Flight Operations Briefing Notes

Takeoff and Departure Operations

Preventing Tailstrike at Takeoff

I Introduction

A tailstrike occurs if the tail of an aircraft touches the runway during takeoff or landing. It can occur with any type of aircraft although long aircraft may be more prone to tailstrike, because tailstrike occurrence is directly related to pitch attitude versus aircraft geometry and main landing gear status.

Tailstrikes can result in significant structural damage to the aircraft and, therefore jeopardize the safety of the flight and lead to considerable maintenance action.

Note:

The purpose of this Flight Operations Briefing Note is to address tailstrikes occurrence at takeoff.

II Background Information – Statistical Data

II.1 Statistical Data

About 25% of reported tailstrikes occur at takeoff and 65% at landing (Source: Airbus-2004).

Note:

*Tailstrike at landing is addressed in the Flight Operations Briefing Note **Preventing Tailstrike at Landing**.*

The main causes of tailstrikes at takeoff are a non appropriate rotation technique and premature rotations. However, it is usually difficult to determine one specific cause for tailstrikes. In fact, tailstrikes involve several contributing factors and often occur in adverse weather conditions (e.g. crosswind, turbulence or windshear).

II.2 Operational Consequences

Flight crewmembers may not always be aware that a tailstrike has occurred at takeoff, because the impact may not be felt. Analysis of in-service events indicates that, in some cases, the tail scraped the runway, so gently, that it was not detected by the flight crew. In such cases, the flight crew may be alerted of a suspected tailstrike by passengers, cabin crewmembers, crew from other aircraft near the runway, ATC or ground personnel.

As a result, the flight crew will then be aware that the fuselage skin is probably damaged, and that the cabin must, therefore, not be pressurized. Cabin vertical speed therefore may become the same as aircraft vertical speed, which should then be limited for passenger comfort.

Flight at an altitude that requires a pressurized cabin must be avoided, and a diversion to a suitable airport must be performed so that damage assessment can take place.

Note: *In the event of a tailstrike, refer to the applicable FCOM procedure.*

III Operational and Human Factors Involved in Tailstrikes at Takeoff

Analysis of in-service events highlights that the following factors may reduce, when combined, the tail clearance margin (i.e. distance between the aircraft tail and the ground) at takeoff:

- Early rotation
- Rotation technique
- Thrust / Weight ratio
- Slats / Flaps configuration
- Erroneous CG position and trim setting
- Crosswind
- Shock absorber oleo inflation.

III.1 Early Rotation

An incorrect V_R may cause an early rotation, that will lead to an increase in pitch attitude at liftoff and, as a result, a reduced tail clearance.

Analysis of in-service events shows that early rotations can occur when:

- The calculated V_R is not correct for the actual aircraft weight or flaps configuration (for example, computing V_R using the ZFW instead of the actual takeoff Gross Weight)
- There is a mistake in the displayed V_R due to an FMS CDU typing error
- The pilot flying commands rotation below V_R due to gusts, windshear, obstacle on the runway, or confusion in callouts.

Note:

*More information on operational and human factors affecting takeoff speed computation and utilization is available in the Flight Operations Briefing Note **Understanding Takeoff Speeds**.*

III.2 Rotation Technique

Rotation rates that are too fast increase the risk of tailstrike, whereas rotation rates that are too slow increase the takeoff distance and takeoff run.

If the established rotation rate is not satisfactory, the pilot must avoid rapid and large corrections, which cause sharp reaction in pitch from the aircraft.

If, to increase the rotation rate, a further and late aft sidestick (or control column, as applicable) input is made around the time of liftoff, the possibility of a tailstrike is significantly increased. This is especially a risk on aircraft that may have a large inertia (e.g. long aircraft) since the initial rotation rate produced by a given sidestick (or control column, as applicable) input takes time to build up (when the rotation rate has developed, it remains relatively constant for a stick position).

For long aircraft, the sensory feedback provided to the flight crew, during rotation, is different to that provided for shorter aircraft due to the length of the fuselage and its flexibility:

- The aircraft is longer, therefore for a same rotation rate, the local vertical acceleration sensed by the flight crew is higher.
- Due to the flexibility of the aircraft, firstly, the pilot senses a delay in the rotation; then, the sensory effects of the local vertical acceleration are somehow amplified.

This sensory feedback shall not lead the pilot to overact by making large changes in the sidestick (or control column, as applicable) inputs, which lead to potential large pitch oscillations.

III.3 Thrust/Weight Ratio

The possibility of a tailstrike increases during takeoff with low thrust to weight ratios, where the aircraft performance is limited by the second-segment climb gradient.

Heavy aircraft taking off from high altitude airport or in hot conditions are more sensitive to tailstrikes than other aircraft.

III.4 Slats/Flaps Configuration

For a given aircraft weight, a variety of flap configurations are possible. In general, a high flaps configuration decreases the probability of a tailstrike, by reducing the required pitch for liftoff.

For a given configuration, the lower the V_R the higher the risk of tailstrike. The minimum V_R is determined by V_{MU}, therefore, when V_{MU} appears as the limit in the computed takeoff speeds, the tailstrike margin is reduced.

III.5 Erroneous CG Position / Trim Setting

The main purpose of the pitch trim setting for takeoff is to provide consistent rotation characteristics. If, for any reason, the trim setting does not match the CG position, the aircraft will not rotate as usual (**Figure 1**):

- With a forward CG or the pitch trim erroneously set to the nose-down direction, the flight crew will notice that the aircraft is "heavy to rotate", and that aircraft rotation will be very slow in response to the usual takeoff control input
- With an aft CG or the pitch trim erroneously set to the nose-up direction, the flight crew might have to counteract an early autorotation, until V_R is reached.

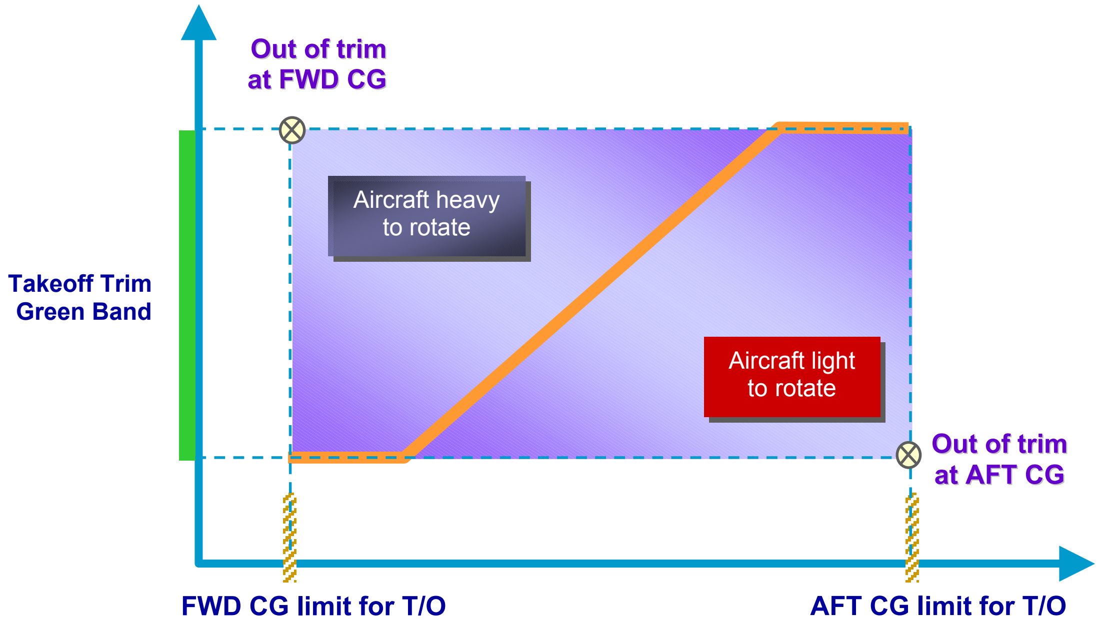

Figure 1

Relationship between Takeoff Trim and Aircraft CG

III.6 Crosswind

In the case of crosswind, the flight crew should minimize lateral inputs on ground and during rotation, in order to avoid spoilers extension. If the spoilers are extended on one wing, there is a reduction in lift combined with an increase of drag, and therefore, a reduction in tail clearance and an increased risk of tailstrike.

III.7 Shock Absorber Oleo Inflation

The correct extension of the main landing gear shock absorber (and therefore the nominal increase in tail clearance during rotation) relies on the correct inflation of the oleos. An under inflated oleo-pneumatic shock absorber will decrease the tail clearance.

IV Preventive Strategies and Lines of Defense

IV.1 Preflight

Takeoff Flaps Configuration

When performance limits the takeoff weight, the flight crew uses the maximum thrust available and select the configuration that provides the highest takeoff weight.

When the actual takeoff weight is lower than the maximum permitted weight, the flight crew uses a flexible takeoff thrust. For a given aircraft weight, several flap configurations are possible. Usually, the flight crew selects the configuration that provides the maximum flexible temperature, in order to increase the engine lifespan.

Note:

The first degrees of flexible thrust have an impact on maintenance costs about 5 times higher than the last one.

The configuration that provides the maximum flexible temperature varies with the runway length. Usually, the highest flexible temperature is obtained with the highest flaps configuration on short runways, but with the lowest flaps configuration if the runway is medium or long (i.e. second segment limitation may be the limiting factor).

Therefore, the optimum configuration for flexible temperature may not be the same as the optimum configuration for tail clearance.

The flight crew should be aware that the highest flaps configuration provides the highest tail clearance.

Rotation Speed (Vr)

Both flight crew members should crosscheck the V_R to verify that the inserted value is the appropriate value for the aircraft weight and configuration. A review of takeoff data is part of the takeoff briefing, and of the briefing confirmation during taxi, that are described and discussed in the Flight Operations Briefing Notes **Conducting Effective Briefings**.

Note:

The verification of the oleo-pneumatic shock absorbers is performed by the maintenance personnel. There are no means to check that the pressure is correct, during the pilot external inspection. However, the flight crew should check for asymmetry between both landing gears, and for any visible hydraulic leak.

IV.2 Crew Rotation Technique

- At V_R, the flight crew should initiate the rotation with a smooth positive backward sidestick (or control column) input in order to achieve a continuous rotation rate of approximately 3°/sec. Avoid aggressive and sharp inputs.

  The higher the inertia of the aircraft is (e.g. long aircraft), the more it is important to initiate the rotation with a smooth positive nose up order.

  Figure 2 indicates the sequence for a standard takeoff. However, flight crewmembers should keep in mind that this sequence can vary depending on the scenario (e.g. windshear), and the PF should be ready to react in any abnormal situation.

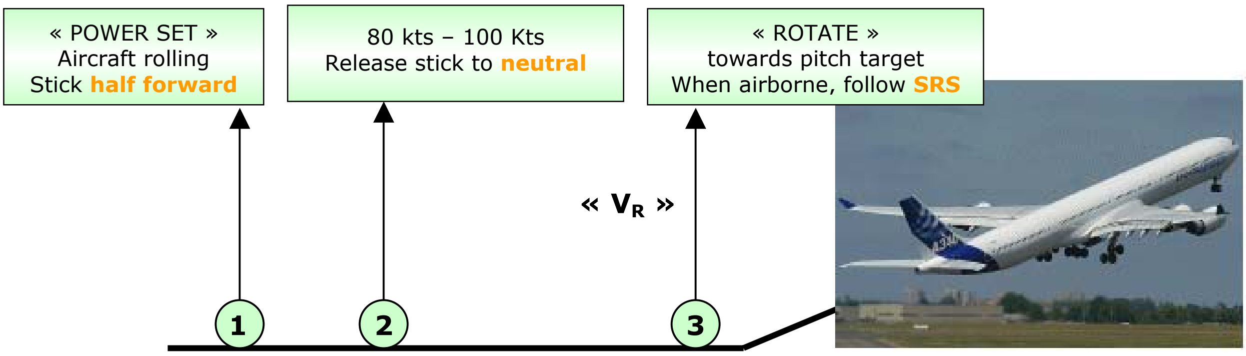

Figure 2

Typical Takeoff Sequence

- If there is crosswind during takeoff, the flight crew should avoid large lateral inputs.
- The PF must perform the rotation mainly head-up, using visual references outside the aircraft until airborne, or at least until the visual references are lost, depending on visibility conditions. The PF must then monitor the pitch attitude on the PFD.

IV.3 Training Programs

Tailstrike prevention should be part of the recurrent training program due to the fact that many flight crew actions can be improved to help minimize the risk of a tailstrike.

Airbus has released a new document, in electronic format called Tailstrike Avoidance e-briefing.

The Airbus e-briefing provides various types of information in a single document, for pilot self-education and/or instructors briefing, including: Text, video (e.g. rotation technique), powerpoint presentations and audios.

Relevant technical data in the Flight Crew Operating Manual (FCOM), such as aircraft geometry limits or pitch attitude after liftoff, also provides an awareness of the aircraft characteristics, which helps to avoid a tailstrike.

V Summary of Key Points

The following key points will help to reduce the risk of tailstrike at takeoff:

- Visually check for any asymmetry between both landing gears and for any visibile hydraulic leak, before the flight
- Carefully crosscheck the takeoff data with other flight crewmember
- Select the appropriate flaps setting option; consider using a higher flaps configuration
- Set (or check) the pitch trim correctly
- Avoid large lateral inputs during rotation
- Rotate at V_R (not before)
- Apply a correct rotation technique, in particular:
  - Perform the rotation mainly using outside visual reference until airborne:

    "Don't chase flight director and don't rotate to excessive attitude"
  - Avoid rapid and large corrections
  - Perform a smooth nose up order, with no additional input at liftoff.

If a tailstrike occurs at takeoff, the flight crew must avoid flying at altitudes that require a pressurized cabin, and perform a diversion to a suitable airport so that damage assessment can take place.

VI Associated Flight Operations Briefing Notes

The following Flight Operations Briefing Notes provide complementary information and can be consulted to obtain a complete overview on the subject of tailstrike avoidance at takeoff:

- **Understanding Takeoff Speeds**
- **Conducting Effective Briefings**
- **Standard Calls**

VII Airbus References

- Flight Crew Operating Manual Bulletins (All Airbus aircraft) – Avoiding Tailstrikes
- A318/A319/A320/A321 & A330/A340 Flight Crew Training Manuals – Normal Operations – Takeoff – Tailstrike Avoidance
- A330/A340 e-briefing – Tailstrike Avoidance

VIII Additional Reading Materials / Websites References

- Flight Safety Foundation – Accident Prevention – May 2005

Note:

This document is available on the Flight Safety Foundation website:
http://www.flightsafety.org/.

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