U.S. ARMY

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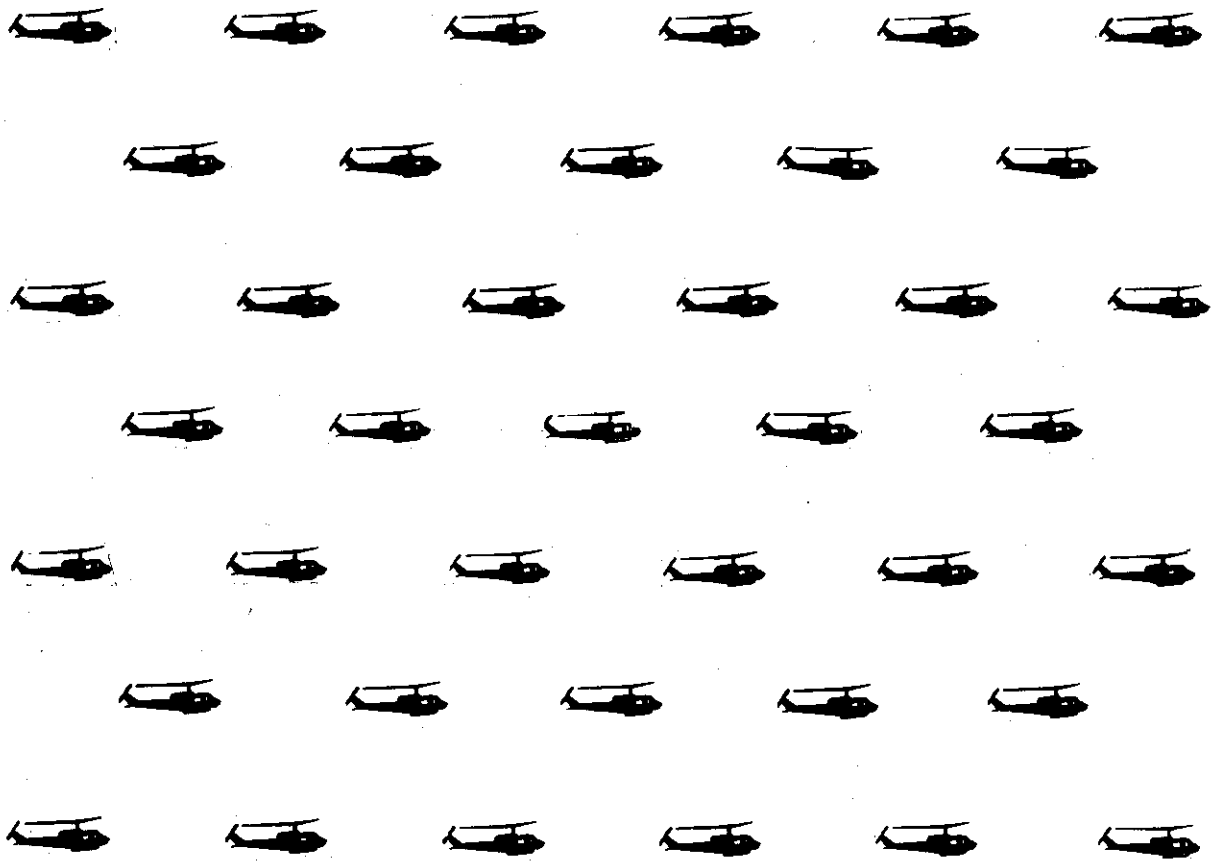
HELICOPTER FORMATION FLYING



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HEADQUARTERS
UNITED STATES ARMY AVIATION SCHOOL
Fort Rucker, Alabama, _____19__

HELICOPTER FORMATION FLYING

CHAPTER 1

GENERAL

1. PURPOSE AND SCOPE

a. This text establishes the principles of flying U.S. Army helicopters in tactical formations from simple two-helicopter formations through multi-helicopter formations.

b. The information in this text applies to all Army helicopters and helicopter units. It may be used as a guide by commanders, staff officers, and other personnel of Army aviation units who conduct training in formation flying.

c. The material contained herein is applicable to nuclear and nonnuclear warfare.

d. Users of this text are encouraged to submit recommended changes or comments to improve it. Comments should be keyed to the specific page, paragraph, and line of the text in which change is recommended. Reasons should be provided for each comment to insure understanding and complete evaluation. Comments should be forwarded direct to the Commandant, United States Army Aviation School, Fort Rucker, Alabama 36360.

2. GENERAL

a. Terms used to describe helicopter formations have not been standardized throughout the U.S. Army. Many of the terms now in use have little relationship to the numerical or organizational composition of helicopter formations.

b. When TOE's for aviation units change, the unit organization and the number of helicopters assigned to a unit change. Consequently, to develop helicopter formation terminology based on TOE organization is impractical. However, since the principles and basic elements of helicopter formations rarely change, it is reasonable to base terminology upon the number of helicopters in those formation elements considered fundamental to formation flying.

3. TERMINOLOGY

The following terminology is used throughout the armed services. Each service may place a slightly different connotation on these terms. In the explanatory examples, "x" stands for "aircraft," "helicopter," "airplane," or "plane," although the emphasis in this text is upon helicopter formations.

a. Element.

(1) The U.S. Army defines element as a 2-x or 3-x formation. The 2-x element is the basic building block for all larger formations.

(2) The U.S. Air Force defines element as a 2-x formation.

(3) The U.S. Navy does not use element to describe a specific formation; the Navy defines a 2-x or 3-x formation as a section.

(4) All services (Army, Navy, and Air Force) use the term element in a general sense. Example: Elements of the 1st Cavalry Division attacked the enemy in Vietnam.

b. Flight.

(1) The U.S. Army defines flight as a 4-x, 5-x, or 6-x formation.

(2) The U.S. Air Force defines flight as a 4-x formation.

(3) The U.S. Navy does not use flight to define a specific formation; the Navy defines a 4-x or a 6-x formation as a division.

(4) All services (Army, Navy, and Air Force) use the term flight in the general sense to describe any number of aircraft. Example: Captain Jones led a flight of eight helicopters in an attack against the enemy in Vietnam.

c. Company Formation of Aircraft.

(1) The U.S. Army defines a 12-x to 16-x formation as a company formation. The company formation is composed of three or four flights of 4-x each.

(2) The U.S. Air Force does not use the term company formation. The Air Force defines a 12-x formation as a formation composed of three flights; a 16-x formation, as a squadron.

(3) The U.S. Navy does not use the term company formation. The Navy defines a 12-x formation as a flight of 12-x or three divisions of 4-x each. A 16-x formation is described as a flight of 16-x or four divisions of 4-x each.

d. Battalion Formation of Aircraft.

(1) The U.S. Army defines a battalion formation as a formation of two or more companies. Thus a battalion of 48-x would consist of three companies of 16-x each.

(2) The U.S. Air Force defines a 48-x formation as a 2-squadron formation or a 48-x flight. For those Air Force units assigned 16-x per squadron, a 48-x formation would be described as a wing formation.

(3) The U.S. Navy describes a 48-x formation as a flight of 48-x or two squadrons. A Navy or Marine Air Group normally consists of three or more squadrons.

e. Summary of U.S. Army Terminology. From the above discussion, the U.S. Army terminology for formation flying can be summarized in the following specific terms:

element - 2-x or 3-x.
flight - 4-x, 5-x, or 6-x.
company - 12-x to 16-x.
battalion - two or more companies.

Note. See paragraph 5 for the numbering of aircraft in formation.

4. DEFINITIONS

a. 45° Bearing. A relative bearing between the nose of the helicopter and the pilot's line of sight, right or left, depending upon the direction of the rendezvous and joinup.

b. Column Formation. A formation in which all of the largest integral subdivisions (each in identical formation) are positioned one directly behind the other.

c. Crossover. General. The generic term used to describe the action of an aircraft passing laterally from one position (in a formation) above the altitude of a specified aircraft to another position in the formation.

(1) Fixed wing. In fixed wing formation flying, the airplane performs the crossover by passing laterally over the top or part of the top of another airplane.

(2) Rotary wing. In rotary wing formation flying, the helicopter performs the crossover by passing laterally above and to the immediate rear of another helicopter.

d. Crossunder. General. The generic term used to describe the action of an aircraft passing laterally from one position (in a formation) below the altitude of a specified aircraft to another position in the formation.

(1) Fixed wing. In fixed wing formation flying the airplane performs the crossunder by passing laterally beneath the underside or part of the underside of another airplane.

(2) Rotary wing. The crossunder is not performed with helicopters in formation because of the inherent danger involved.

e. Echelon Formation. An arrangement of aircraft in flying formation in which each aircraft or each flight of aircraft flies at the same level or at a level above or below another aircraft or flight in the formation, and usually at a distance to the right or left.

f. Formation (Flying). A formation consists of two or more aircraft, holding positions relative to each other, and under the command of a designated aviator therein.

g. Free Cruise. Free cruise is the technique whereby the wingman maintains a specified distance from the leader but may vary the bearing from the leader during turns. This distance is measured perpendicular to the lateral line that passes through the tail region of the leader to the lateral line that passes through the nose region of the wingman. The wingman, as he maintains this distance, is free to maneuver during turns (or if otherwise required) in the airspace extending from 45° on either side of the leader's tail. In other words, it is said that the aviator owns the airspace extending from 45° on either side of the leader's tail and is free to maneuver through

this airspace during turns. This technique applies to flight, company, or larger formations.

h. Hand Signals. A visual signal or communication made by using the hands and arms. By using the appropriate hand signal, a flight leader can signal the wingman to move from one position to another.

i. Horizontal Distance and Vertical Separation of Aircraft.

(1) Horizontal distance.

(a) Close formation. In a close formation, the horizontal distance between helicopters is normally 1 1/2 rotor-disc diameters measured between tip path planes.

(b) Loose formation. In a loose formation, the horizontal distance between helicopters is 3 to 6 rotor-disc diameters.

(c) Extended formation. In an extended formation, the horizontal distance between helicopters may be any required distance in excess of 6 rotor diameters, dependent upon tactical requirements.

(2) Vertical separation.

(a) Flat (separation). All helicopters or all flights of helicopters are flown at the same altitude.

(b) Stepped-up (separation). The vertical separation between the wingman and the element leader is measured from the altitude of the leader upward to the altitude of the wingman. Example: The wingman was flying a 3-foot stepped-up position on the leader.

(c) Stepped-down (separation). The vertical separation between the wingman and the element leader is measured from the altitude of the leader downward to the altitude of the wingman. Example: The wingman was flying a 3-foot stepped-down position on the leader.

Note. The stepped-down formation is never utilized for helicopter formation flying because wingmen are likely to experience difficulty in distinguishing the flicker of their own rotor blades from that of the leader, thereby, increasing the probability of an accident.

j. Join Up. To form separate airplanes or helicopters into a specific flight formation.

k. Lead; Lead Helicopter. The helicopter at the head of a helicopter formation. Also the aviator who flies in the lead helicopter.

l. Nose to Tail Distance. The distance from the tail region of a specified formation leader to the nose region of a particular wingman; or, in multiple formations, the distance from the tail region of one formation to the nose region of another formation.

m. Rendezvous. A prearranged meeting at a given time and place from which to begin an action or phase of operation, or to which to return after an operation; e.g., to assemble, meet, or arrive at a rendezvous; to meet with another or others in rendezvous.

n. Rendezvous and Join Up. To assemble and form into a specific flight formation.

o. Staggered Trail (Left or Right). A formation in which all aircraft are alternately staggered behind the leader.

p. Trail. A formation in which all aircraft are in single file, each directly behind the other. The aircraft may be flown at the stepped-up position or at the same level.

q. Wingman. An aviator who flies at the side and to the rear of or directly behind an element leader, commonly in a 2-helicopter or 3-helicopter formation; also, the helicopter flown in this position.

5. SEQUENTIAL NUMBERING OF AIRCRAFT IN A FORMATION

To provide for the Army's future requirements and present operational necessities, it is important that a consistent system of numbering aircraft in any type of flying formation be established. Aircraft formations are usually illustrated and described as seen from above (plan view). The basic or key formation (from which other related formations may be formed) is utilized to determine the numbering sequence. The two basic or key formations are the two-helicopter

element (flexible position with the prerogative of free cruise) and the three-helicopter element (fixed position) V-formation that does not provide for free cruise.

a. Flexible Position Formations. Flexible position formations that employ the principle of free cruise include but are not limited to the following:

(1) The two-helicopter element. The arrows in figure 1 indicate the "lateral space area" a helicopter may occupy in free cruise (para 4).

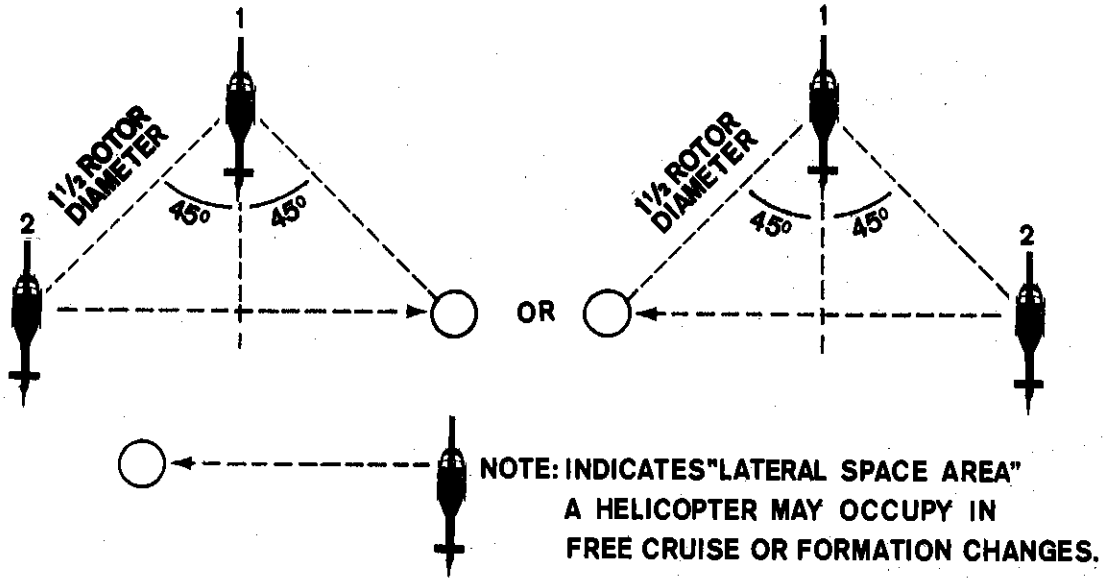


Figure 1. Two-helicopter element.

(2) The three-helicopter element. This V-formation is a flexible position of "heavy right" or "heavy left," as shown in figure 2.

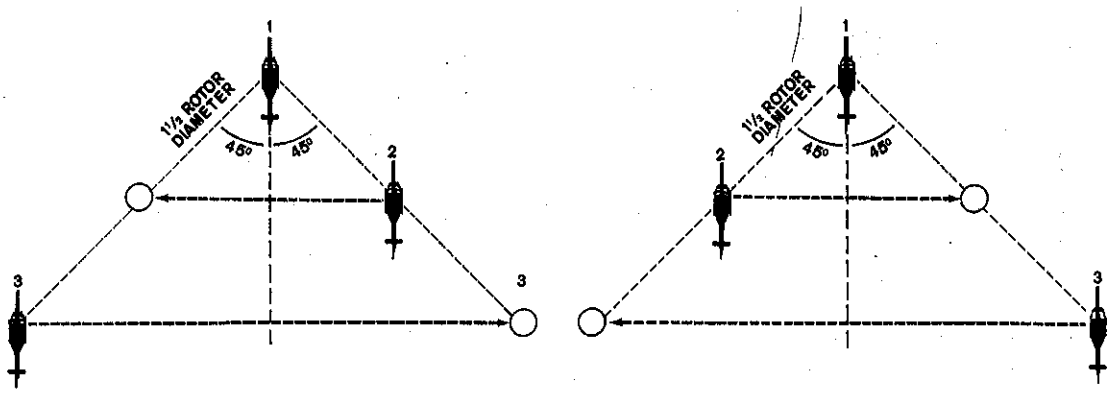


Figure 2. Three-helicopter element (flexible position).

(3) The four-helicopter flight. This formation is for tactical flight and may be flown heavy left or heavy right, as shown in figure 3.

(4) The five-helicopter flight. As shown in figure 4, this tactical flight formation may be flown heavy left or heavy right.

(5) The six-helicopter flight (4/2). As shown in figure 5, this tactical flight formation, heavy left or heavy right, is composed of one 4-helicopter flight and one 2-helicopter element.

(6) The six-helicopter flight (3/3). This tactical flight formation (fig. 6), heavy left or heavy right, is composed of two 3-helicopter elements (flexible position).

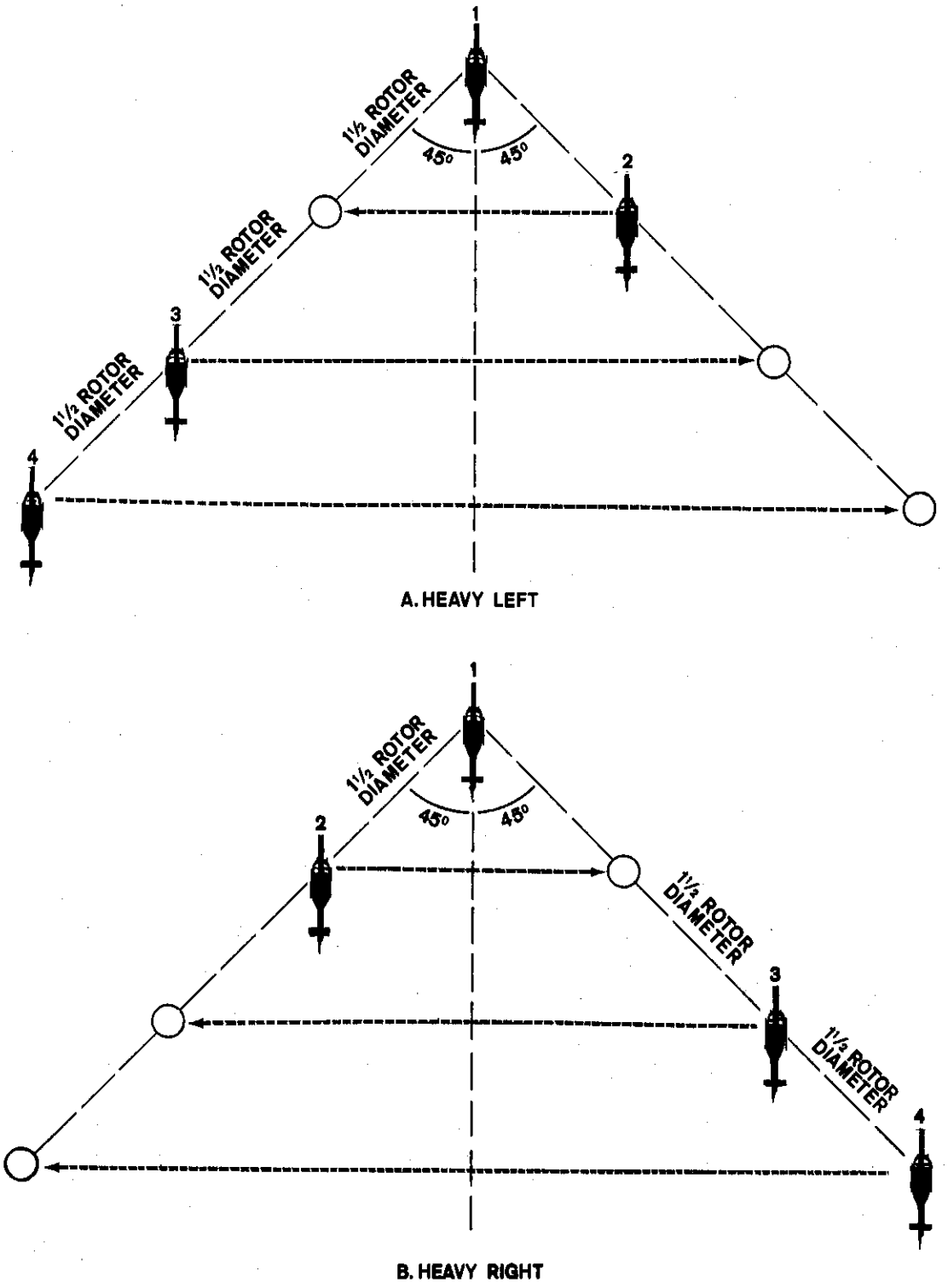


Figure 3. Four-helicopter tactical flight formation.

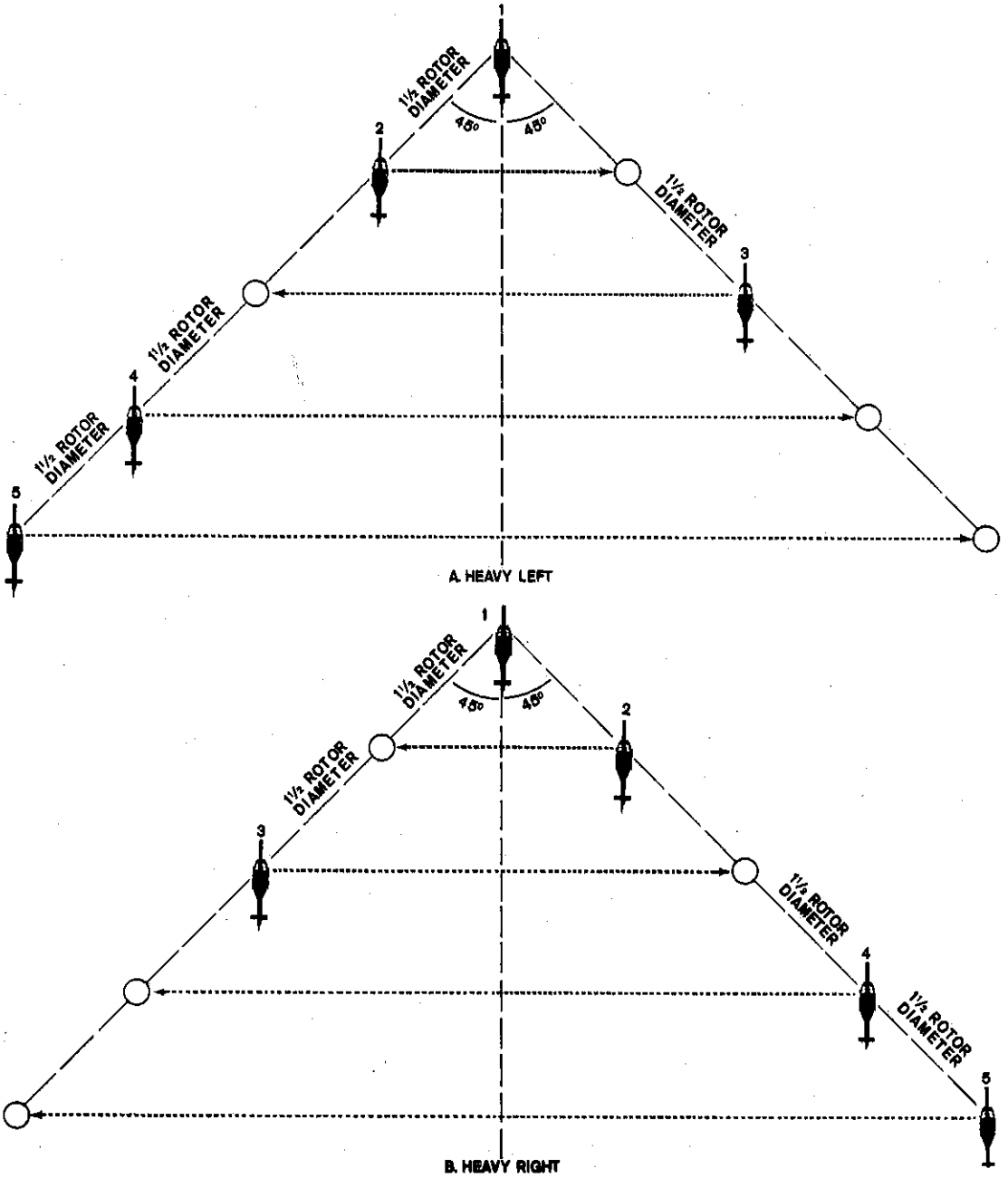


Figure 4. Five-helicopter tactical flight formation.

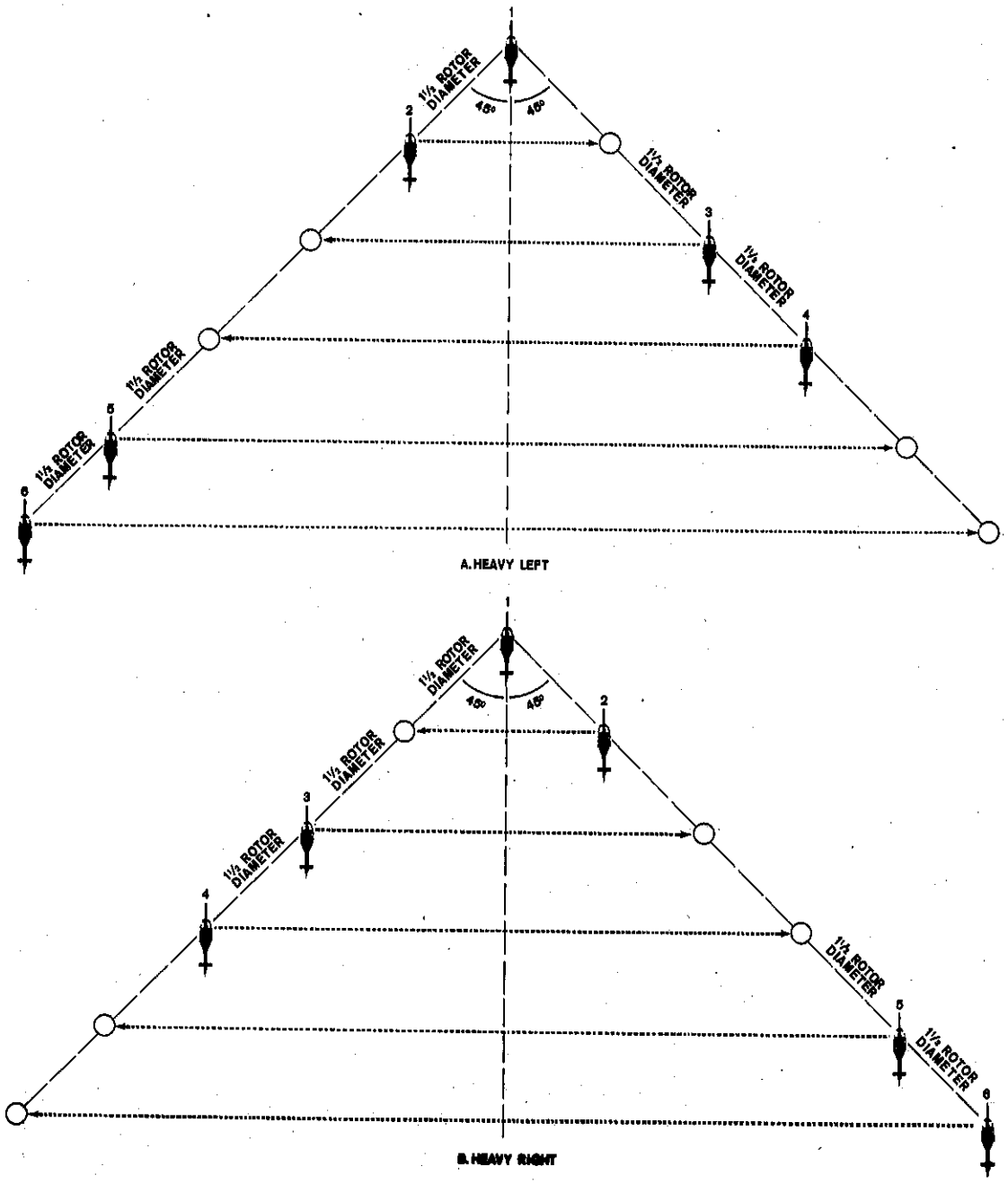


Figure 5. Six-helicopter tactical flight formation (4/2).

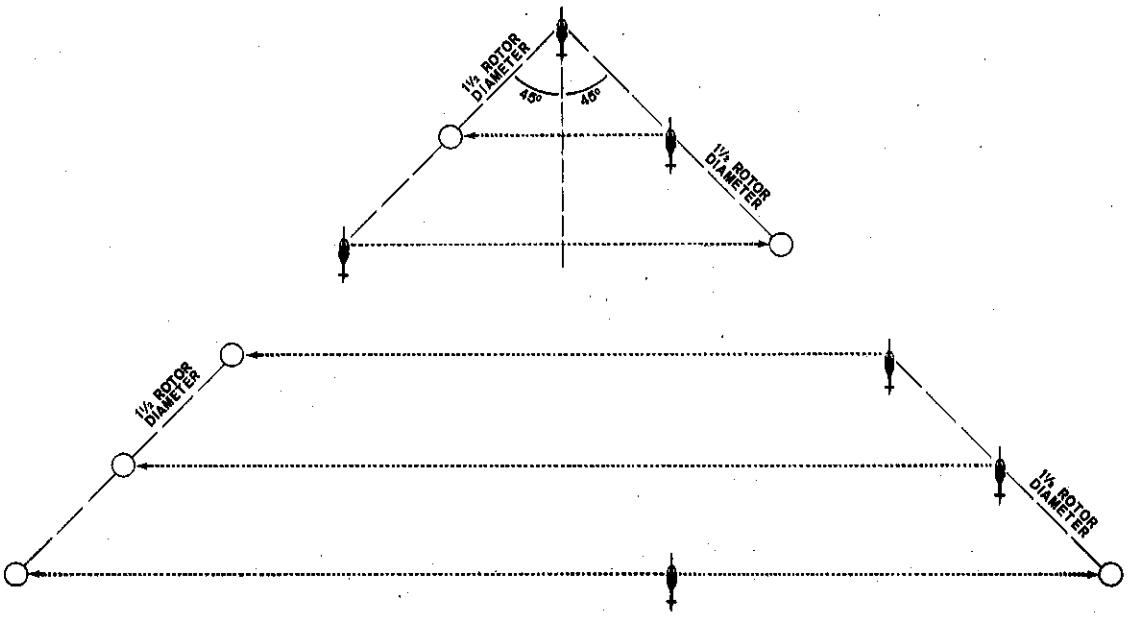


Figure 6. Six-helicopter tactical flight formation (3/3).

b. Numerical Sequence of Free Cruise Formations. Aircraft within free cruise formations are numbered, starting with the leader as No. 1; then, progressively, left to right laterally through each succeeding lateral space area (in the same manner as words and lines on a written page). These formations can be changed easily into other related formations such as a column or trail, right echelon, and left echelon, and still maintain their original numerical sequence within the new formation without one or more aircraft being repositioned into a new lateral space area.

c. Fixed Position Formations. Formations that require the wingman to remain in a fixed position in turns rather than employ free cruise include but are not limited to the following:

(1) The three-helicopter element, fixed position. The fixed-position three-helicopter element is shown in figure 7.

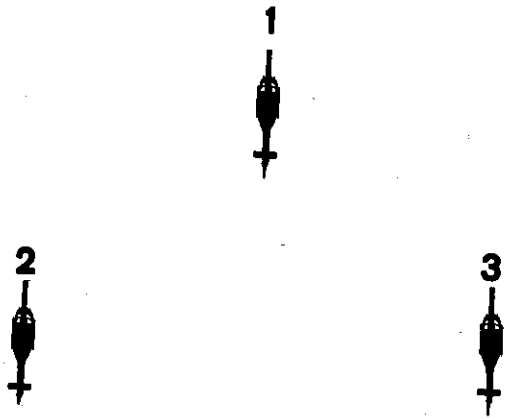


Figure 7. Three-helicopter element (fixed position).

(2) The five-helicopter flight, fixed position. This flight is shown in figure 8.

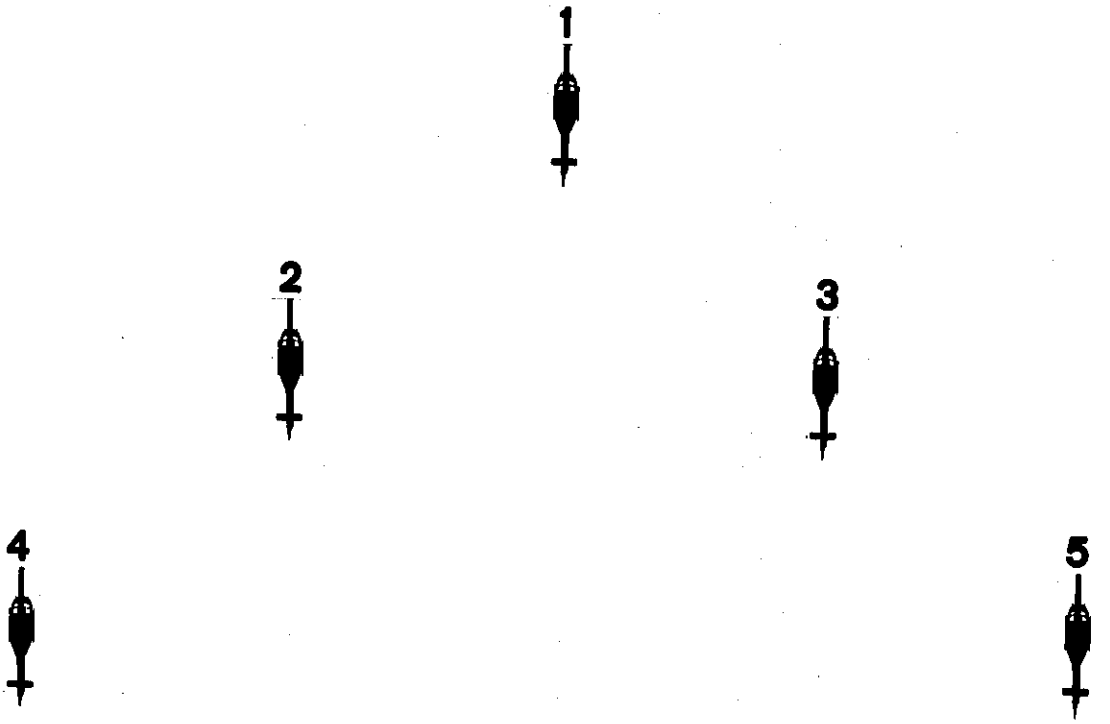


Figure 8. Five-helicopter flight (fixed position).

(3) The six-helicopter flight in column of vees, fixed position. This flight is shown in figure 9.

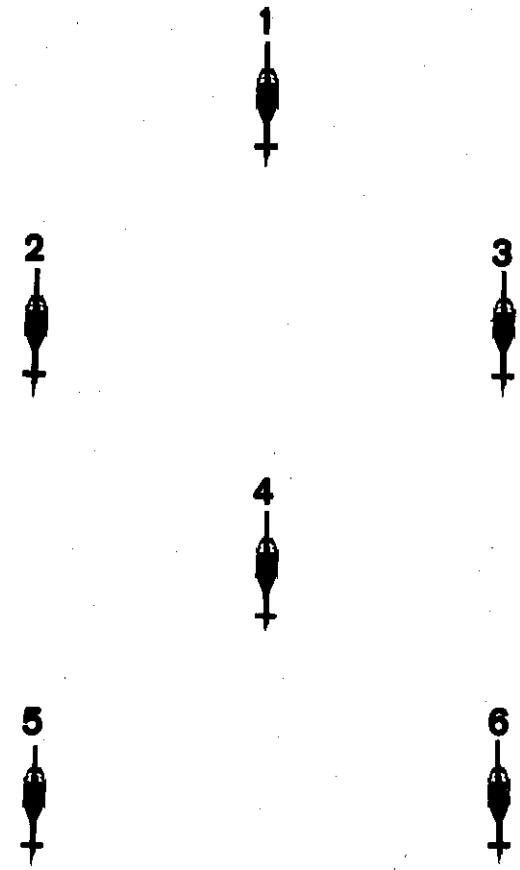


Figure 9. Six-helicopter flight in column of vees (fixed position).

d. Numerical Sequence of Fixed Position Formations. Aircraft within the fixed position formations are numbered starting with the leader as No. 1; then, progressively, left to right laterally through each succeeding lateral space area (in the same manner as words and lines on a written page). These formations can be changed into other

related formations such as column or trail, left echelon, and right echelon and the aircraft still maintain their original numerical sequence within the new formations. However, one or more aircraft will have to be repositioned into a new lateral space area in order to maintain the proper numerical sequence. (See paragraph 20b and fig. 15 for additional information.)

CHAPTER 2

PRINCIPLES OF HELICOPTER FORMATION FLYING

6. INTRODUCTION

a. Formation flying is the maneuvering of aircraft (into a flight pattern) in accordance with established tactics, techniques, and procedures, upon the command of a designated leader. It includes the rapid but controlled change from a specific formation suitable for one set of conditions to another formation designed to meet the requirements of an entirely different set of conditions.

b. Aerodynamic interference between in-flight helicopters must be anticipated. When two helicopters operate in close proximity, as in trail formation, the interacting patterns of airflow alter the aerodynamics of each helicopter. The leading helicopter may experience an increase in downwash at the tail and a noseup change in pitching movement. The trailing helicopter will experience a reduction in downwash at the tail, and a nosedown change in pitching movement. Thus, a definite possibility of collision exists because of the trim change experienced by each helicopter. In formation flying, the aviator must anticipate this type of interference, particularly when flying in the trail position or when executing a crossover from one position in the formation to another. Care must be taken to anticipate the trim change and to maintain adequate clearance.

c. Careful planning before conducting formation flights is essential to the safe, efficient control and maneuver of any size formation. Safe and orderly formation flight is the result of extensive training, continuous practice, and a high degree of air discipline. Personnel undergoing this type training must do so with an extreme sense of responsibility and with constant vigilance. Although formation flying is not inherently dangerous, any aspect of this training can be disastrous if principles are violated.

d. The tactics, techniques, and procedures set forth in this manual apply to the requirements of armed and unarmed helicopter formations.

e. The distance between helicopters or formations of helicopters can be greatly increased to fit the tactical situation. At higher

altitude, for example, a flight of four helicopters should be positioned 50 to 100 meters or farther apart, so that a burst of antiaircraft fire would not destroy the entire flight.

7. FORMATION CONSIDERATIONS

Factors to be considered in determining the best formation to be used in a specific situation include -

a. Mission Requirements.

(1) Mission of the supported unit.

(2) Mission of the helicopter unit.

b. Enemy Considerations.

(1) Antiaircraft fires.

(2) Air attack.

(3) Defense of the landing zone when applicable.

(4) Observation.

c. Fire Support Plan.

(1) Artillery support available and LZ preparation planned.

(2) Air support.

(a) Air support.

(b) Air Force/Navy (type aircraft).

(c) Navy gunfire.

(3) Type ordnance to be used in "Preparation" and Suppression Series.

d. Terrain and Weather.

(1) Configuration of en route obstacles or corridors.

(2) Size, shape, and surface of landing zones; obstacles in or affecting approaches to landing zones.

(3) Ceiling and visibility.

(4) Winds and air turbulence.

e. Formation Maneuver and Flexibility.

(1) Changes in the mission or situation.

(2) Evasive tactics.

f. Armed Aerial Escort.

(1) Amount of armed escort required.

(2) Number and type of armed escort helicopters available.

(3) Position in the formation.

(4) Mission of the armed helicopters.

g. Control of Formation.

(1) Degree of control required.

(2) Method of control (radio, hand signals, prearranged timing, etc.).

h. Other Considerations.

(1) Type aircraft.

(2) Crew training and experience.

8. RESPONSIBILITIES OF FORMATION LEADERS

a. Formation leaders must execute all flight maneuvers as smoothly as possible.

b. They must maintain correct formation positions. All subordinate or alternate formation leaders must be prepared to assume the next higher lead position when required.

c. Unit briefing officers and flight leaders will present special instructions concerning tactics, communications, and plans applicable to each mission. The preflight briefing will be detailed and complete,

covering each aviator's and crewmember's duties, responsibilities, and course of action. Briefing may include, but need not be limited to, the following:

(1) Mission number, helicopter assignments, call signs, and flight positions.

(2) Type of mission; destination; fuel load and refueling instructions and fuel reserve to be on board over certain graphic locations to insure that the aircraft can return.

(3) Flight chain of command (alternate formation leaders).

(4) Time to start engine, communication check, take off, join up, and time on target.

(5) Routes, altitudes, terrain, geographic landmarks, and indicated air speed (outbound and inbound).

(6) Anticipated weather, and instructions for weather penetrations.

(7) Target or landing site assignments; start point (SP); release point (RP); and method and sequence of approach, landing, departure, rendezvous, and other checkpoints and flight routes.

(8) Suppressive fires allowed.

(9) Emergency procedures including downed aircraft procedure, escape and evasion, alternate fields en route, and lost communications procedures.

(10) Navigational aids and rescue facilities.

(11) Methods of marking targets or actions on receiving fire.

(12) Type prestrike (artillery or air); time and gun target line.

(13) Landing zone description and organization.

(14) Medical evacuation facilities and location.

(15) Enemy situation, stressing location of automatic and antiaircraft weapons.

(16) Briefing of troops being transported concerning emergency procedures, lifevests, liferafts, smoking regulations, operation of survival equipment, etc.

(17) Air and ground radio frequencies, communication procedures, and color coding of smoke signals.

(18) Procedures for radio check prior to takeoff.

d. Unit debriefing officers and flight leaders will conduct a thorough debriefing after every formation flight to include the general conduct of the flight operations and applicable portions of the above paragraph.

9. FREE CRUISE

a. When aviators are required to fly a fixed position in a formation that cannot be freely varied in turns, excessive power changes are necessary to maintain position. Such power changes increase fuel consumption, pilot fatigue, etc. For example, in a 3- or 5-helicopter V-formation, the position of the wingman remains fixed, even in steep right or left turns. The only way a wingman can maintain his rigidly defined position is to increase power if he is on the outside of a turn, and to decrease power if he is on the inside of a turn.

b. In a 2-helicopter element, the position of the wingman is not as rigid as in a 3-helicopter element fixed position V-formation. The wingman has the prerogative in a steep turn to move freely from a position 45° to the right rear on one side of the leader to a position 45° on the other side. Such a prerogative is called free cruise (para 4). It allows the wingman to maintain position with an established power setting by matching his relative speed with that of the leader.

(1) The wingman's relative speed is less than that of the element leader when the wingman is on the outside of a turn. Thus, he must use a slightly faster rate of turn and move momentarily toward the 45° position on the inside of the turn until a point is reached where his relative speed matches that of the leader.

(2) The wingman's relative speed is greater than that of the element leader when the wingman is on the inside of a turn. Thus, he must use a slightly slower rate of turn and move momentarily toward the 45° position on the outside of the turn until a point is reached where his relative speed matches that of the leader.

c. In a 4-helicopter flight formation, when the second element is in heavy right or heavy left position, the same procedures (b above) apply. The second element may slide toward the outside of the turn when its relative speed is greater than that of the flight leader, and toward the inside of the turn when the relative speed is less than that of the flight leader.

d. The same procedure (c above) can be used when two or more flights are in formation. Thus, large numbers of helicopters can be flown in formation without sacrificing maneuverability.

10. RENDEZVOUS AND JOINUP PRINCIPLES

To understand the rendezvous and joinup, the term 45° bearing as defined in paragraph 41 must be clearly understood. There are three distinct types of rendezvous and joinup: the running, the circular, and the 180° reversal.

a. The Running Rendezvous and Joinup. A running rendezvous and joinup is a means of assembling a number of helicopters into a formation while proceeding on course. It may occur during an on-course climb or while the helicopters are at a constant altitude. Helicopters executing a running rendezvous and joinup should join in position rather than in echelon, as follows:

(1) If fuel consumption and/or time presents no problem, the leader may elect to proceed directly on-course with the remainder of the flight joining by using higher power settings. This can be accomplished by the lead aircraft maintaining 20 knots less than the en route airspeed until the flight has joined. If fuel consumption and/or time has to be considered, the leader should S-turn about the base course until all members of the formation have joined. By using a 20° to 30° angle of bank, the leader will turn until the heading is 60° off the track to be made good and then reverse to a 60° deviation in the opposite direction. These turns should be continued until all members of the flight have joined.

(2) The members of the flight joining will continue on base course until the leader is on a 45° bearing, then turn until the leader is on a 45° bearing to their opposite side. When the leader reverses the turn, all helicopters that have commenced their joinup will reverse course, cut to the inside of the turn, and place the leader on a 45°

bearing. This procedure is continued until each helicopter has joined the formation. By employing the S-turn, all members of the formation use approximately the same power settings.

b. The Circular Rendezvous and Joinup. The circular rendezvous and joinup is used to overcome conditions which prevent pilots from keeping the helicopter ahead in sight after takeoff (instrument climb-out, etc.).

(1) The leader will take off, climb on top, and, upon reaching the orbit point, establish an orbit using 20° to 30° bank.

(2) The position of the leader in his orbit will determine the procedures used by the rest of the flight as each pilot approaches position for joinup. This position on the circle will be in terms of a position on the face of a clock relative to the center of the orbit. The point at which the joining helicopter crosses the circle will always be the 6 o'clock position. When the joining helicopter reaches the outside of the rendezvous circle and the leader is in a left-hand turn orbit between the 2 and 6 o'clock position or in a right-hand orbit between the 10 and 6 o'clock position, the joining helicopter turns toward the leader. This turn is held until the leader is on a 45° bearing and the joining pilot's line of sight is on the leader. The joining pilot then maintains the same relative bearing on the leader until joinup is effected.

(3) If the leader is in a position on the circle other than that described in (2) above, the joining helicopter will continue to the center of the circle. When at the center, if the leader is between the 10 and 2 o'clock position, the joining helicopter will turn toward the leader until the nose of his helicopter is pointed directly toward the leader's helicopter. The joining helicopter pilot will then level his helicopter and fly straight and level until the leader is on a 45° bearing to either side of his nose. He will then roll his helicopter into a 45° bank and hold it until the leader is on a 45° bearing to the opposite side of his nose and his line of sight is on the leader's helicopter. If the leader is in a position other than between 10 and 2 o'clock when the joining helicopter reaches the center of the rendezvous circle, the joining

helicopter will roll into a 45° bank and hold until the leader is on a 45° bearing and his line of sight is on the leader's helicopter.

c. The 180° Reversal Rendezvous and Joinup. This is the most difficult type of rendezvous and joinup to perform and requires skill and teamwork from all members of the formation.

(1) To perform the 180° reversal method of rendezvous and joinup, all helicopters will be in trail formation behind the leader.

(2) After allowing enough time for every aircraft to get into position behind the leader, the leader will commence a 180° standard rate turn in the desired direction.

(3) After the leader has moved approximately 45° to the left or right, the second helicopter should commence the rendezvous turn. Normally, by turning early, the second helicopter will be able to join up before the leader has completed his 180° turn. Each succeeding pilot should commence his turn, in order, as the leader approaches a 45° bearing to the left or right. This turn should be relatively steep but should be adjusted to position the joining helicopter slightly ahead of the leader and on a closing angle to the rendezvous heading of approximately 45°. As the distance narrows, the closing angle to rendezvous heading should be reduced to ease the relative motion. All relative motion should be stopped before the rendezvousing helicopter makes the final joinup into position.

(4) At times the 180° rendezvous turn will not be executed exactly as desired. If the turn is made too early, the joining helicopter will find that he is well ahead of the leader; conversely, a late turn will place the joining helicopter to the rear of the leader. The rendezvous and joinup can be salvaged, however, if the relative bearing to the leader is within 5° to 10° of the desired bearing of 45°.

(5) The individual aviator should, upon completion of the 180° rendezvous turn, make an immediate estimate of both his closing angle to the rendezvous heading and the bearing to the leader's helicopter. If the relative bearing

to the leader is shallow, an immediate increase in speed will save the rendezvous. If the relative bearing to the leader is excessive, a slight reduction in power will save the rendezvous.

(6) The aviator of the joining helicopter should pay careful attention to his closing angle on the rendezvous heading. If the joining helicopter is on the correct relative bearing to the leader but his closing angle to the rendezvous is very shallow (less than 30° to the rendezvous heading), he should immediately increase speed. Conversely, if the joining helicopter is in the correct relative bearing to the leader but his closing angle is steep (greater than 50° to the rendezvous heading), he should reduce speed slightly and continue his turn toward the rendezvous heading.

Note. The helicopter ahead must be kept in sight at all times. Therefore, if the helicopter ahead falls behind in making a rendezvous, succeeding aviators must adjust their turn to keep him in sight even at the expense of also falling behind. If the helicopter ahead falls only slightly behind, the following helicopter can usually continue a normal rendezvous turn and wait momentarily on the inside of the turn until the helicopter ahead effects a joinup.

CHAPTER 3

TYPE FORMATIONS

11. THE ELEMENT

a. Two-Helicopter Element. The basic tactical formation consists of two helicopters of the same type. The element leader is normally designated the No. 1 helicopter; the wingman, the No. 2 helicopter. The wingman may fly to the right rear or left rear of the leader, depending upon the leader's instructions. The wingman is in right echelon position when flying on the right rear, and in left echelon position when flying on the left rear. In either echelon position, the correct angular location of the wingman is 45° to the rear of the element leader. His spatial distance from the leader is 1 1/2 times the diameter of the rotor disc with a stepped-up vertical distance of 3 to 5 feet (fig. 1). The echelon position of the wingman should not exceed the 45° bearing. Both the angle of 45° and the vertical separation are measured from like parts of the two helicopters; e.g., rotor hub to rotor hub or cockpit to cockpit. The wingman's echelon position provides a full view of the lead helicopter from either the pilot's or copilot's seat and thus permits detection of any change in attitude or flightpath of the element leader. This is a highly maneuverable and flexible formation suitable for free cruise procedure.

b. Three-Helicopter Element.

(1) When tactical missions require a flexible 3-helicopter element (A, fig. 2), the third helicopter may be positioned as the second element in a tactical 4-helicopter flight (fig. 3). This arrangement is a highly maneuverable and flexible formation suitable for the free cruise procedure.

(2) Where there is less requirement for maneuver and flexibility, a fixed position 3-helicopter V-formation (fig. 7) may be used. This arrangement provides a compact, easily controlled formation especially suitable for parades or administrative missions. It may also be used for tactical missions where the situation requires a very compact and rigidly controlled formation in order to get the maximum number of helicopters into a small landing zone. The compactness of the V-formation makes it one of the easiest

to protect by armed helicopters or other escorting aircraft. For numerical position designations of helicopters in a 3-helicopter V-formation (fixed position), see figure 7.

12. THE FLIGHT

a. Four-Helicopter Flight.

(1) The 4-helicopter tactical (heavy left or heavy right) flight formation, composed of two 2-helicopter elements, is an excellent tactical formation, adaptable to a wide range of tactical missions and deployments. In this formation, the leader of the second element flies 45° to the rear and 3 to 5 feet above the flight leader, and opposite the side of the wingman of the lead element. Spacing between elements should be sufficient to permit the wingman of the lead element to move to either echelon position without danger. A, figure 3 shows a flight with the second element on the left (heavy left) and B, figure 3 shows the second element on the right (heavy right).

(2) For parades, administrative flights, and some tactical situations, the 4-helicopter flight may be arranged in a diamond formation (fig. 10). The advantages and disadvantages of this formation are the same as those for the 3-helicopter V-formation (fixed position) (para 11b(2)) with respect to compactness and maneuverability. In the tactical environment, the diamond formation has the disadvantage of placing the No. 4 helicopter in a position that causes No. 4 to fly over the same ground as the No. 1 helicopter. Enemy antiaircraft gunners can fire at No. 1 and No. 4 without having to shift their fire.

b. Five- and Six-Helicopter Flights. Although a flight normally consists of four helicopters, certain situations, such as a platoon-size operation, may require a flight formation of five or six helicopters.

(1) A 5-helicopter tactical flight formation (fig. 4) is composed of two elements. The first is a 3-helicopter element; the second, a 2-helicopter element. The spacing between the first and second elements should be sufficient to permit the No. 3 helicopter to move to and from either echelon position. The flight may be heavy right or heavy

left (fig. 4). Each wingman, as well as the second element, is positioned to utilize the free cruise procedure in turns.

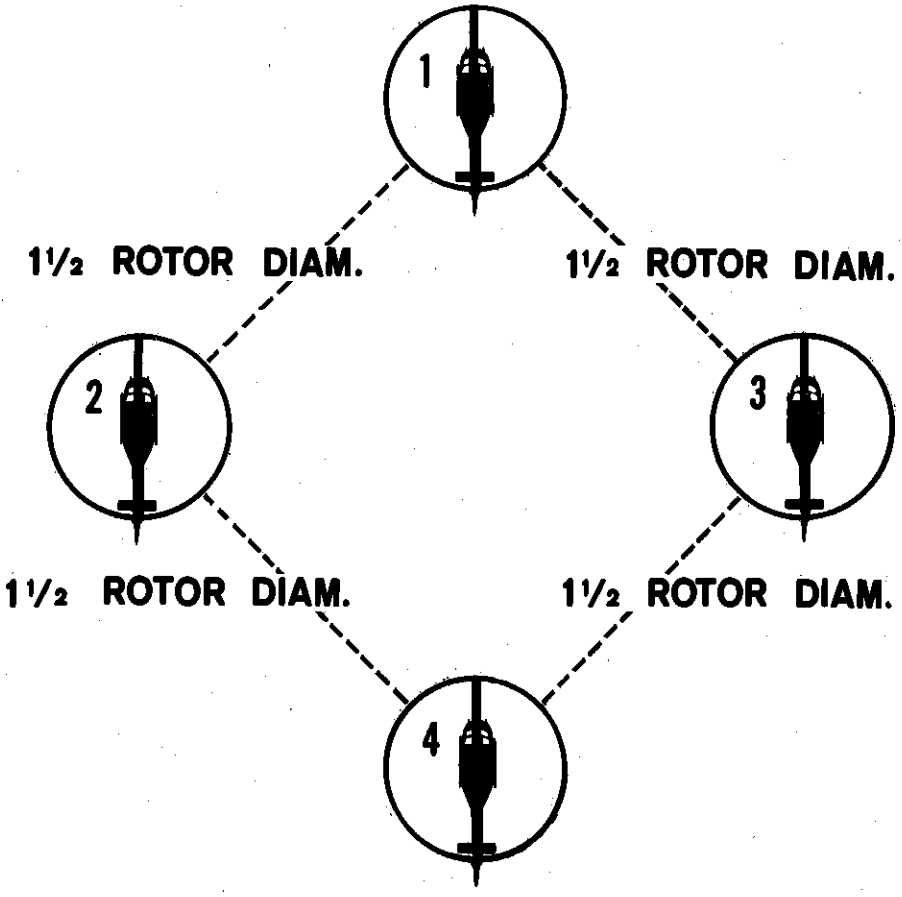


Figure 10. Four-helicopter flight in diamond formation.

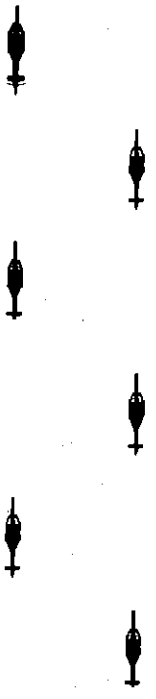
(2) A 5-helicopter flight V-formation (fixed position) (fig. 8) is compact and easy to control. It is somewhat devoid of maneuverability and cannot utilize free cruise. It should not be used when the threat of enemy air attack is present or there is a likelihood of encountering sophisticated enemy antiaircraft weapons.

(3) One type of 6-helicopter tactical (flexible position) formation is a flight composed (fig. 6) of two 3-helicopter elements in Vee formation (flexible position). The second element may be in a column formation or positioned 45° to either side of the first element and can utilize free cruise.

(4) Another 6-helicopter tactical formation is composed (fig. 5) of a 4-helicopter flight and a 2-helicopter element. The 4-helicopter flight may be in the heavy right or heavy left configuration. (Since a 4-helicopter flight is composed of two 2-helicopter elements, the additional 2-helicopter element is numbered the third element.) The third 2-helicopter element is positioned 45° to the rear of the flight leader on the side opposite the second element (fig. 5). Each helicopter within the formation is positioned to utilize the free cruise procedure.

(5) When forming a flight of more than five helicopters into a fixed position V-formation, the flight should be formed into a column of Vees (fig. 9) with no more than three helicopters per V-formation or element. More than three helicopters in a single V element would severely limit maneuverability of the formation. The spacing between Vees should be sufficient to allow either wingman of the lead element to move to either echelon position.

c. Staggered Trail Formation. The staggered trail formation may be formed with four or more helicopters (fig. 11). It is appropriate for certain tactical operations, but it is not recommended when antiaircraft weapons (e.g., 50 cal. machine gun; 20- or 40-mm or larger antiaircraft weapons) may be encountered.



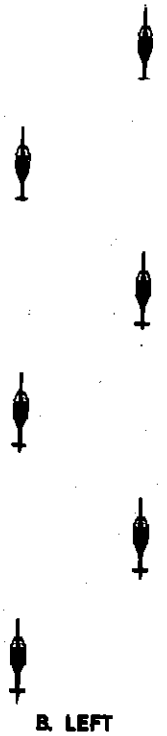


Figure 11. Staggered trail formation.