

# Helicopter Control: Loss of Tail Rotor Effectiveness (LTE)

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## What is LTE?

Loss of Tail Rotor Effectiveness is an aerodynamic flight characteristic that at some stage will catch the unwary helicopter pilot with potentially disastrous consequences. This phenomenon will affect all single engine helicopters at airspeeds of less than 30 knots and normally manifests itself as an uncommanded rapid yaw rate.

In most American manufactured helicopters, with anti-clockwise rotating main rotor blades, torque produced by the main rotor causes the fuselage of the helicopter to rotate in the opposite direction (nose right). The anti-torque system provides thrust which counteracts this torque and provides directional control whilst hovering. The inverse would apply to some European and Russian produced machines, where the main rotor blades rotate clockwise. For the purpose of this article, we will focus on anti-clockwise rotating main rotor blades found with most American manufactured helicopters.

A helicopter's tail rotor relies on a stable and relatively undisturbed airflow in order to provide a steady and constant anti-torque reaction. LTE is a condition that occurs when the flow of air through the helicopter's tail rotor is changed in some way, either by altering the angle or the speed at which the air passes through the tail rotor system.

When the pilot applies anti-torque through the foot pedals, the amount of tail rotor thrust produced is changed. Should more thrust be generated than is required, the helicopter will yaw to the left. The inverse is obviously true if less thrust is generated. By changing the amount of tail rotor thrust the pilot is able to maintain his heading whilst hovering. In a perfect no-wind condition, there exists a specific amount of tail rotor thrust required to prevent the machine from either yawing left or right. This is commonly known as tail rotor trim thrust.

In actual flying conditions, the wind velocity and direction is constantly changing and therefore the required tail rotor thrust required is altered. Should the machine execute an uncommanded right yaw, it may be owing to the wind reducing the amount of tail rotor thrust available. Of course, the opposite may also occur with the helicopter performing an uncommanded yaw to the left owing to the wind actually adding to the anti-torque system thrust.

The angle of attack (pitch) of the individual blades will determine the thrust output of the

tail rotor. Any input on the anti-torque pedals by the pilot, will result in a thrust reaction from the tail rotor. Altering the amount of thrust delivered for the same yaw input will create an imbalance. Loss of effective control in the yawing plane and LTE will occur if this imbalance goes to the extreme. Changes in tail rotor thrust can be effected by numerous external influences.

## The main influences to LTE are:

- Main rotor blades generate downdraft that interferes with the airflow over the tail rotor.
- Main rotor blade vortices developed at the main blade tips entering the tail rotor; and
- Turbulence affecting the airflow surrounding the tail rotor.

## LTE may occur under the following conditions:

1. Right turns during low airspeed: The helicopter may start yawing to the right which would require an immediate correction of left anti-torque pedal. If the pilot's response is inadequate, the yaw rate may increase beyond the point of recovery.
2. Hi-power low Airspeed: Should a left cross-wind or tailwind be experienced at the same time, an uncommanded right yaw may occur.
3. Large changes in collective (power) at low airspeed.
4. Tailwinds: If tailwinds are experienced and loss of translational lift occurs, it will result in an increased high power demand and an additional anti-torque requirement.
5. Low Speed; downwind turns: The same results as in condition 2 & 4.
6. Hovering Out of Ground Effect (OGE): Be especially careful if wind speed is in the 7-13 knot range, as a loss of translational lift may occur and hence an unexpected high power demand and a resultant requirement for rapid anti-torque input from the pilot.

## Additional factors that may influence the onset of LTE

- Proximity of physical obstructions: Flying around at low airspeed around ridge lines or buildings may change the airflow around the helicopter.
- Gross Weight and Density Altitude: Helicopter pilots are aware of the fact that increasing either of these will decrease the margin of power available between hovering and maxi-

mum power. Try and conduct low level, low airspeed flight at minimum weight if possible.

- Low Indicated Airspeed: The tail rotor provides nearly all of the directional control of a helicopter at airspeeds below translational lift. If for some reason the required amount of tail rotor thrust is not available, the machine will yaw to the right.
- Power Droop: A rapid application of collective (power) may lead to a temporary drop in main rotor rpm, known as a power droop. This will in turn result in a decrease in available tail rotor thrust and as a result additional anti-torque input may be required to counter the main rotor torque.

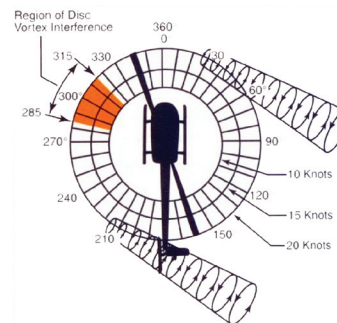
## Flight Characteristics of LTE

There are basically four azimuth wind directions that may contribute to or create an environment conducive to LTE. Be aware of the fact that some of these regions may overlap and that the actual azimuth may change depending on the ambient air condition.

Once again bear in mind that these conditions apply specifically to airspeeds of less than 30 knots in single rotor helicopters.

The aircraft characteristics and relative wind azimuth regions quoted as per FAA's *Flying Rotorcraft Handbook* are:

## Main Rotor Disc Vortex Interference (285° to 315°)



Winds at velocities of about 10 to 30 knots from the left front will cause the main rotor vortex to be blown into the tail rotor by the relative wind. The effect of this main rotor disc vortex is to cause the tail rotor to operate in an extremely turbulent environment.

During a right turn, the tail rotor will experience a reduction of thrust as it comes into the area of the main rotor disc vortex. The