NTSB
SAFETY ALERT
National Transportation Safety Board

Loss of Tail Rotor Effectiveness in Helicopters

Be alert for uncommanded yaw so you don't get caught off guard!

The problem

- In helicopters, loss of tail rotor effectiveness (LTE), or unanticipated yaw, is an uncommanded rapid yaw that does not subside of its own accord. LTE can occur in all single-engine, tail rotor-equipped helicopters at airspeeds lower than 30 knots and, if uncorrected, can cause the pilot to lose helicopter control, potentially resulting in serious injuries or death.

- Various factors can contribute to LTE, including varying airflow from the main rotor blades (particularly at high power settings) or from the environment, which can affect the airflow entering the tail rotor; operating at airspeeds below translational lift; operating at high altitudes and high gross weights; operating near large buildings or ridgelines, which can cause turbulence; and the relative wind direction (see figures 1 and 2).[1]

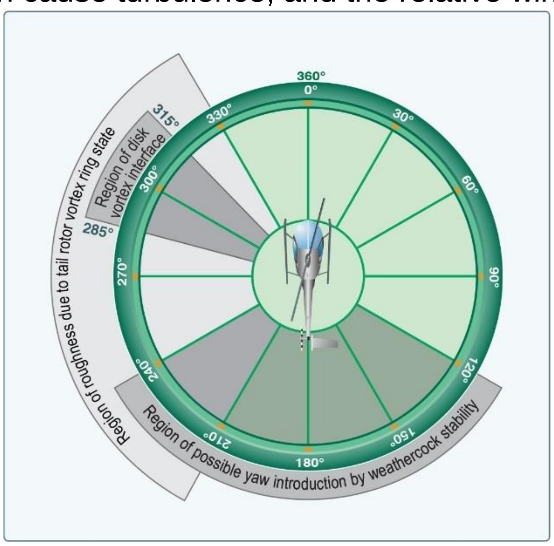

Figure 1. Relative wind directions that can contribute to LTE for counterclockwise main rotor helicopters.

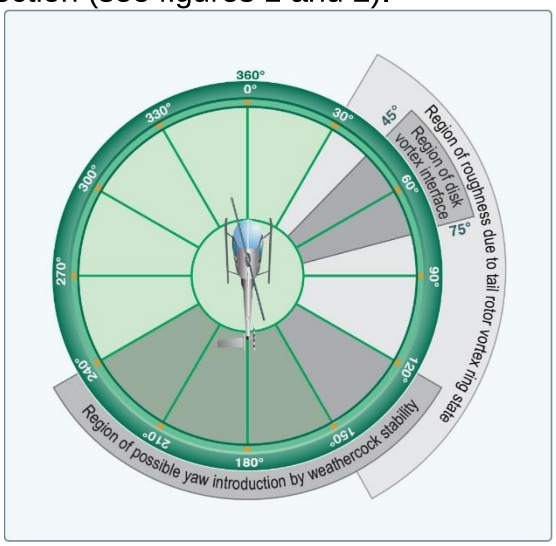

Figure 2. Relative wind directions that can contribute to LTE for clockwise main rotor helicopters.

[1] On US-manufactured single-rotor helicopters, the main rotor rotates counterclockwise as viewed from above. The torque produced by the main rotor causes the fuselage of the helicopter to rotate in the opposite direction (nose right). On some European- and Russian-manufactured helicopters, the main rotor rotates clockwise as viewed from above. In those helicopters, the torque produced by the main rotor causes the fuselage to rotate nose left. Operating with the relative wind direction within ±15° of the 10-o'clock position (for counterclockwise main rotor helicopters) or the 2-o'clock position (for clockwise main rotor helicopters) generates vortices that directly blow into the tail rotor. Also, tailwinds from 120° to 240° can cause high workloads. Finally, crosswinds can create roughness due to tail rotor vortex ring state (wind from 210° to 330° on counterclockwise main rotor helicopters or from 30° to 150° on clockwise main rotor helicopters).

- Due to safety concerns, training for LTE is rarely done in an actual helicopter. Simulators allow pilots to practice recovery; however, the element of surprise—and the rapid yaw that pilots may experience when the helicopter encounters LTE in flight—is difficult to realistically achieve in some simulators.

Related accidents

During the 10-year period from 2004 to 2014, the National Transportation Safety Board (NTSB) investigated 55 accidents involving LTE. In the following cases, the pilots were unable to recover when the helicopters encountered unanticipated yaw. All three cases involved helicopters with counterclockwise rotating main rotor blades.

- The pilot was making an approach to a hospital helipad into light wind at night when he chose to go around. The pilot lowered the helicopter's nose, added power, and raised the collective; the helicopter then entered a rapid "violent" right spin. The pilot applied left antitorque pedal and cyclic but was unable to recover. The helicopter spun several times before impacting power lines and terrain. Just before the pilot added power to go around, the helicopter was traveling about 5 knots groundspeed. At such a low groundspeed, the tail rotor is required to produce nearly 100% of the directional control. The pilot likely did not adequately account for the helicopter's low airspeed when he applied power to go around, which resulted in a sudden, uncommanded right yaw due to LTE. (CEN15FA003)

- The pilot and two passengers were surveying deer, with the helicopter about 50 to 100 ft above ground level with a 5- to 10-knot left crosswind and an indicated groundspeed of 30 to 35 knots. As terrain began to rise, the pilot added power to clear a ridge. The pilot reported that, when the helicopter was about 100 ft from the top of the ridge, the helicopter began to yaw to the right. He added power to clear the ridgeline, which greatly increased the right yawing motion. The helicopter began spinning, crossed over the ridgeline backward, and continued spinning before it contacted the ground and rolled over onto its left side. A passenger reported that, although the wind was about 10 knots when they started the survey, the wind speed increased when the helicopter reached the top of the ridge, and the pilot had to correct for it twice before the helicopter began spinning to the right. The helicopter was operating with wind coming from the left and at a high power setting; the unanticipated right yaw and subsequent spinning of the helicopter are consistent with LTE. (CEN13TA165)

- The pilot had planned a Part 91 sightseeing flight around New York City with two passengers; however, four passengers arrived for the flight. The pilot did not complete performance calculations before the accident flight, and the helicopter was in excess of its maximum allowable gross weight at takeoff. Shortly after departure, while the helicopter was climbing to 60 ft above the water, the pilot failed to anticipate and correct for conditions (high gross weight, low indicated airspeed, and a right downwind turn) conducive to LTE, which resulted in LTE and an uncontrolled spin. (ERA12MA005)

What can you do?

- Include wind speed and direction in your preflight planning because it can greatly affect your helicopter's susceptibility to LTE.
- Know your helicopter's performance limitations, as outlined per the manufacturer, and adhere to them.
- Be aware of your helicopter's flight control characteristics, particularly tail rotor pedal forces, so that you can quickly recognize and resolve the onset of unanticipated yaw.
- Review the Federal Aviation Administration's (FAA) *Helicopter Flying Handbook* for specific tips on avoiding LTE. Here are a few tips to get you started:
    - Conduct a thorough preflight planning assessment with particular attention to the helicopter's maximum allowable gross weight.
    - Maintain awareness of the wind direction and speed in flight, especially in high workload areas, when flying along ridgelines and around buildings, and when hovering in wind of about 8 to 12 knots when a loss of translational lift can occur.
    - Avoid tailwinds or crosswinds (the direction depends on the type of helicopter you are flying) when operating below an airspeed of 30 knots.
    - Avoid out-of-ground-effect operations and high-power-demand situations below 30 knots.
    - Monitor the amount of antitorque pedal being used. If insufficient pedal is available, you may not be able to counteract an unanticipated right yaw.
- Train for and know how to recover immediately from LTE so that you are prepared. Remember that LTE can be sudden, and pilots have described the onset of yaw as "violent."

Interested in more information?

The following FAA resources are available on the FAA's website (www.faa.gov):

- The *Helicopter Flying Handbook* (FAA-H-8083-21A), chapter 11, "Helicopter Emergencies and Hazards," provides an in-depth explanation of LTE.
- Advisory Circular 90-95, "Unanticipated Right Yaw in Helicopters," explains unanticipated yaw in helicopters, why it occurs, how to prevent it, and how pilots can respond to it.

The NTSB has produced a video regarding LTE, which includes one investigator's experience with LTE and tips on what you can do to be prepared.

The NTSB's Aviation Information Resources web page (www.ntsb.gov/air) provides convenient access to NTSB aviation safety products. The reports for the accidents referenced in this safety alert are accessible by NTSB accident number from the Aviation Accident Database link, and each accident's public docket is accessible from the Accident Dockets link for the Docket Management System. This safety alert and others can be accessed from the Aviation Safety Alerts link.