Helicopter Flying Handbook (FAA-H-8083-21A)
Addendum – Change 1

January 2016

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Record of Changes

Change 1 (4/19/2016)

- Added language regarding the Rotorcraft Flight Manual to first paragraph of "RPM Control" section (page 1).
- Added language regarding the application of aft cyclic upon a decrease in rotor RPM to rebuild RPM to the end of the last paragraph of "RPM Control" section (page 2).
- Added "Rotorcraft Flight Manual (RFM)" to the end of the paragraph in the "Risk Management during Autorotation Training" section (page 2).

Helicopter Flying Handbook Addendum

This addendum follows the U.S. Joint Helicopter Safety Analysis Team's (US JHSAT) recommendations on autorotation training and is designed to address the identified mistakes causing a significant number of helicopter accidents in the training environment, personal travel, corporate, and air carrier operations. A review of NTSB reportable accidents and incidents during autorotation training/instruction and loss of power emergency landings indicates that the predominant probable cause is failure to maintain main rotor revolutions per minute (RPM) (Nr) and airspeed found in the Rotorcraft Flight Manual (RFM)" or within "a POH that contains a RFM within the specified range, resulting in an excessive and unrecoverable rate of descent."

The following information will be integrated into the Helicopter Flying Handbook in the next revision:

RPM Control

Rotor RPM in low inertia rotor systems has been studied in simulator flight evaluations which indicate that the simultaneous application of aft cyclic, down collective, and alignment with the relative wind (trim) at a wide range of airspeeds, including cruise airspeeds, is critical for all operations during the entry of an autorotation. The applicable Rotorcraft Flight Manual (RFM) should be consulted to determine the appropriate procedure(s) for safely entering an autorotation. This is vitally important since the procedure(s) for safely entering an autorotation may vary with specific makes and/or models of helicopters. A basic discussion of the aerodynamics and control inputs for single rotor systems is in order here.

Helicopter pilots must understand the use of the collective for RPM control during power off autorotations in a turn. Upward movement of the collective reduces the RPM and downward movement increases the RPM. Cyclic movement is primarily associated with airspeed control in powered flight, but may not be given the credit appropriate for rotor RPM control during practice and emergency power off autorotations. As long as the line of cyclic movement is parallel with the flight path of the helicopter (trimmed), the aft movement of the cyclic also creates greater air flow up through the bottom of the rotor disk and contributes to an increase in rotor RPM. If the flight path is 10 degrees to the right of the longitudinal axis of the helicopter, theoretically, the cyclic should be moved 10 degrees aft and left of the longitudinal axis to get maximum air up through the rotor system. Most pilots, however, in accordance with the RFM or company standard operating procedures (SOPs), perform practice autorotations at an airspeed much lower than cruise airspeed.

The pilot's immediate reaction to loss of power resulting from lowering the collective may be to lean forward slightly, which delays the needed simultaneous application of aft cyclic to prevent the accompanying lowering of the nose and associated loss of RPM. A slight gain in altitude at cruise airspeed during the power off entry into an autorotation should not be of great concern as is the case for the execution of practice or actual quick stops.

The problem with recommended procedures to practice autorotations is that in a real power failure at cruise airspeed pilots as a result of various accident investigations apparently are not getting the simultaneous application of down collective and aft cyclic and torque pedal application for trim initiated in a timely manner. Although low inertia rotor blade systems are blasted for their ability to maintain rotor RPM down in the flare and cushion segment, they require less energy to regain safe rotor RPM, but are equal in the initial stages of the autorotation entry by the pilot who should immediately apply simultaneous down collective, aft cyclic and trim the helicopter for entry into an autorotation at cruise airspeed. If rotor RPM has been allowed to decrease, or has inadvertently decreased below acceptable limits, an application of aft cyclic may help rebuild rotor RPM. This application of aft cyclic must be made at least at a moderate rate and may be combined with a turn, either left or right, to increase airflow through the rotor system. This will work to increase rotor RPM. Care should be maintained to not over-speed the rotor system as this is attempted.

Risk Management during Autorotation Training

This section describes enhanced guidelines for autorotations during rotorcraft/helicopter flight training, as stated in Advisory Circular (AC) 61-140. There are risks inherent in performing autorotations in the training environment, and in particular the 180-degree autorotation. This section describes an acceptable means, but not the only means, of training applicants for a rotorcraft/helicopter airman certificate to meet the qualifications for various rotorcraft/helicopter ratings. You may use alternate methods for training if you establish that those methods meet the requirements of the Helicopter Flying Handbook (HFH), FAA practical test standards (PTS), and the Rotorcraft Flight Manual (RFM).

Autorotation with Turns

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 following technique describes an autorotation with a 180-degree turn.

The pilot establishes the aircraft on a downwind heading at the recommended airspeed, and parallel to the intended touchdown point. Then, taking the wind into account, the pilot establishes the ground track approximately 200 feet laterally from the desired course line to the touchdown point. In strong crosswind conditions, the pilot should be prepared to adjust the downwind leg closer or farther out, as appropriate. The pilot uses the autorotation entry airspeed recommended by the RFM. When abeam the intended touchdown point, the pilot smoothly reduces collective, then reduces power to the engine to show a split between the rotor RPM and engine RPM and simultaneously applies appropriate anti-torque pedal and cyclic to maintain proper attitude/airspeed. Throughout the autorotation, the pilot should continually crosscheck the helicopter's attitude, rotor RPM, airspeed, and verify that the helicopter is in trim (centered trim ball).

After the descent and autorotation airspeed is established, the pilot initiates the 180-degree turn. For training operations, initially roll into a bank of at least 30 degrees, but no more than 60 degrees. It is important to maintain the proper airspeed, rotor RPM, and trim (centered trim ball) throughout the turn. Changes in the helicopter'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 autorotational turn. The pilot should exercise caution to avoid using excessive aircraft pitch attitudes and to avoid chasing airspeed indications in an autorotational 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 bank angle of no more than 60 degrees should be encountered during this turn. Monitor the trim ball (along with one's kinesthetic sense) and adjust as necessary with cyclic and anti-torque pedal 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 rotor RPM.

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 as close as possible into the wind 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 a certificated flight instructor (CFI), 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.

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.

During the turn to the course line, the pilot 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.

Throughout the maneuver, rotor RPM should be maintained in the range recommended in the RFM 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, as 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.

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:

- the horizon for attitude, ground track, and nose alignment;
- the altitude to set the flare and for closure (groundspeed); and
- the instrument cross-check of airspeed, rotor RPM, and engine RPM in the descent.

Every autorotational flare will be different depending on the existing wind conditions, airspeed, density altitude (DA), and the aircraft gross weight. 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 consider 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.

The following common errors should be prevented:

- Entering the maneuver at an improper altitude or airspeed.
- Entering the maneuver without a level attitude (or not in coordinated flight).
- Entering the maneuver and not correcting from the initial deceleration to a steady state attitude (which allows excessive airspeed loss in the descent).
- Improper transition into the descent on entry.

- Improper use of anti-torque on entry.
- Failure to establish the appropriate cross-wind correction, allowing the aircraft to drift.
- Failure to maintain coordinated flight through the tum.
- Failure to maintain rotor RPM within the RFM recommended range.
- Excessive yaw when increasing collective to slow rate of descent during power recovery autorotations.
- During power recovery autorotations, a delay in reapplying power.
- Initial collective pull either too high or too low.
- Improper flare (too much or not enough).
- Flaring too low or too high (AGL).
- Failure to maintain heading when reapplying power.
- Not landing with a level attitude.
- Landing with aircraft not aligned with the direction of travel.
- Insufficient collective cushioning during full autorotations.
- Abrupt control inputs on touchdown during full autorotations.