. Change power between 15 inches MP to 23 inches MP to demonstrate yaw about yaw about vertical axis.

c. Place feet on floor, change power between 15 inches and 23 inches of MP to deonstrate yaw about vertical axis.

d. Demonstrate pedal trim exercise, changing power between 15 inches to 23 inches of MP, while simultaneously maintaining pedal trim to hold constant heading.

e. Change power between 15 inches and 23 inches MP while student maintains heading using pedals only.

5. Straight and level flight (deonstrate maneuver).

a. Practice maintaining level attitude longitudinally and laterally by reference points on the bubble and their relationship to the horizon with peripheral vision (using cyclic only).

b. Practice maintaining altitude by reference to the altimeter (using collective pitch only).

c. Practice maintaining constant airspeed by reference to the cockpit reference points and cross-checking the airspeed.

d. Practice maintaining constant heading with pedals only.

e. Practice maintaining level attitude and heading with cyclic control and collective pitch.

f. Practice maintaining level attitude and constant altitude with cyclic and collective pitch.

g. Practice maintaining heading and altitude with collective pitch and pedals only.

h. Practice maintaining level attitude, heading, and altitude with all controls combined.

i. Practice entering a slip, level helicopter, maintain pedal position obtained in slip, then slowly press opposite pedal until helicopter is properly trimmed.

j. If difficulty is encountered with one control, review individual control, then the various combinations, then finally all the controls combined again.

6. Coordination of controls sequence

a. Practice changing rpm between 3200 and 3000 OH-23D, 2900 and 2700 TH-55A, rotating throttle slowly, stop needly on required figure by a slight counter pressure, stabilize needle with counter pressures as required (throttle only).

b. Practice decreasing MP from 23 inches to 15 inches and simultaneously rotate throttle to maintain 3200 rpm. (TH-55A 2900).

c. Practice increasing MP from 15 inches to 23 inches and simultaneously rotate throttle to maintain 3200 rpm, 2900 (TH-55A) (continue to practice this exercise until desired proficiency is attained.)

d. Practice above exercise using only pedals.

e. Practice above exercise, using pedals, collective pitch, and throttle combined.

f. Practice above exercise, maintaining constant airspeed of 40 knots (using cyclic only).

g. Practice above exercise, maintaining 40 knots with all controls combined.

h. Practice changing airspeed between 30 knots and 50 knots using cyclic control only.

i. Practice the above exercise using the pitch, throttle, cyclic and pedals simultaneously to maintain rpm, heading, and about the same altitude.

j. If difficulty is encountered with one control, in the coordination sequence, review individual control, then the various combinations, then finally all controls combined again.

k. Demonstrate common errors.

7. Turns (demonstrate maneuver).

a. Demonstrate and practice rolling into a medium banked turn (cyclic only), note simultaneous increase in rate of turn, as bank increases. Recover, note simultaneous decrease in rate of turn as bank decreases.

b. Practice rolling into a medium bank which requires 20 degrees of turn for entry and 20 degrees of turn for recovery. (Constant pressure). Do not vary the pressure). Do not vary the pressure on the cyclic control for roll out, even though the roll out point is missed; adjust the constant pressure for the roll out of the next turn to compensate for error on the preceding turn. (This procedure is to develop judgment of timing, and pressures may vary in more advanced stages of training.)

c. Demonstrate skids and slips during entry and recovery of a turn.

d. Demonstrate skid and slips while in the turn by pressing left and right pedal.

e. Demonstrate skids and slips while in the turn by holding a constant pedal position, changing power between 15 and 23 inches MP.

f. While in a turn, practice pressing a pedal to enter a skid or slip, then pressing opposite pedal as required to properly trim the helicopter.

g. While in a turn, practice changing power between 15 inches and 23 inches of MP, maintain proper pedal trim.

h. Demonstrate common errors.

Demonstration of Controls Hovering

1. Demonstrate effect of pedals

   a. Demonstrate effect of pedals upon rpm.

2. Demonstrate effeet of collective pitch control.

   a. Ascend and descend from 2 to 8 feet stopping at 2 feet intervals.

   b. Demonstrate method of releiving pressure of a heavy collective pitch.

   c. Demonstrate effect of collective ptich upon rpm.

3. Demonstrate effect of cyclic control

   a. Hover forward, level the helicopter and coast to a stop.

   b. Demonstrate lateral and rearward movement stopping with same method.

   c. Demonstrate effect of over-controlling laterally and longitudinally.

4. Review and practice use of pedals.

5. Review and practice use of collective pitch.

6. Review and practice use of cyclic.

7. Practice use of pedals and collective pitch combined.

8. Practice use of pedals and cyclic combined.

9. Practice use of collective pitch and cyclic combined.

10. Practice using all controls combined.

11. If difficulty is encountered with one control, review that individual control, then various combinations, then finally all controls combined again.

12. Demonstrate common errors.

13. Hovering take-off and landing (demonstrate maneuver).

    a. Ascend and descend from 2 to 8 feet stopping at 2 feet intervals (collective pitch only)

b. Ascend and descend from 2 to 8 feet with a constant slow rate of ascent -- ~~and descent~~ (collective pitch only)

c. Ascend and descend from ground to 8 feet.

d. Ascend and descend from ground to 8 feet with constant slow rate pedals only).

e. Ascend and descend from ground to 8 feet with constant slow rate (cyclic only).

f. Execute same maneuver with pedals and collective pitch combined.

g. Execute same maneuver with collective pitch and cyclic combined.

h. Execute same maneuver with all controls combined.

i. If difficulty is encountered with one control, review that individual control, then various combinations then finally all controls combined again.

j. Practice landing with forward movement of 5 to 8 knots with all controls combined.

k. Demonstrate common errors.

14. Hovering turns (demonstrate maneuver).

a. Turn 360 degrees, with a pause every 30 degrees (pedals only).

b. Turn 360 degrees with a constant slow rate of turn, using light pressure and counter pressure (using pedals only).

c. Practice turns using collective pitch only.

d. Practice turns using cyclic only.

e. Practice turns with pedals and collective pitch combined.

f. Practice turns with pedals and cyclic combined.

g. Practice turns with collective pitch and cyclic combined.

h. Practice turns with all controls combined.

i. If difficulty is encountered, with one control review individual control, then various combinations then finally all controls combined.

j. Demonstrate common errors.

15. Hovering flight (demonstrate maneuver).

    a. Practice turning throttle into override with helicopter.

    b. Practice turning throttle into override and pressing right pedal two-thirds of travel, and pressing cyclic control slightly to the right simultaneously, with helicopter parked.

    c. Practice maneuver using pedals only.

    d. Practice maneuvers using collective pitch only.

    e. Practice maneuver using cyclic only.

    f. Practice maneuver using pedals and collective pitch combined.

    g. Practice maneuver using pedals and cyclic combined.

    h. Practice maneuvers using collective pitch and cyclic combined.

    i. Execute maneuver with all controls combined.

    j. If difficulty is encountered with one control, review that individual control, then various combinations, then finally all controls combined again.

    k. Practice maneuver from 3 feet with about 5 knots forward movement with all controls combined.

16. Normal take-off (demonstrate maneuver).

    a. Practice exercise of slowly accelerating and maintaining 3 feet of altitude (using collective pitch only).

    b. Practice exercise above using all controls.

    c. Demonstrate transverse flow effect.

    d. Demonstrate effect of insufficient forward cyclic as effective translational lift is obtained.

    e. Demonstrate common errors.

17. Normal approach (demonstrate maneuver).

    a. Demonstrate rate of closure, hover at 3 feet and move forward at 5 knots ground speed. Observe the rate of movement of the compass across the ground.

b. While observing the ground speed, demonstrate rate of movement which is too slow.

c. Increase hovering speed and demonstrate rate of movement which is too fast.

d. From 300 feet, descend on 12 degree line to pre-determined point, maintain 40 knots and sight picture. Note apparent increase in rate of closure during descent.

e. From 300 feet 40 knots, descend on a 12 degree line to a pre-determined point. Maintain apparent rate of closure of 5 knots by decelerating as required during the descent.

f. Demonstrate sight picture for normal approach. Hover or land behind a pre-determined point with it fixed in the proper position on the bubble to observe the sight picture.

g. Practice visualizing a line of descent by making approaches to a point unknown to the student and have him tell you the termination point after completing about one-third of the approach. These approaches should be made from various angles, so that the student cannot use the sight picture as a crutch.

h. From 300 feet 40 knots, practice descending on a 12 degree line (using collective pitch only).

i. From 300 feet 40 knots, practice descending on a 12 degree line, maintaining apparent rate of closure of 5 knots by decelerating as required during the descent (using cyclic only).

j. From 300 feet 40 knots, practice descending on a 12 degree line to a pre-determined point using all controls combined, to maintain the proper angle, heading, and proper rate of closure.

k. Review exercises as required to perfect the maneuver or to correct errors.

l. Demonstrate common errors.

18. Simulated forced landing (demonstrate maneuver)

a. Make sure carburetor heat is within the "green arc."

b. Instructor split needles, student practice timeing of lowering collective pitch using only the pitch.

c. Practice step "b" and student also apply right pedal simultaneously as ptich is lowered.

d. Practice maneuver using all controls and establish air-apeed of 45 knots after autorotation is entered.

e. Practice maneuver requiring a turn to reach a suitable area headed generally into the wind.

f. After student becomes familiar with maneuver the instructor will initiate a simulated forced landing by closing the throttle without forewarning the student, and the student should·

(1) Lower collective pitch to full down position (except at low altitude).

(2) Add right pedal to trim helicopter.

(3) Check that rotor rpm is within the "green arc".

(4) Select a landing area and maneuver helicopter so as to make an approach as nearly into wind as possible.

(5) Stabilize airspeed between 45 and 50 K, (may be varied as necessary to reach landing area.)

(6) Hold collective pitch in the full down position.

(7) Close throttle at about 100 feet (if a power recovery has not been called for) and call out "override".

(8) Complete an autorotative landing or execute a power recovery, if instructed to do so, and either come to a hover or fly away as instructed.

(9) Instructor will maintain desired engine rpm and call for a power recovery when he decides not to land.

20. Power recovery (demonstrate maneuver).

a. Student practice - apply collective pitch and throttle as necessary to join needles at 3200 RPM, (2900 TH-55A), smoothly coordinating the two movements to avoid an excessive loss of rotor RPM or an engine over-rev.

b. Should an actual power failure occur prior to or during an attempted power recovery, the collective pitch should be lowered as much as altitude will permit to conserve rpm, and the helicopter must be levelled at an altitude that will permit a safe forced landing. If the helicopter "bounces" during the landing, the collective pitch should be utilized to avoid reaching an abnormal attitude prior to the next point of touchdown. Large or quick rearward cyclic movements should not be made.

PRIMARY INSTRUCTIONAL TECHNIQUE

1. Maximum performance take-off (demonstrate maneuver).

   a. Practice exercise of pivoting and climbing to 10 feet, with full power, descent at a 20 degree angle, 5 knots ground speed.

   b. Practice the above exercise using cross-check of tachometer and aircraft attitude. This teaches that even though rpm must be checked during take-off, peripheral vision can be used to maintain attitude.

   c. Practice exercise of increasing to full power and desceasing power to 23 inches MP, maintaining rpm with collective pitch.

2. Steep approach (demonstrate maneuver)

   a. For instructional techniques, see normal approach.

   b. Initially, descent at an angle of less than 20 degrees, gradually progressing to an angle of 20 degrees.

3. Demonstrate power recovery from a low rotor rpm condition. Open throttle and milk collective pitch as required to obtain 3200 rpm. Emphasize minimum loss on altitude during recovery. This exercise should be practiced at 500 feet initially. Then the exercise may be practiced at minimum altitude of 10 feet and 335 rotor rpm, by applying collective pitch and levelling off, decreasing rotor rpm to not less than 335, then execute above recovery at approximately 8 feet above the ground. This exercise is to insure that student will exercise power recovery in the event of a bad landing and/or ballooning.

WHERE IS CLOCK?
MAKE COFFEE

HIGH
WIND
BAR
APP/DEP
T/O

LO
T/O

GR.