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LOSS OF TAIL ROTOR EFFECTIVENESS (LTE) DURING HIGH ALTITUDE AND HIGH ALL UP WEIGHT OPERATIONS

1. Introduction.

1.1 This AIC is issued in the exercise of the powers conferred under Section 24o of the Civil Aviation Act 1969.

1.2 The recent helicopter accident investigations conducted by Ministry of Transport has led to belief that the pilot experienced loss of tail rotor effectiveness (LTE), during high altitude with high all up weight operationsand was unable to control the helicopter before impacting the ground.

1.3 The purpose of this AIC is to bring to the attention of all helicopter pilots especially flying the light weight helicopter, on the latest information on LTE and to comply with the mandatory requirement of weight reduction forhigh altitude flying.

1.4 In all cases of LTE 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.

2. WHAT IS LTE?

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

2.2 LTE is an aerodynamic condition that can affect all single rotor helicopters that utilise a conventional tail rotor. Whilst the design of the main and tail rotor blades and the tail boom assembly can affect the characteristics and susceptible of a helicopter to LTE, it will not nullify the phenomenon totally. 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) or with marginal wind condition when hovering outside ground effect (OGE) is more likely to suffer LTE due to high power (but within limit of gearbox or engine) 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.

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

2.4 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 make 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 especially at high pitch angle situation. Taking this imbalance to the extreme will result in the loss of effectiveness control in the yawing plane and LTE will occur.

3. THE MAIN AERODYNAMIC INFLUENCE THAT AFFECTS THE TAIL ROTOR AS CONTRIBUTING FACTORS TO LTE ARE:

3.1 Airflow and downdraft generated by the main rotor blades interfering with the airflow entering the tail rotor assembly;

3.2 Main blade vortices developed at the main blade tips entering the tail rotor: and

3.3 Turbulence and other natural phenomena affecting the airflow surrounding the tail rotor

4. CONDITIONS OR COMBINATION OF THESE CONDITIONS CAN BE CONTRIBUTORY FACTORS TO LTE.

4.1 A high power setting, hence large main rotor and tail rotor pitch angle, induces considerable main rotor blade downwash and hence more turbulence occurred, prone to happen when flying low speed at high altitude;

4.2 A slow forward speed, typically at speed where translational lift is in the process of change, where the airflow around the tail rotor will vary in direction and speed; and

4.3 The airflow relative to the helicopter, the worst case being when the relative wind is within +-15 of the 10 or 2 o’clock position (American/French types respectively) when the generated vortices can be blown directly into the tail rotor.

5. Certain flight activities lend themselves to being more at high risk to LTE than others; for example high altitude flying for border survey, low speed aerial filming and low speed mountainous flying find themselves in low and slow situations over geographical areas where the exact wind speed and direction are hard to determine**.**

6. HOW CAN LTE BE AVOIDED?

6.1 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:

a) Whenever possible, AVOID combinations of:

b) Low and slow flight outside of ground effect;

c) Winds from +-15 of the 10 o'clock (French) or 2 o'clock (American) position;

d) Tailwinds that may alter the onset of translational lift hence induce high power demands;

e) Low speed downwind turns;

f) Large changes of power at low airspeeds; and

g) Low speed flight in the proximity of physical obstructions that may alter a smooth airflow.

6.2 Pilot 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.

7. WHAT TO DO IF LTE IS ENCOUNTERED

7.1 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) of pull out of a manoeuvre safely and re-plan, is always the save 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.

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

8. MANDATORY REQUIREMENTS

The following measures shall be taken by Operator and aircraft commander:

a) **Helicopter operators** shall inform all flight crew on the danger of LTE and to cover the topic of LTE during recurrent ground training.

b) A high power requirement is the direct implication of All Up Weight **helicopter operator and aircraft commander** to ensure the maximum all up weight (MAUW) allowable be calculated based on Weight Altitude Temperature (WAT) graph. Various incidents / accidents involving the Bell 206 series with conventional tail rotor (without high altitude tail rotor kit installation) are reported to be LTE related.

C) The reduction of weight with altitude for such type is as listed in ''Attachment A'. The weight reduction in 'Attachment A' can be used as a rule of thumb for

aircraft commander in deciding his MAUW at high altitude environment. Those figures are derived from the aircraft flight manual using altitude vs. gross weight for height – velocity diagram graph.

d) For more specific MAUW calculation **aircraft commander** may use the appropriate helicopter flight manual which can override those figures in ‘Attachment A.’

e) **Helicopter operator** shall ensure a weighing machine is to be provided with the helicopter for accurate measurement of actual body or baggage weight for accurate MAUW calculation.

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Attachment A

WEIGHT REDUCTION WITH ALTITUDE FOR TAKE OFF AND LANDING (IGE) - BELL 206 SERIES

Based on Standard Temperature and Pressure at Mean Sea level of Malaysian Standard Athmosphere.

HELICOPTER TYPE	WEIGHT REDUCTION FROM MAXIMUM ALL UP WEIGHT WITH HEIGHT
1. Bell 206 B Series	75 lbs for every 1000 feet AMSL
2. Bell 206 L Series	125 lbs for every 1000 feet AMSL