KUWAIT AIRWAYS

FLIGHT SAFETY

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KUWAIT AIRWAYS CORPORATION

FLIGHT SAFETY & QUALITY ASSURANCE

Issue 7, May 2006

Introduction

We hope you enjoyed reading the April issue. In this issue, we have a report on the serious incident on A320 and an article on Response to Stall warning activation at takeoff based on Airbus briefing notes. We are certain that you will enjoy reading these.

We look forward to your feedback, suggestions and of course contribution to this newsletter in the form of articles, anecdotes, pictures, etc. which can be sent to the address given below.

A320 Roll Control Problem

Based on BFU Investigation report no. 5X004-0/01 April 2003

At 11:00 hrs UTC on March 21, 2001, an Airbus A320-200 departed from runway 18 of Frankfurt/Main for a flight to Paris, France. 115 passengers and 6 crew members were aboard the airplane. Immediately following the lift-off the airplane assumed a slight bank angle to the left. The commander, who was the pilot flying, tried to correct the attitude by a slight input on the left sidestick. However, the bank angle increased continuously up to approx. 22°. With the commander's call out :"I can't do anything more" the first officer took over the controls with the words " I have control". The First Officer reported that he instinctively made an input to the right on his sidestick, which prevented the bank angle from increasing even further, but did not lead to an improvement of the situation. Only after he had pressed the "TAKE OVER PUSH BUTTON" on his sidestick, he regained full control of the airplane and was in a position to restore the normal flight attitude. He switched on the autopilot no. 2 and had the airplane climb to Flight Level 120.

At FL 120, the crew cautiously checked the behavior of the airplane control system. The autopilot no. 2 was switched off and the First Officer checked the airplane control system with the right-hand sidestick. The airplane reaction was in accordance with the control inputs. Afterwards the pilot-in-command took over the control. He slowly moved the sidestick to one side and after a short shaking movement the airplane unexpectedly moved to the opposite side. When it had become clear that the airplane reaction to control inputs on the left-hand sidestick was opposite to the inputs, the flight was discontinued. The First Officer took over the controls and safely landed the airplane in Frankfurt. The airplane was then handed over to the maintenance organization.

This A320-200 manufactured in 1990, is a fly-by-wire airplane i.e. all control surfaces (elevator, stabilizer, ailerons and spoilers) except for the rudder are controlled electrically by means of an hydraulic actuators. The hydraulic actuators for the rudder are controlled mechanically. In addition there is a mechanical back-up system for the rudder and the stabilizer. Seven computers are provided for the primary control of the airplane:

- Two Elevator Aileron Computers (ELAC) for the elevator and aileron control as well as the control of the SECs to control the spoilers (global roll computation)
- Three Spoiler Elevator Computers (SEC) to control the spoilers and as standby system for the elevator and stabilizer control
- Two Flight Augmentation Computers (FAC) to stabilize the airplane flight attitude, e.g. damping of the Dutch Roll effect in flight, support of the roll control by turn coordination, rudder trim coordination in case of engine failure and adoption of rudder travel function depending on speed.

Two sidesticks - one for the Captain and the other for the First Officer – allow manual control inputs; the two side sticks are not linked mechanically with each other. When the sidestick is moved, the movement is translated into electrical signal which goes to the corresponding computer which generates the command for control surface. For one pilot to take control he/she must depress the take-over push button on the sidestick and

In this issue

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www.atsb.gov.au/

continue to press the button for more than 30 seconds.

After handing over to the maintenance organization, a Flight Control Check was carried out in the presence of the crew, during which the symbols of the ailerons on the ECAM monitor first and for a very short moment moved into the corresponding direction, as if everything were alright, before the ailerons moved into the opposite direction.

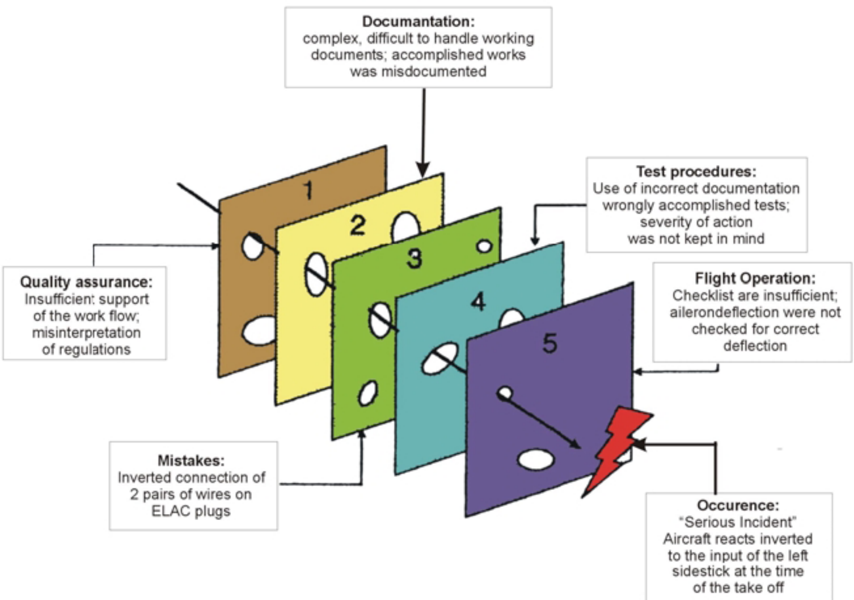
Prior to this flight, the airplane was at the maintenance organization for two days for repair purposes and the entries in the technical log book indicated that all prior reported anomalies had been resolved and that the airplane had been released to service in accordance with regulations.

On several previous flights, problems had occurred on one of the two ELACs. When the computer was replaced, a bent pin, which could not be repaired, was found on the plug of the ELAC no. 1. Therefore the whole plug of the ELAC no. 1 was replaced and rewired. In this process, two pairs of wires were connected inverted, the Command Channel and the Monitor Channel.

The preflight control check by the crew had not shown any anomalies. Nor there were any anomalies during taxi or takeoff run and the problem was found as the airplane was rotated for takeoff.

The BFU – the German Federal Bureau for Aircraft Accident Investigation which investigated this serious incident in its report concluded the following.

The serious incident is due to the fact that during repair work on the plug of the Elevator Aileron Computer (ELAC) no. 1 two pairs of wires had been connected inverted which remained undetected and the error was not recognized by the flight-crew during the "FLIGHT CONTROL CHECK".



The **contributing factors** were:

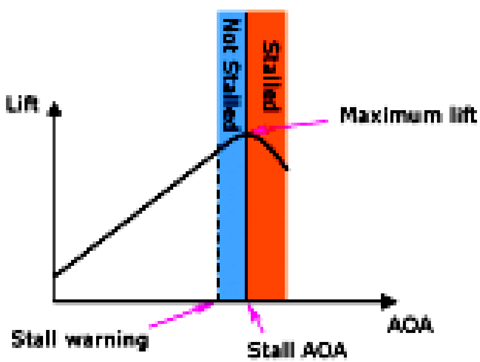
- An unclear and difficult to handle documentation so that a wrong wiring diagram was used
- Diversion from the manufacturer's data by the Maintenance Support
- Manufacturer's instructions which are not formulated unambiguously
- Functional check by the cross checking staff member was carried out incorrectly
- Insufficient functioning of the Quality Assurance
- The lack of supervision of the maintenance organization by the operator
- A quantitatively and qualitatively insufficient supervision of the maintenance organization and the operator by the supervising authority.
- Deficiencies in the "AFTER START CHECK-LIST" for the conduct of the "FLIGHT CONTROL CHECK".

The causal chain that went uninterrupted in precipitating this serious incident is illustrated above in the form of Swiss cheese model modified to a chronological sequence.

Response to Stall Warning Activation at Takeoff

Adopted from Airbus Flight Operations Briefing Notes on the same subject

Airworthiness regulations require protection against stall at three levels namely: adequate speed margin (Vmin vs. Vstall), unmistakable recognition of stall qualities (natural or artificial) prior to the real stall, and an acceptable aircraft behavior when stalled (e.g. max bank angle).



Present day transport aircraft are equipped with Stall Warning Systems which gives audio alerts (cricket sound) and tactile alerts (stick shaker effect) as stall is impending. The Stall Warning System is triggered when the aircraft's Angle-Of-Attack (AOA) exceeds a pre-determined value which depends on the slat con-figuration. The warning indicates the proximity of the aircraft's AOA with respect to the stall AOA. The stall warning is however, inhibited on ground, until liftoff.

Stall Warning Activations at Takeoff are the result of one, or a combination of the following four factors i.e.

- Weather Factors − Windshear, Icing conditions.
- Human Factors − Incorrect takeoff speed
  - Incorrect slats/flaps configuration
  - Incorrect loading (e.g. cargo not positioned as per the load & trim sheet, ...)
  - Insufficient aircraft de-icing in cold weather operations.

- 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 or an incorrectly rigged AOA probe, or by a computer failure.

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).

In the event of a stall warning, the situational awareness by the flight crew is essential for successfully applying the recovery technique. This is very important for aircraft that do not have full protection throughout the envelope. The situational awareness is principally necessary at take0ff, where the risk of ground contact exists. While this note is primarily aimed at aircraft that do not have flight envelope protection i.e. for A300/A310/A300-600, the key points at the end are applicable to all aircraft types with or without flight envelope protection.

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 has a positive climb performance capability. It should be noted that a*n "approach to stall" is a controlled flight maneuver. An aircraft that is stalled is out of control, but is recoverable. "Approach to stall" should never be confused 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,** 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, t**he 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.

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.

The guideline to respond to stall warning is analogous to the guidelines that are provided during flight crew training for an engine failure: i.e. Immediate procedure for aircraft control, and then performance management

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.

Cockpit Preparation – Takeoff Briefing

The Takeoff Briefing should address the following:

- <u>Clean Aircraft Concept</u>

  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 & 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.
- <u>Windshear Awareness</u>

  Flight crews should consider all available windshear-awareness items, assess the conditions for a safe takeoff, and delay takeoff until conditions improve, as warranted.
- <u>Performance Computation</u>

  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.

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 VR. 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.

Approach to Stall Recognition

The following information should be a part of basic aeronautics:

• Stall Speed Awareness

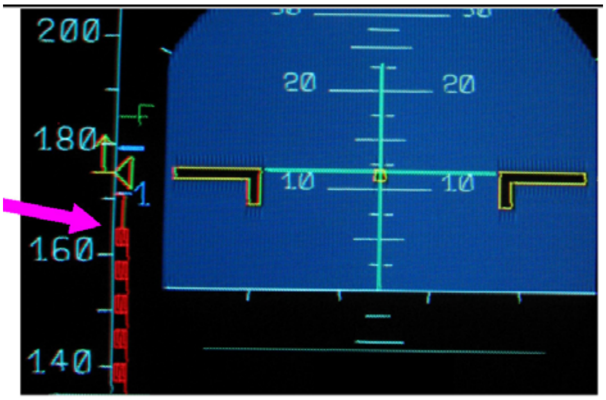
The stall speeds that are published in the Aircraft Flight Manual (AFM) have been defined for specific conditions (e.g. wings level, normal load factor near 1.0). In other conditions (e.g. excessive bank angle), the stall may occur above the published stall speed. Flying at the minimum speed (e.g. V2) 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 V2
− 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 (adjacent figure)
− The vertical speed does not increase as expected.

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.



Red and black strip displayed on PFD(e.g.A310/A300-600)

Training Program

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.

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.

Airbus references

- A300/A310/A300-600 FCOM - Procedures and techniques - Recovery from Stall Warning
- A310/A300-600 FCTP - Abnormal Operation Briefings - Flight controls - Recovery from Approach to Stall

In-flight humour

Pilot - "Folks, we have reached our cruising altitude now, so I am going to switch the seat belt sign off. Feel free to move about as you wish, but please stay inside the plane till we land ... it's a bit cold outside, and if you walk on the wings it affects the flight pattern."

Heard on an Airline just after a very hard landing: The flight attendant came on the intercom and said, "That was quite a bump and I know what ya'll are thinking. I'm here to tell you it wasn't the airline's fault, it wasn't the pilot's fault, it wasn't the flight attendants' fault.....it was the asphalt!"

Web watch

www.planecrashinfo.com - database on air crash and latest accidents including links to accident reports are here, CVR data for some accidents are available in mp3 format, - useful /interesting SITE

The Confidential Aviation Hazard Reporting System (CAHRS) provides a means of reporting hazards and risks in the aviation system before there is loss of life, injury or damage. It is open to anyone who wishes to submit a hazard report or safety deficiencies confidentially and non-punitively. Reports help to identify deficiencies and provide safety enhancement in areas of aviation. CAHRS forms can be collected at different location of KAC (i.e. Flight Dispatch) Premises. Completed forms can be dropped in FS&QA allocated box at Flight Dispatch or e-mailed to kwioe@kuwaitairways.com or faxed to 00965-4749823 or mail to Flight Safety and Quality Assurance office, Operations Department, P.O. Box 394, Safat 13004, Kuwait Airways –Kuwait.