U.S. Department
of Transportation
Federal Aviation
Administration

Advisory Circular

Subject: Autorotation Training | **Date:** 5/23/13 | **AC No:** 61-140

Initiated by: AFS-800 | **Change:**

1. PURPOSE. The purpose of this advisory circular (AC) is to describe enhanced guidelines for autorotations during rotorcraft/helicopter flight training. The Federal Aviation Administration (FAA) has found a need to raise awareness of the risks inherent in performing autorotations in the training environment, and in particular the 180 degree autorotation. In this AC, the FAA recommends procedures that will mitigate safety risk during autorotations. This information is intended to supplement information about autorotation training found in the current edition of the Helicopter Flying Handbook (HFH), FAA-H-8083-21. This AC is not mandatory and does not constitute a regulation. This AC describes an acceptable means, but not the only means, of training applicants for a rotorcraft/helicopter airman to meet the qualifications for various rotorcraft/helicopter ratings under Title 14 of the Code of Federal Regulations (14 CFR) part 61. You may use alternate methods for training if you establish that those methods meet the requirements of the HFH and FAA practical test standards (PTS).

2. AUDIENCE. This AC applies to all persons involved in rotorcraft/helicopter flight training, including certificated flight instructors (CFI), Designated Pilot Examiners (DPE), and FAA aviation safety inspectors (ASI). All pilots involved with autorotation training are strongly encouraged to review the information in this AC and apply the techniques as appropriate.

3. RELATED READING MATERIAL. The FAA's principal guidance on autorotation can be found in the current edition of the HFH, FAA-H-8083-21. This AC supplements and expands the guidance from the HFH.

4. BACKGROUND.

a. Helicopter Accidents. The U.S. Joint Helicopter Safety Analysis Team (U.S. JHSAT) Compendium Report (2000, 2001, and 2006) shows that training continues to be one of the top operational categories of helicopter accidents in the United States, representing 17.9 percent of all accidents. Of the 523 helicopter accidents reviewed, failures in autorotation training were noted in 68 accidents, or 13 percent. Furthermore, six accidents within the previous five years of issuance of this AC involved a National Transportation Safety Board (NTSB) probable cause as "180 degree autorotations." Although this is less than 1 percent of accidents in this time period, this advanced maneuver requires attention in an effort to reduce all helicopter accidents. This supports the International Helicopter Safety Team (IHST) initiative of an 80 percent accident rate reduction by 2016.

b. Common Safety. This AC follows IHST recommendations on autorotation training and is designed to address the identified mistakes causing a significant number of helicopter accidents in the training environment. The AC addresses the common safety issues in this segment of training. Autorotation training procedures and practices have not been specifically addressed in prior ACs. This AC promotes the recommendations of the IHST for autorotation training and is designed to address the identified errors that cause a significant number of helicopter accidents in the training environment.

c. Elevation of Accident Rate. In 2011, after evaluating three years of helicopter accident data, the FAA and IHST recognized an unacceptable increase in the helicopter accident rate. Autorotation during training and in actual emergencies was an occurrence category for 32 percent of those accidents, and the IHST developed recommendations that it felt could be employed to reduce risk in helicopter autorotation operations.

d. Predominant Cause of Accidents/Incidents. A review of NTSB reportable accidents and incidents during autorotation training/instruction indicates that the predominant probable cause is failure to maintain main rotor revolutions per minute (RPM)(Nr) and airspeed within the pilot's operating handbook (POH) specified range, resulting in an excessive and unrecoverable rate of descent.

5. TURNING AUTOROTATION TECHNIQUE. Turns (or a series of turns) can be made during autorotation to facilitate landing into the wind or avoiding obstacles. Turns during autorotation should be made early so that the remainder of the autorotation is flown identically to a straight-in autorotation. The most common turns in an autorotation are 90 degrees and 180 degrees. The technique below describes an autorotation with a 180 degree turn.

a. Technique for a 180 Degree Turning Autorotation to Touchdown.

(1) Establish the aircraft on a downwind heading at the recommended airspeed, and parallel to the intended touchdown point. Taking the wind into account, establish the ground track approximately 200 feet laterally from the desired course line to the touchdown point. In strong crosswind conditions, be prepared to adjust the downwind leg closer or farther out, as appropriate. Use the autorotation entry airspeed recommended by the POH. When abeam the intended touchdown point, smoothly reduce collective, then reduce power to the engine to show a split between the rotor rpm and engine rpm. Apply appropriate anti-torque pedal and cyclic to maintain proper attitude. Throughout the autorotation, pilots should continually cross-check aircraft attitude, rotor rpm, airspeed, and that the helicopter is in trim (centered trim ball).

(2) After the descent and autorotation airspeed is established, initiate the 180 degree turn. For training operations, initially roll into a bank of at least 30 degrees, but no more than 50-60 degrees. It is important to maintain the proper airspeed, rotor rpm, and trim ball centered throughout the turn. Changes in the aircraft's attitude and the angle of bank will cause a corresponding change in rotor rpm within normal limits. Do not allow the nose to pitch up or down excessively during the maneuver, as it may cause undesirable rotor rpm excursions. Pitot-static airspeed indications may be unreliable or lag during an autorotative turn. Pilots should also exercise caution to avoid using excessive aircraft pitch attitudes to chase airspeed indications in an autorotative turn.

NOTE: Approaching the 90 degree point, check the position of the landing area. The second 90 degrees of the turn should end with a roll-out on a course line to the landing area. If the helicopter is too close, decrease the bank angle (to increase the radius of turn); if too far out, increase the bank angle (to decrease the radius of the turn). A maximum bank angle of 50-60 degrees should be encountered during this turn. Monitor the trim ball and adjust as necessary to maintain coordinated flight. Prior to passing through 200 feet above ground level (AGL), if landing or making a surface-level power recovery, the turn should be completed and the helicopter aligned with the intended touchdown area. Upon reaching the course line, set the appropriate cross-wind correction. If the collective pitch was increased to control the rpm, it may need to be lowered on rollout to prevent decay in rpm.

(3) This maneuver should be aborted at any point the following criteria is not met: If the helicopter is not in a stabilized approach to landing profile (i.e. it's not aligned with the touchdown point, after completing the 180 degree turn), if the rotor RPM is not within limits, if the helicopter is not at a proper attitude/airspeed, or if the helicopter is not under proper control at 200 feet. It is essential that the pilot on the controls (or an instructor, when intervening) immediately abort the maneuver and execute a smooth power recovery and go-around. It is important for the CFI who is intervening at this point to remember that the go-around is a far safer option than trying to recover lost rotor rpm and reestablish or recover to the hover or even the preferred hover taxi.

b. Minimizing Altitude Loss. From all entry positions, but particularly true of the 180 degree entry, a primary concern is getting the aircraft into the course line with as much altitude as possible. Once the collective has been lowered and the engine set to flight idle, the helicopter will lose altitude. A delayed turn will result in a lower altitude when arriving on the course line. Additionally, an uncoordinated flight condition (trim-ball not centered) will result in an increased sink rate, which may be unrecoverable if not corrected.

c. Interior and Exterior Scan Pattern. During the turn to the course line, pilots should use a scan pattern to see outside as well as inside the cockpit. Of primary importance outside is maintaining the appropriate descending attitude and a proper turn rate. Essential items to scan inside are rotor RPM and centered trim ball. Rotor RPM will build anytime "G" forces are applied to the rotor system. Usually this occurs in the turn to the course line and during the deceleration flare.

d. Maintaining Rotor RPM Range Throughout Maneuver. Rotor RPM should be maintained in the range recommended in the POH throughout the maneuver. Rotor RPM outside of the recommended range will result in a higher rate of descent and less glide-ratio. When the rotor rpm exceeds the desired value as a result of increased "G" load in the turn, timely use of up collective will increase the pitch of the blades and slow the rotor to the desired rpm. In an autorotation, rotor RPM is the most critical element. It provides the lift required to stabilize an acceptable rate of descent and the energy necessary to cushion the landing. Collective should be moved to the full down position to maintain rotor RPM immediately following a loss of power.

However, rapid or abrupt collective movement could lead to mast bumping in some rotorcraft with teetering rotor systems.

e. Managing Energy. Energy is a very important property of all rotating components, and the kinetic energy stored in the rotor system is used to cushion the landing. More lift is produced at the bottom of an autorotation by raising the collective, which increases the angle of attack of the blades. The rotor RPM will also rapidly decay at this point and it is essential to properly time the flare and the final collective pull to fully arrest the descent and cushion the landing. Upon arriving into the course line prior to the flare, the scan should focus almost entirely outside. The scan should include:

(1) Outside - to the horizon for attitude, ground track, and nose alignment;

(2) Down - for altitude to set the flare and for closure (groundspeed); and

(3) In the cockpit - to cross-check airspeed, rotor rpm, and engine rpm in the descent.

f. Autorotational Flares. Every autorotational flare will be different depending on the existing wind conditions, airspeed, Density Altitude (DA), and the aircraft gross weight.

g. Effects of Aborted Autorotation. Helicopters operating at a high DA will need to take into account the effects on the control of the helicopter when recovering from an aborted autorotation. Some effects to be considered are:

- Higher rate of descent.
- Reduced rotor rpm build in autorotation.
- Low initial rotor rpm response in autorotation.
- The requirement for a higher flare height.
- Reduced engine power performance.

6. COMMON ERRORS.

a. Entering the maneuver at an improper altitude or airspeed.

b. Entering the maneuver without a level attitude (or not in coordinated flight).

c. Entering the maneuver and not correcting from the initial deceleration to a steady state attitude (which allows excessive airspeed loss in the descent).

d. Improper transition into the descent on entry.

e. Improper use of anti-torque on entry.

f. Failure to establish the appropriate cross-wind correction, allowing the aircraft to drift.

g. Failure to maintain coordinated flight through the turn.

h. Failure to maintain rotor rpm within the POH recommended range.

i. Excessive yaw when increasing collective to slow rate of descent during power recovery autorotations.

j. During power recovery autorotations, a delay in reapplying power.

k. Initial collective pull either too high or too low.

l. Improper flare (too much or not enough).

m. Flaring too low or too high (AGL).

n. Failure to maintain heading when reapplying power.

o. Not landing with a level attitude.

p. Landing with aircraft not aligned with the direction of travel.

q. Insufficient collective cushioning during full autorotations.

r. Abrupt control inputs on touchdown during full autorotations.

7. AUTOROTATION TRAINING RECOMMENDATIONS. The following recommendations apply equally to both straight-in autorotations and the 180 degree turning autorotations. Instructors should teach the entry, descent (with and without turns), the go-around, and the flare recovery separately.

a. Initial Training. While the goal is for helicopter pilots to attain a safe level of proficiency in performing a 180 degree autorotation from 700 feet (or from the pattern altitude, as appropriate), the FAA recommends that initial training for a 180 degree autorotation be introduced over a number of flight lessons and start with a much higher altitude as the entry point, progressively reducing the altitude and therefore gradually increasing the level of difficulty.

b. Higher Entry Point Autorotation. The instructor should first demonstrate a 180 degree autorotation with an entry from above 1,500 feet AGL using at least 1,000 feet to complete the turn but noting all the relevant points as described in paragraph 5 of this AC. This maneuver should be concluded by performing a power recovery and go-around no lower than 500 feet AGL. Prior to student solo, a 180 degree autorotation should be performed as a demonstration maneuver only. Post-solo, the student should be given the opportunity to practice this maneuver with the instructor from a similar height until reasonably proficient.

c. Lower Entry Point Autorotation. Once the student is proficient in performing this maneuver to the go-around point at 500 feet, the instructor should then demonstrate the 180 degree autorotation from a lower entry point, such as 1,000 feet AGL. This maneuver should introduce the flare and power recovery to a suitable area on the ground. The student should then be given the opportunity to practice this maneuver with an entry at 1,000 feet AGL, terminating in a flare and power recovery at a safe hover altitude above the ground, until proficient from the lower altitude. The instructor can then select a lower entry altitude, such as 700 feet AGL (or the

pattern altitude where the training is taking place) and demonstrate a further 180 degree autorotation to a flare and power recovery. The student should be taught, with careful monitoring from the instructor, to develop the necessary skills in executing an autorotation, bearing in mind that this maneuver has become more difficult for the student as altitude is reduced and time available for the 180 degree turn is now more limited.

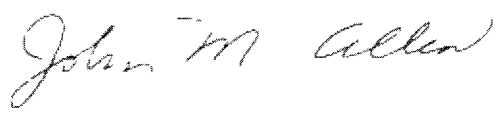
8. PILOT CURRENCY. To lower the likelihood of an accident, pilots who are not current or proficient should not be expected to perform a 180 degree autorotation with an entry point below 1,000 feet AGL in a training environment without first practicing the maneuver from a higher entry point. If a pilot has not flown at all for a number of days (e.g., 10 days or more) or has not recently flown a 180 degree autorotation (e.g., within the last 30 days), flight instructors and check airman should re-introduce this maneuver. The pilot in training should start the training from a higher altitude and once again decrease the entry level altitude to minimize risk.

9. EXAMINER SUPERVISION. To mitigate the risk involved in this maneuver, DPEs or FAA ASIs should determine the applicant's level of proficiency and recency of experience with turning autorotations during the oral portion of the practical test. This discussion should occur before the flight portion of the practical test, and should include a description of the number of autorotations that have been performed by the applicant from an entry point of 700 feet AGL or below.

10. PTS LISTING. This AC will be listed in each PTS below as being associated with the straight-in and the 180 degree autorotation. This AC will be listed as a required reference document for the CFI practical test and will include a requirement for the CFI candidate to demonstrate a clear understanding of these recommendations during his/her examination by the DPE or ASI. Responses should indicate clear understanding of the various elements of energy management involved in the maneuver and the issues associated with the ability of low-time students to manage those energies.

- FAA-S-8081-3A, Recreational Pilot Practical Test Standards for Airplane, Rotorcraft/Helicopter, and Rotorcraft/Gyroplane (Recreational).
- FAA-S-8081-15A, Private Pilot Practical Test Standards for Rotorcraft (Helicopter, Gyroplane) (Private).
- FAA-S-8081-16A, Commercial Pilot Practical Test Standards for Rotorcraft (Helicopter, Gyroplane) (Commercial).
- FAA-S-8081-7B, Practical Test Standards for Rotorcraft (Helicopter, Gyroplane) (CFI).

11. WHERE YOU CAN FIND THIS AC. You can find this AC on the FAA's Web site at http://www.faa.gov/regulations_policies/advisory_circulars. You can view Federal Aviation Regulations at http://www.faa.gov/regulations_policies/faa_regulations/.



/s/ John M. Allen
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