SAFETY REGULATION GROUP

FLIGHT OPERATIONS DEPARTMENT COMMUNICATION

Civil Aviation Authority

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Website address: **http://www.caa.co.uk/publications**

1/2004

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1 LOSS OF TAIL ROTOR EFFECTIVENESS (LTE)

1.1 Introduction

1.1.1 A recent accident investigation conducted by the Air Accidents Investigation Branch has led to the belief that the pilot experienced Loss of Tail Rotor Effectiveness (LTE) and was unable to prevent the helicopter from completing several revolutions before impacting the ground.

1.1.2 The purpose of this FODCOM is to bring to the attention of all Commercial Helicopter Pilots the latest information on LTE.

1.2 History

1.2.1 The following statements have all come from real accident or incident reports, from both private and professional helicopter pilots working in a variety of environments.

- The pilot reported that he was on approach to a ridgeline landing zone about 70 ft above ground level decelerating through about 20 kt. Suddenly a gust of wind induced a loss of directional control. The helicopter began to rotate rapidly about the mast and impacted the ground.

- The pilot reported that he made a low pass over a mountain peak into a 40 kt headwind before losing tail rotor effectiveness. He then lost directional control and struck the ground.

- The pilot was manoeuvring the helicopter at about 300 ft AGL at slow speed when the aircraft entered an uncontrolled descending turn. Unable to regain control the pilot closed the throttle and attempted an emergency landing.

1.2.2 In all the cases described above, the helicopters were all correctly rigged, maintained and fully serviceable prior to the incidents and were carrying no significant defects that affected the flight in any way. They all, however, experienced phenomena known as Loss of Tail Rotor Effectiveness.

1.3 What is LTE?

1.3.1 LTE can be described as a critical low speed aerodynamic flight condition that can result in an uncommanded rapid yaw rate that does not subside and which can result in the loss of an aircraft if it remains unchecked.

1.3.2 LTE is the result of a control margin deficiency; it is not a maintenance malfunction.

1.3.3 LTE is an aerodynamic condition that can affect all single rotor helicopters that utilise a conventional tail rotor. Whilst the design of main and tail rotor blades and the tail boom assembly can affect the characteristics and susceptibility of a helicopter to LTE, it will not nullify the phenomenon entirely. Tail rotor capability is a factor and a helicopter type that is prone to reaching full pedal when, for example, hovering out of wind Inside Ground Effect (IGE) is more likely to suffer LTE due to high power (high, but in limits, gearbox torque or engine power) than a helicopter with good pedal margins in the same situation. Pilots should be aware of the characteristics of the helicopter they fly and be particularly aware of the amount of tail rotor pedal typically required for different flight conditions.

1.3.4 LTE can occur on helicopters with either anti-clockwise or clockwise rotating main blades, but the direction of the relative wind that makes them susceptible to LTE will differ. Thus an American design will be susceptible with the relative wind from the front left arcs, whilst French designs will be susceptible with relative winds from the front right arcs.

1.3.5 LTE is a condition that occurs when the flow of air through a conventional tail rotor is altered in some way, either by, altering the angle or speed at which the air passes through the rotating blades of the tail rotor system. An effective tail rotor relies on a stable and relatively undisturbed airflow in order to provide a steady and constant anti-torque reaction. The pitch, and inevitably the angle of attack of the individual blades will determine the thrust output of the tail rotor. A change to any of these criteria will inevitably alter the amount of thrust generated. When a pilot makes a yaw pedal input he will effect a thrust reaction from the tail rotor. Altering the amount of thrust delivered for the same yaw input will create an imbalance. Taking this imbalance to the extreme will result in the loss of effective control in the yawing plane and LTE will occur.

1.3.6 This alteration of tail rotor thrust can be effected by numerous external influences. The main influences, hence the main contributing factors to LTE are:

- Airflow and downdraft generated by the main rotor blades interfering with the airflow entering the tail rotor assembly;
- Main blade vortices developed at the main blade tips entering the tail rotor; and
- Turbulence and other natural phenomena affecting the airflow surrounding the tail rotor.

1.3.7 Wind tunnel tests have shown that the aerodynamic turbulence induced with all three phenomena above are both complex and interrelated however three conditions appear to be contributory factors to LTE.

- Firstly, a high power setting, hence large main rotor pitch angle, induces considerable main rotor blade downwash and hence more turbulence than when the helicopter is in a low power condition;
- Secondly a slow forward airspeed, typically at speeds where translational lift is in the process of change, where airflow around the tail rotor will vary in direction and speed; and
- Thirdly the airflow relative to the helicopter, the worst case being when the relative wind is within ±15º of the 10 or 2 o'clock position (American/French types respectively) when the generated vortices can be blown directly into the tail rotor.

1.3.8 Certain flight activities lend themselves to being more at high risk to LTE than others; for example powerline and pipeline patrol sectors, low speed aerial filming as well as in the Police and Helicopter Emergency Medical Services (HEMS) environments can find themselves in low and slow situations over geographical areas where the exact windspeed and direction are hard to determine.

1.4 How can LTE be avoided?

1.4.1 The exact parameters described above will vary from type to type depending on rotor orientation (clockwise or anti), the size of the machine and the geometric and aerodynamic relationship between the main and tail rotors. However there are certain flight phases where LTE is more likely to occur regardless of the type. The following is a general 'how to avoid LTE' list:

Whenever possible, AVOID combinations of:

- Low and slow flight outside of ground effect;
- Winds from ±15º of the 10 o'clock (American) or 2 o'clock (French) position;
- Tailwinds that may alter the onset of translational lift hence induce high power demands;
- Low speed downwind turns;

- Large changes of power at low airspeeds; and
- Low speed flight in the proximity of physical obstructions that may alter a smooth airflow.

1.4.2 Pilots should be aware that if they enter a flight regime where combinations of the above occur, then they are entering a potential LTE situation. In this case they should realise the possibility of experiencing LTE, recognise its onset and be prepared to react very quickly to it before it builds up.

1.5 What to do if LTE is encountered

1.5.1 The exact actions to be taken having encountered the phenomenon will vary according to the circumstances, but gaining forward airspeed will remove the problem. Awareness of LTE to assist in early detection of it, followed by firm corrective action to counter the effect will always pay dividends. Early identification followed by the immediate application of corrective action by getting the nose forward to regain airspeed is the key to a safe recovery - hence the need for the pilot to ensure he has the height and space available to recover. Understanding the phenomenon is by far the most important factor, and the ability and option to either 'go around' if making an approach (positive airspeed will always counter the effects of LTE) or pull out of a manoeuvre safely and re-plan, is always the safe option. Having the ability to 'fly away' down a safe route and re-think should always be part of a pilot's planning process in all phases of flight.

1.5.2 Helicopter pilots should be aware of LTE and should avoid entering into the flight phases where LTE could occur. The specific wind directions and speeds may vary with helicopter types and in some cases the danger arcs indeed overlap so detection may not be easy.

1.6 Recommendation

1.6.1 Helicopter operators should bring the details of this FODCOM to the attention of all their flight crew, and should consider covering the topic of Loss of Tail Rotor Effectiveness during recurrent ground training.

Captain D J Chapman
Head Flight Operations Department
9 January 2004

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