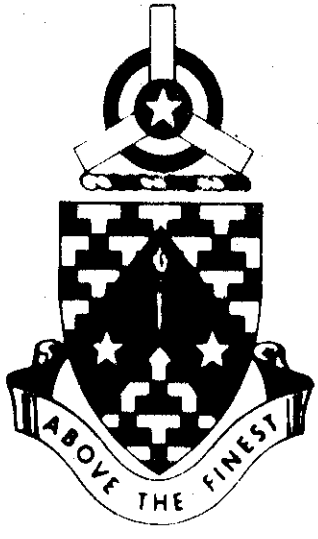
PROGRAMED TEXT

AUTOROTATION

AM-42



NOVEMBER 1968

UNITED STATES ARMY

PRIMARY HELICOPTER SCHOOL

FORT WOLTERS, TEXAS

PROGRAMED TEXT

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FILE NO: AM-42

PROGRAM TITLE

Autorotation

POI SCOPE: Interpret the conditions occurring upon entry into autorotation, the conditions existing in the rotor system during descent, the effects of airspeed on descent, flare effect, and forces acting on the rotor at termination.

INSTRUCTOR REFERENCES:

TM 1-260

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PREFACE

To become highly proficient in autorotations, a student must understand the forces acting on a helicopter during autorotation as well as the mechanical control movements needed to perform a safe landing.

Start with frame 1 and work each frame in succession. Each frame will usually ask you a question. The correct answer is printed on the top of the next frame. If you were incorrect, turn back and restudy the information before continuing on to the next frame. When you have finished the text, complete the self evaluation exercise. Now begin by studying the performance objectives on page iv.

PERFORMANCE OBJECTIVES

Without the aid of references you will be able to:

1. List the four conditions that occur when the collective is initially lowered for autorotation.

2. List the three major conditions that exist in the rotor system during the autorotative descent.

3. Interpret the effect of airspeed on rate of descent and maximum and minimum descent.

4. Interpret the effect of a flare.

5. Interpret the forces affecting the rotor system at the termination of autorotation.

No errors allowed.

FRAME 1

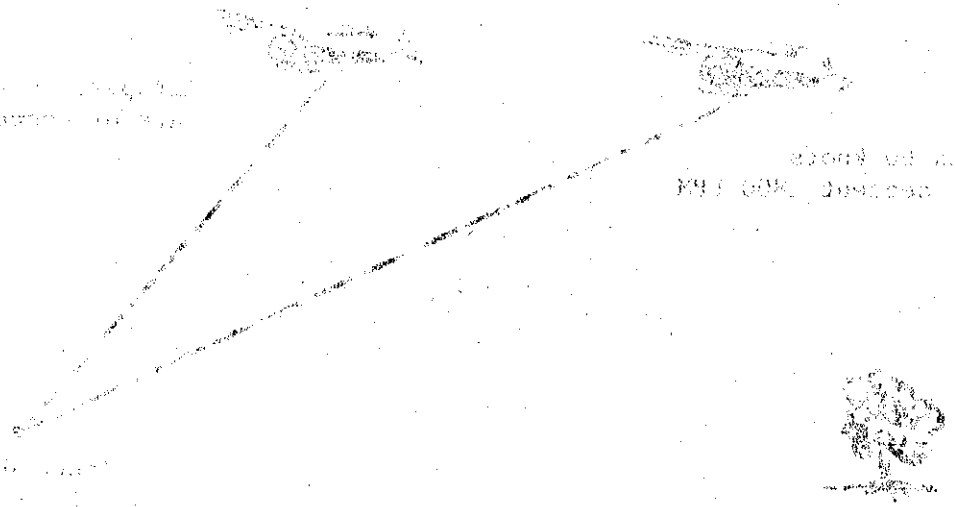
Autorotation is the term used to describe the capability of a helicopter to glide to a safe landing when the engine fails.

When a helicopter enters autorotation the flow of air through the blades reverses and flows upward through the rotor system rather than downward. This is called Autorotative Flow.

If the flow of air is upward and pitch is left in the blade (collective pitch is not lowered), the angle of attack will:

a. Increase

b. Decrease



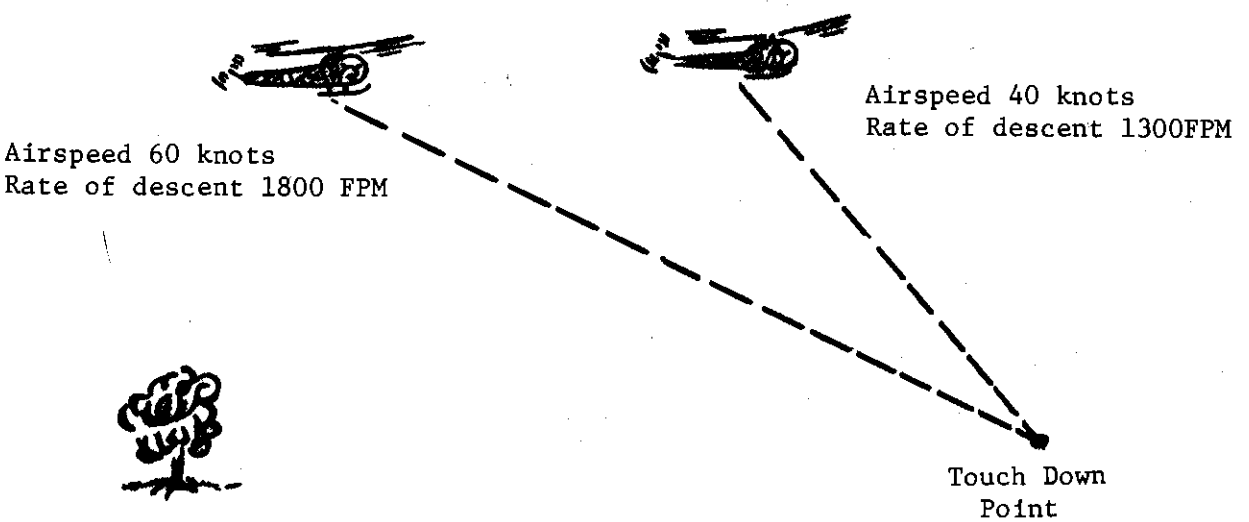
ANSWER: b. The inboard section of the rotor disc is stalled due to its high angle of attack.

FRAME 6

During an autorotation, airspeed has a great effect on rate of descent and glide distance.

1. Slower airspeed causes a slower rate of descent and a shorter glide distance.

2. Greater airspeed causes a faster rate of descent and a longer glide distance.



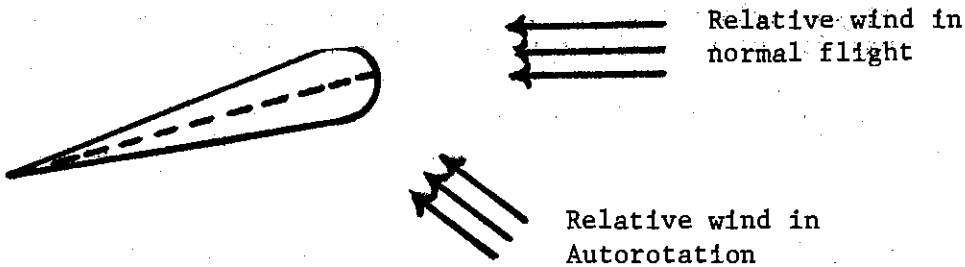
By varying the airspeed, an aviator can autorotate to any available jungle clearing.

Are zero airspeed autorotations dangerous?

a. Yes

b. No

ANSWER: a. If you said Increase you are correct.



The angle of attack increases if the collective pitch is not lowered when one enters autorotation. The angle of attack is so great that RPM is lost and the entire blade stalls. The helicopter will then become a free falling object.

If the angle of attack is decreased by lowering the collective pitch, the upward or autorotative flow of air through the blades creates lift and causes the blades to continue to rotate at the same RPM as in powered flight. Thus RPM will stabilize.

FRAME 2

Will the rotor blades, in autorotation with a decreased angle of attack, an autorotative flow of air, and stabilized RPM, have the same torque as blades in powered flight?

a. Yes

b. No

ANSWER: a. Yes. In a zero airspeed autorotation the relative wind has a vertical flow. Even with the collective pitch lowered the angle of attack is too great and the rotor system stalls. Due to the high rate of descent one will not be able to make a safe touch down. Each helicopter has a minimum airspeed for autorotation. The recommended safe airspeed is found in the Operator's Manual for the aircraft.

FRAME 7

Helicopters also have a maximum glide speed in autorotation which is found in the Operator's Manual. If you exceed this airspeed your maximum glide distance will decrease. Why? Excessive drag increases your rate of descent; therefore, you cannot glide as far.

Two important rules to remember are:

1. Slower airspeed causes _____

2. Faster airspeed causes _____

ANSWER: b. No. In autorotation the rotor system is driven by the force of the relative wind passing through the rotor system. This is an external force, thus there is no torque from the engine.

FRAME 3

Consider a helicopter with a single main rotor system with counter-clockwise revolution. The engine quits, you lower the collective pitch, and enter autorotation. When you lower the collective pitch the fuselage would:

a. Turn to the right.

b. Turn to the left.

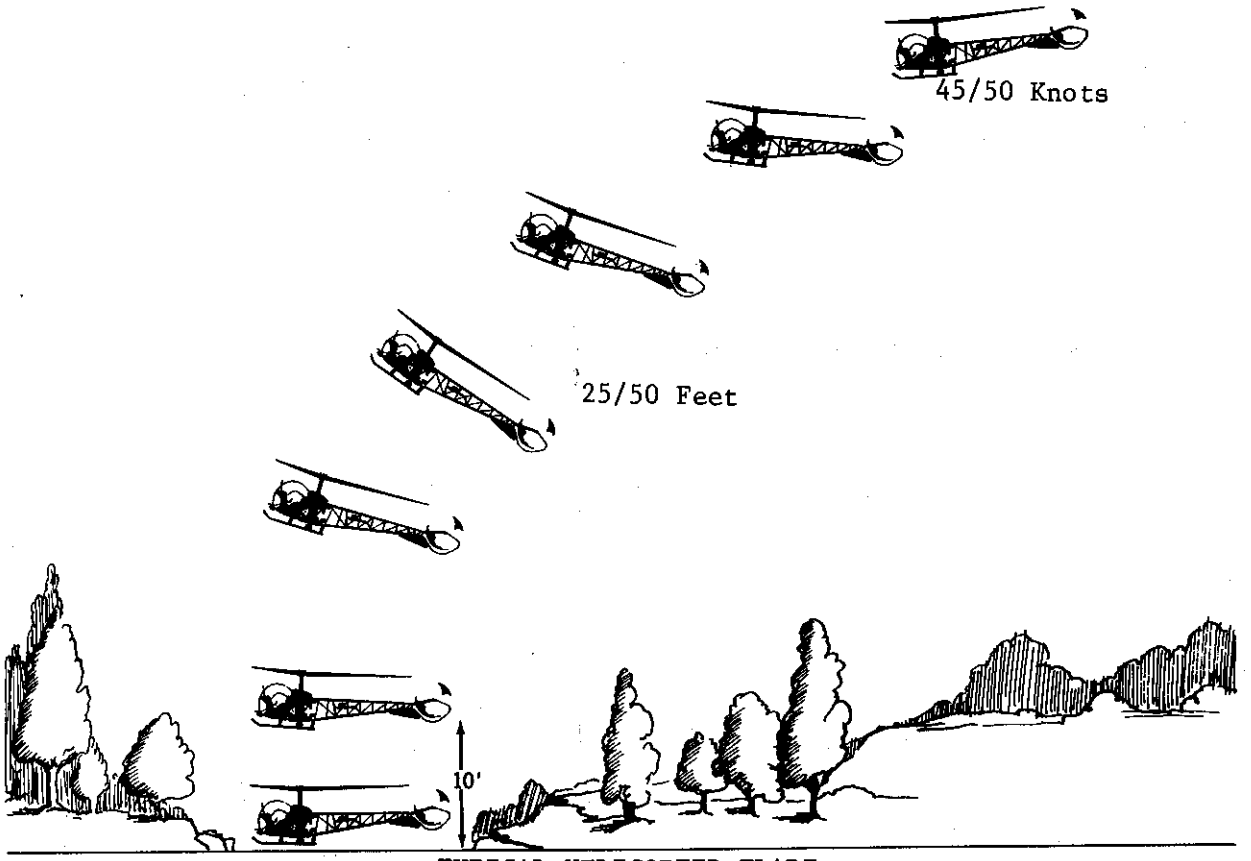
c. Remain headed in the direction of flight.

Why? the torque is inward

ANSWER: 1. Slower airspeed causes a slower rate of descent and a shorter glide distance.
2. Faster airspeed causes a faster rate of descent and a longer glide distance. (Provided maximum recommended glide speed is not exceeded)

FRAME 8

At a point 25 to 50 feet above the ground, depending on the type of aircraft, we should start slowing the rate of descent. This is done by flaring which decreases forward airspeed.



TYPICAL HELICOPTER FLARE

A flare takes the force of our forward airspeed, induces it into the rotor system causing an increase in angle of attack, thus increasing lift. The greater volume of air acting on the rotor disc will normally increase RPM (somewhat) during the flare.

The maximum effect of this lift should occur 5 to 10 feet above the ground and nearly stop the rate of descent.

1. Why should the maximum effect of the flare occur 5 to 10 feet above the ground? ground effect better if fall 5' than 30'

2. Which of the following occurs in the flare?
   a. Increased rotor RPM
   b. Decrease in rate of descent
   c. Decrease in airspeed
   d. Decrease in rotor RPM

ANSWER: b. The fuselage will turn to the left. Why? Because the tail rotor continues to counteract the torque produced by the main rotor system and engine. Therefore one must push right pedal to eliminate the pitch in the tail rotor, because the tail rotor is over compensating for the reduced main rotor torque.

FRAME 4

Which of the following DOES NOT occur upon the initial lowering of the collective pitch to enter autorotation?

a. Angle of attack increases

b. Angle of attack decreases

c. RPM stabilizes

d. Autorotative flow of air

e. Loss of engine and rotor torque

ANSWERS: 1. Why? Because after the maximum effect of the flare occurs, the helicopter will fall. If given the choice, most individuals would prefer a 5 foot drop rather than a 20 foot drop.
2. a. Increase in rotor RPM b. decrease in rate of descent c. decrease in airspeed.

FRAME 9

To control this increase in RPM at the maximum effect of the flare, the collective pitch is gently lifted, increasing the angle of attack, thus preventing an excess of rotor RPM.

After the maximum effect of the flare, how does one put the helicopter safely on the ground?

As the helicopter sinks toward the ground, additional collective pitch is pulled allowing one to set the aircraft on the ground as in powered flight. During this increase in the angle of attack of the blades, RPM is lost as the rotation of the blades supplies the power to create lift.

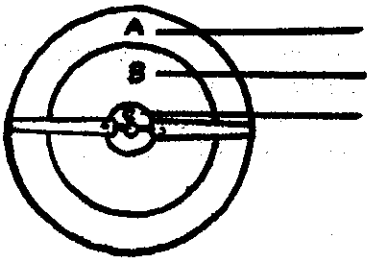
Which of the following occurs during collective pitch pull?

a. Increased angle of attack
b. Increased lift
c. Greatly reduced rate of descent
d. All of the above

ANSWER: a. Angle of attack increases

FRAME 5

During autorotation, portions of your rotor blade will stall due to excessive angle of attack, but the rotor disc still produces more than enough lift to provide controlled flight.



A. Outboard 30% disc area
B. Middle 45% disc area
C. Inboard 25% disc area

The outboard 30% of the rotor disc area is not stalled but does not produce enough lift to overcome its own drag. The middle 45% of the disc area produces lift keeping the helicopter in a safe autorotation glide. The inboard 25% is stalled and contributes considerable drag.

Which section of the rotor disc area produces the least amount of lift?

a. Outboard

b. Inboard

c. Middle

TURN TO PAGE 2 FRAME 6

ANSWER: d. All of the above.

SELF EVALUATION EXERCISE

1. The conditions that occur when the collective pitch is initially lowered for autorotation are:

   a. Autorotative flow, angle of attack increases, RPM stabilizes, and loss of torque effect on the airframe.

   b. Autorotative flow, angle of attack decreases, RPM stabilizes, and increased torque effect on the airframe.

   (c) Autorotative flow, angle of attack decreases, RPM stabilizes, and decreased torque effect on the airframe.

   d. Autorotative flow, negative angle of attack, negative RPM, and decreased torque effect on the airframe.

2. The section of rotor disc which provides most of the lift for the autorotative glide is:

   (a) Middle.

   b. Inboard.

   c. Outboard.

3. In an autorotation, a greater airspeed and rate of descent will normally

   (a) Increase glide distance.

   b. Decrease glide distance.

   c. Increase engine RPM

4. There is a minimum airspeed for autorotation because:

   a. When airspeed is reduced torque increases.

   (b) The blades will stall at less than minimum airspeeds.

   c. Center of gravity increases.

   d. When airspeed is reduced the angle of attack is reduced.

5. A flare will:

   a. Increase rate of descent.

   b. Increase engine RPM.

   c. Increase airspeed.

   d. Decrease rate of descent and airspeed.

6. At the termination of an autorotation, lifting the collective pitch will:

   a. Stop the descent and increase RPM.

   b. Stop the descent and increase lift.

   c. Stop the descent and decrease lift.

ANSWERS TO SELF EVALUATION EXERCISE

1. c Autorotative flow,angle of attack decreases, RPM stabilizes, and decreased torque effect on the airframe.

2. a Middle

3. a Increase glide distance.

4. b The blades will stall at less than minimum airspeeds.

5. d Decrease rate of descent and airspeed.

6. b Stop the descent and increase lift.

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