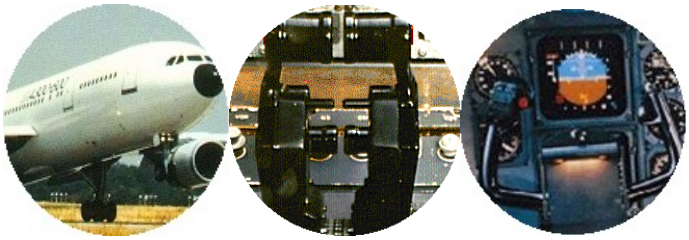

Flight Operations Briefing Notes

Takeoff and Departure Operations

Response to Stall Warning Activation at Takeoff

I Introduction

This Flight Operations Briefing Note provides an overview of:

- The operational guidelines to follow in response to a stall warning at takeoff, for an improved understanding of recovery techniques
- The factors that lead to stall warning activation at takeoff, and
- The corresponding prevention strategies.

Flight crew situational awareness, in the event of a stall warning, is essential to the successful application of recovery techniques. This is particularly true for aircraft that do not have full protection throughout the flight envelope. This heightened awareness is principally necessary at takeoff, when the risk of ground contact exists.

Note:

This Flight Operations Briefing Note is primarily designed for aircraft that do not have flight envelope protection (e.g. A300/A310/A300-600).

However, the key points at the end of this briefing note are also applicable to all aircraft types, with or without flight envelope protection. For this reason, all pilots are invited to read this document.

II Background Information

II.1 Stall Warning Definition

Airworthiness regulations require three levels of protection against stall:

- Adequate speed margin (minimum speed vs. V_{stall})
- Unmistakable recognition of stall qualities (natural or artificial) prior to the real stall
- Acceptable aircraft behavior when stalled (e.g. max bank angle).

Nowadays, if a stall is impending, most aircraft are equipped with such artificial stall warning, as audio alerts (cricket sound) and tactile alerts (stick shaker effect).

A stall warning triggers when the aircraft's Angle-Of-Attack (AOA) exceeds a predetermined value: This value depends on the slat configuration.

The warning indicates the proximity of the aircraft's AOA compared to the stall's AOA (**Figure 1**).

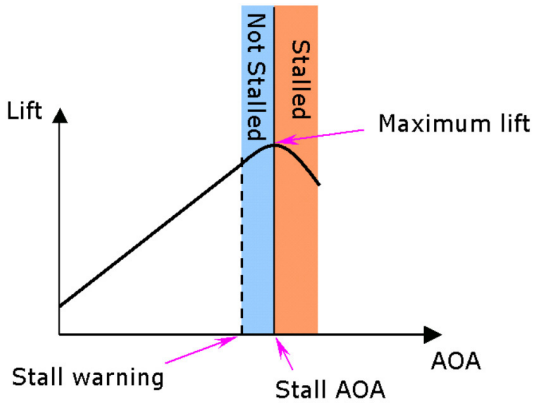

Figure 1

Lift at given Angle-of-Attack

The stall warning is inhibited on ground, until liftoff.

II.2 Operational Consequences

When an aircraft is airborne, stall warning activation can be catastrophic, if the flight crew does not respond correctly and effectively.

Worldwide experience records events where flight crews have been misled by a spurious / untimely stall warning activation at liftoff. Some of them have resulted in fatal accidents (e.g.: rejected takeoff after rotation, CFIT).

III Applicable Standards / Techniques

If a stall warning triggers at a low altitude, the flight crew should consider that there is an immediate flight path threat, and a potential risk of ground contact.

In other words, **there is no time to differentiate between a real or spurious stall warning, and there is no altitude to convert to speed.**

However, when a stall warning triggers (i.e. stick shaker activation), aircraft still have positive climb performance capability.

Note:

An "approach to stall" is a controlled flight maneuver. An aircraft that is stalled is out of control, but is recoverable. Do not confuse an "approach to stall" with "a full stall".

When ground clearance is not an issue, the recommended technique is to recover from the near-stall condition in the minimum amount of time, by applying power and nose down input.

When ground clearance is an issue, the recommended technique is to lose as little altitude as possible, by applying full power and by flying an optimum pitch attitude.

This optimum pitch attitude depends on the aircraft's proximity to the ground:

- **At Liftoff:**

  At liftoff, an optimum pitch attitude of 12.5 degrees is required.

  This pitch attitude is necessary to avoid the risk of ground contact, and ensures an increase in speed, regardless of the aircraft's takeoff weight, center of gravity, type (i.e. A300/A310/A300-600), actual slats and flaps configuration, or if there is an engine failure.

- **After Liftoff:**

  The optimum pitch attitude is a reduced pitch. However, this reduction is no more than necessary to enable the airspeed to increase while there is a risk of ground contact.

Note:

The "Procedures and Techniques" section of the A300/A310/A300-600 FCOMs provides the complete recovery procedure to be applied in the event of a stall warning activation.

An analogy can be made with the guidelines that are provided during flight crew training to be applied in the event of an engine failure:

- Immediate procedure for aircraft control, then
- Performance management.

IV Operational and Human Factors involved in Stall Warning Activation at Takeoff

At takeoff, stall warnings are the result of one, or a combination, of the following factors:

- **Weather Factors:**
  - Icing conditions
  - Windshear.

- **Human Factors:**
  - Insufficient aircraft de-icing in cold weather operations
  - Incorrect loading (e.g. cargo not positioned in accordance with the load and trim sheet, …)
  - Incorrect slats/flaps configuration
  - Incorrect takeoff speed.

- **Flight Crew Techniques:**
  - Early rotation below the specified speed, resulting in a higher peak AOA
  - Maneuvering near the minimum speed at an excessive bank angle
  - Premature retraction of the flaps.

- **Aircraft Systems:**
  - Engine failure and subsequent loss of energy
  - Malfunction of artificial stall warning, leading to spurious stall warnings, caused by a damaged AOA probe, by an AOA probe that is not correctly rigged, or by a computer failure.

V Prevention Strategies / Lines of Defense

The flight crew should pay special attention to the following prevention strategies and “lines of defense”:

- Concentrate on taking action early enough to prevent the occurrence of a stall warning
- Learn how to recognize an “approach to stall”
- During recurrent training, reinforce and confirm the correct flight crew response to a stall warning activation at takeoff.

V.1 Cockpit Preparation – Takeoff Briefing

The Takeoff Briefing should address the following:

- **Clean Aircraft Concept**

  In conditions that are conducive to aircraft icing, the preflight briefing must emphasize the "clean aircraft concept". This concept requires knowledge of:

  – The adverse effects that ice, frost, or snow can have on aircraft performance and on its handling qualities

  – The various ground anti-icing and de-icing procedures, as well as their limitations

  – The necessity to perform walkaround inspections, in order to check for ice accumulation on lifting surfaces.

  Note:

  Airbus brochure "Getting to Grips with Cold Weather Operations" provides additional information concerning the "clean aircraft concept" .

- **Windshear Awareness**

  Flight crews should consider all available windshear-awareness items (Refer to the *Flight Operations Briefing Note* **Windshear Awareness**), assess the conditions for a safe takeoff, and delay takeoff until conditions improve, as warranted.

- **Performance Computation**

  Flight crews should determine the correct performance and takeoff speeds, depending on the prevailing conditions, and they should select the appropriate configuration, power settings, and speeds (Refer to the *Flight Operations Briefing Notes* **Understanding Takeoff Speeds** and **Conducting Effective Briefings**).

V.2 Flying Techniques

During the takeoff roll, the Pilot-Not-Flying (PNF) should be aware of V-speeds, and is responsible for calling out a timely "rotate" at V_R.

On this callout, the Pilot-Flying (PF) should adhere to the standard rotation technique, then follow the FD bars after liftoff.

When the aircraft is above the acceleration altitude, and accelerates above the minimum speed associated with the next configuration (i.e. when there is a positive speed trend on the PFD), the PF should call for slats/flaps retraction. Before initiating the retraction, the PNF should confirm that this condition has been checked.

V.3 Approach to Stall Recognition

The following information should be a part of basic aeronautics:

- **Stall Speed Awareness**

  The stall speeds that are published in the Aircraft Flight Manual (AFM) have been defined for specific conditions (e.g. wings level, normal load factor near 1.0). In other conditions (e.g. excessive bank angle), the stall may occur above the published stall speed.

  Flying at the minimum speed (e.g. V_2) provides a margin with respect to stall, as required by the regulation. However, this margin is reduced when the aircraft is flying under g loads that are greater than 1 g.

  The stick shaker and the stall warning trigger, when the AOA reaches a predetermined value. Therefore, the effect of the load factor is considered to trigger the warning.

  Maneuvering near the minimum speed with an excessive bank angle may therefore lead to a real stall warning activation.

- **Stall Warning Cues at Takeoff**

  As indicated, timely recognition of an "approach to stall" is vital to the successful implementation of the recovery procedure.

  The following alertness factors should be monitored:

  – The speed goes below V_2

  – The speed symbol on the PFD speed scale (depending on the aircraft type) goes below the stick shaker speed displayed as a red and black strip (**Figure 2**)

  – The vertical speed does not increase as expected.

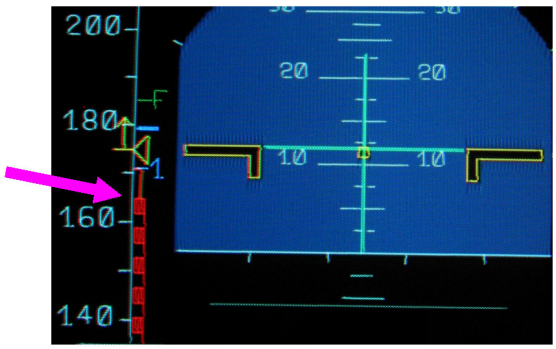

Figure 2

Red and Black Strip Displayed on PFD (e.g. A310/A300-600)

In all stall warning cases, there is a tactile alert (i.e. stick shaker activation) and an aural alert so that the flight crew can feel, and hear the stall warning with enough opportunity to quickly recover aircraft.

V.4 Training Program Outline

The recurrent training program should include a Full Flight Simulator session that takes into account the activation of a stall warning at takeoff. The purpose of such a simulator exercise is for the flight crew to observe and to practice the correct response to stall warning activation at takeoff.

This exercise, proposed in the Airbus standard recurrent training course, should be performed every 3 years.

In addition to the training documentation, the Procedures and Techniques section of the A300/A300-600/A310 FCOM should be used in association with this Flight Operations Briefing Note, as briefing material.

VI Summary of Key Points

Recurrent training for all aircraft types should highlight the following key points, when addressing stall warning awareness and flight crew response to a stall warning activation at takeoff:

- Preventive actions must (ideally) be taken before the stall warning
- At low altitudes, there is no time to distinguish between a real or spurious stall warning, and there is no altitude to convert to speed
- The PF's response must be immediate: Fly optimum pitch attitude (e.g. 12.5 degrees at liftoff) and use maximum allowable thrust
- The recovery maneuver must be continued, until a safe flight path and speed are achieved and maintained.

VII Associated Flight Operations Briefing Notes

The following Flight Operations Briefing Notes can also be reviewed:

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

VIII Airbus References

- A300/A310/A300-600 Flight Crew Operating Manual (FCOM) - Procedures and Techniques - Recovery from Stall Warning
- A310/A300-600 Flight Crew Training Program (FCTP) – Abnormal Operation Briefings – Flight Controls – Recovery from Approach to Stall
- Airbus Brochure: “Getting to Grips with Cold Weather Operations”
- Airbus Brochure: “Getting to Grips with Aircraft Performance”
- Airbus Brochure: “Getting to Grips with Aircraft Weight and Balance”.

IX Additional Reading Materials

The following publications also address events that illustrate this Briefing Note:

- Flight Safety Foundation – Publications - Accident Prevention August 1993
- Flight Safety Foundation – Publications - Accident Prevention July 1998
- Flight Safety Foundation – Publications - Accident Prevention July 2004.

Note:

These Flight Safety Foundation publications can be found on the Flight Safety Foundation website ***http://www.flightsafety.org/ap_home.html****.*

Airbus Customer Services

Flight Operations Support and Services

1 Rond Point Maurice Bellonte - 31707 BLAGNAC CEDEX FRANCE

FOBN Reference : FLT_OPS – TOFF_DEP – SEQ 08 – REV 01 – APR. 2005