

REPUBLIC OF KENYA

**MINISTRY OF TRANSPORT AND
INFRASTRUCTURE**

**DEPARTMENT OF AIR ACCIDENT
INVESTIGATION**

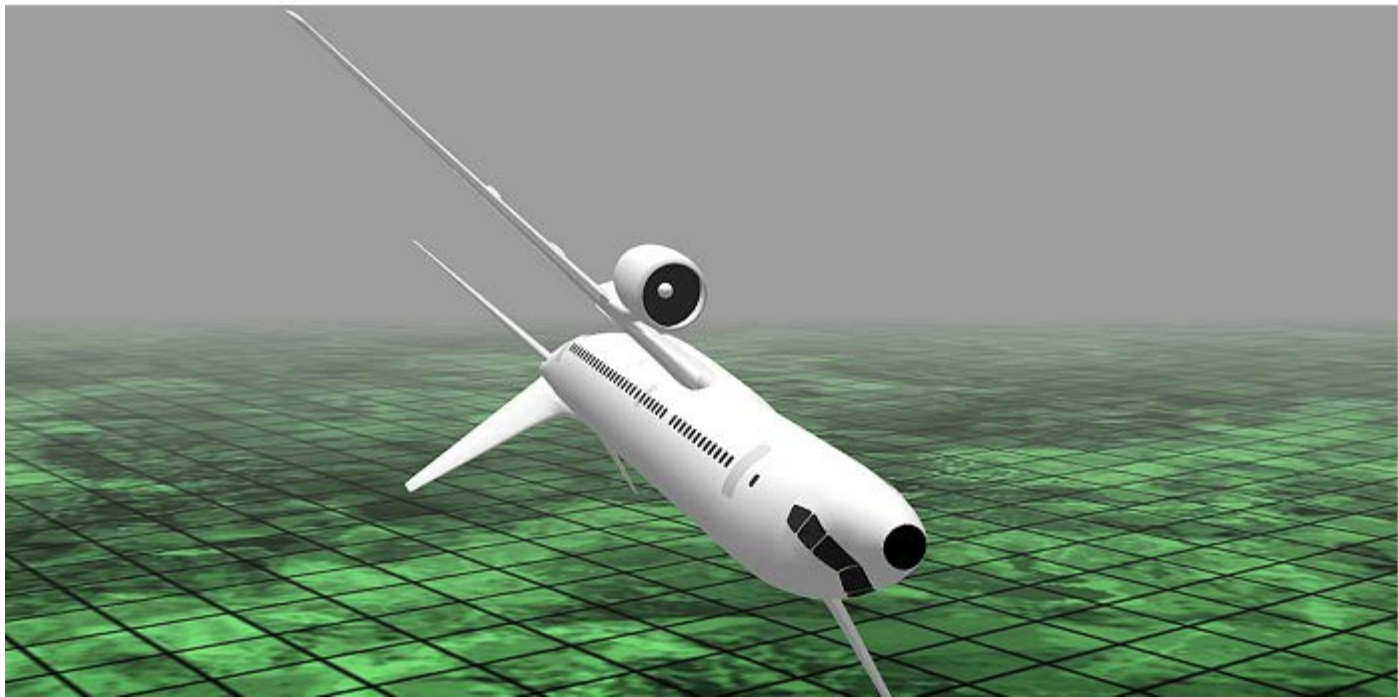
PRESENTER



Colonel Enos Ndoli CEng MRAeS MIEK

Air Accident Investigator
and Lecturer in Aeronautical Engineering
Technical University of Kenya

Airplane Upset Recovery



Airplane Upset

- An airplane in flight unintentionally exceeding the parameters normally experienced in line operations or training:
- Pitch attitude greater than 25 deg, nose up.
- Pitch attitude greater than 10 deg, nose down.
- Bank angle greater than 45 deg.
- Within the above parameters, but flying at airspeeds inappropriate for the conditions.

LOC-I Accidents

- Accidents that result from loss of airplane control have been and continue to be a major contributor to fatalities in the worldwide commercial aviation industry.
- Industry statistical analysis indicates there were 22 in-flight, loss-of-control accidents between 1998 and 2007.
- These accidents resulted in more than 2051 fatalities.
- Data also suggests there are an even larger number of “incidents” where air-planes were upset.

Boeing Statistical Summary

- The information in the previous slide is obtained from:
- “Statistical Summary of Commercial Jet Airplane Accidents, Worldwide Operations, 1998–2007,” Airplane Safety Engineering, Boeing Commercial Airplane Group (Seattle, Washington, USA: July 2008).

Upset Recovery Training

- Several operators have reacted to this situation by developing and implementing pilot training programs that include academic and simulator training.
- Some government regulatory agencies are encouraging airlines to provide education and training to better prepare pilots to recover airplanes that have been upset.



Upset Recovery Training

- Improvement in airplane design and equipment reliability continues to be a goal of airplane manufacturers and others.
- The industry has seen improvements to the point that airplane upsets happen so infrequently that pilots are not always prepared or trained to respond correctly.

KQ Flt 507 Accident

- Let us discuss the following LOC-I accident:

Kenya Airways Flight 507 in Cameroon

KENYA AIRWAYS FLIGHT 507



The aircraft involved in the accident is seen here at [OR Tambo International Airport](#) in January 2007.

Accident Summary

- **Date** 5 May 2007
- **Summary** Pilot error, spatial disorientation
- **Site** Mbanga Pongo, in the Douala III subdivision, 5.42 km south (176°) of the end of Douala Airport runway 12 coordinates: 3.951 N 9.734 E
- **Passengers** 108
- **Crew** 6
- **Fatalities** 114 (all)
- **Survivors** 0

Accident Summary

- **Aircraft type** [Boeing 737-8AL](#)
- **Operator** [Kenya Airways](#)
- **[Registration](#)** 5Y-KYA
- **Flight origin** [Port Bouet Airport](#)
- **Last stopover** [Douala International Airport](#)
- **Destination** [Jomo Kenyatta International Airport](#)

SYNOPSIS

Flight KQA 507 left Abidjan to Nairobi with a scheduled one hour stop in Douala. The scheduled departure from Douala was 2200. Departure was delayed for approximately one hour due to weather and eventually took off at 2306. The aircraft was serviceable for the flight. At the time of departure there was rain and some thunderstorms in the vicinity of the airport. On lift off there was a perceptible tendency of the aircraft to roll to the right, which was easily corrected by the pilot flying through a left aileron input which stopped at 1000 feet. The aircraft started a slow uncommanded roll to the right which was not checked by the crew. Control inputs resumed at 2700ft and 34 degrees of right bank. The pilot's inputs were erratic, leading to excessive bank angle and a rapid loss of height. The aircraft crashed after a spiral dive and was completely destroyed killing all on board.

Probable Cause

- The investigation by the Cameroon Civil Aviation Authority (CCAA) determined that the pilots failed to notice and correct excessive bank following takeoff. This led to the loss of control and crash of the aircraft.

Contributing Factors

- The CCAA determined the probable causes of the crash to be "**loss of control of the aircraft as a result of spatial disorientation...** after a long slow roll, during which no instrument scanning was done, and in the absence of external visual references in a dark night.
- Inadequate operational control, lack of crew coordination, coupled with the non-adherence to procedures of flight monitoring, confusion in the utilization of the autopilot, have also contributed to cause this situation."

Crew Details

- **PIC** 52 years old
- 8,500 hours on jetliners
- In the airline for 20 years

- **FO** Aged 23 years
- Total flying time 831 hours
- had joined the airline one year before the accident.

Piloting of the Airplane

- After the aircraft had climbed to 1000 feet, with the autopilot off, there was no control input from the PIC or the FO for 55 seconds.
- The behavior of the flight crew during these 55 sec demonstrates a lack of rigor in piloting, non-respect of the repartition of tasks on board, confusion in the use of the AFDS, and poor situational awareness.

PILOTING

- As the airplane's right bank angle slowly increases, the captain appears unaware of the airplane's changing attitude. As the bank angle increases beyond 35 degrees right, the captain utters an expression of surprise and the Bank Angle warning alarm sounds.
- The captain resumes control activity and suddenly turns the roll wheel first to the right, aggravating the bank angle.

PILOTING

- Confused movements of the control wheel diminish during 5 seconds, and the bank angle stabilizes at 50 degrees.

PILOTING

The Captain is not apprehending the rate of correction by the AP in mode CMD, and resumes his confused movements of the flight controls, forcing the AP to switch to mode CWS Pitch. These inputs are mostly to the right on both the roll wheel and the rudder, which accordingly aggravates the situation. Since he does not apprehend the reactions of the airplane, he thinks he has lost control of the airplane and cries out “we are crashing”; the FO confirms “Right, yeah, we are crashing, right”; the Captain then aggravates the situation further notably by a prolonged input of right rudder.

PILOTING

The bank angle reaches 90 degrees to the right and is increasing further, the pitch decreases suddenly and the airplane enters into a spiral dive. The FO tells the Captain to level the wings by the right, then quickly corrects himself and says with insistence “Left, Left, Left Captain”.

PILOTING

The FDR indicates conflicting actions on the flight controls at this moment, with the captain applying right wheel and nose up column while the FO counters with left wheel and nose down column. The FO's action is corrective while the captain's action is aggravating, but the situation is already beyond redemption.

Piloting

The reaction of the captain indicates a case of spatial disorientation (non recognized or subtle type), resulting from a long slow turn without monitoring of the EADI, with no exterior visual reference in a dark night transitioning to a case of recognized spatial disorientation as the airplane's right bank angle increased beyond 35 degrees.

Recovery Techniques

High-Bank-Angle Recovery Techniques

- Recognize and confirm the situation
- Disengage autopilot and autothrottle



Figure 3-B.75

Recovery Procedure

The consequences of the disorientation are further aggravated by poor repartition of tasks on board and non-application of the recovery procedure as stated in the company QRH approved by KCAA.

Recovery Procedure

The procedures call for the following:

<ul style="list-style-type: none"> • <i>Recognize and confirm the situation</i> 	<ul style="list-style-type: none"> • <i>On noticing the excessive right bank angle the pilot flying exclaimed and then proceeded to apply a right wheel thereby increasing the bank angle</i>
<ul style="list-style-type: none"> • <i>Disconnect autopilot and autothrottle</i> 	<ul style="list-style-type: none"> • <i>Autopilot was engaged when the bank angle was beyond 45 degrees.</i> • <i>Autothrottle was not disconnected</i>
<ul style="list-style-type: none"> • <i>Roll in shortest direction to wings level</i> 	<ul style="list-style-type: none"> • <i>Application of elevator with bank angle in excess of 90 degrees.</i>
<ul style="list-style-type: none"> • <i>Recover to level flight</i> <ul style="list-style-type: none"> ○ <i>Apply nose up elevator</i> ○ <i>Apply nose up trim if required</i> ○ <i>Adjust thrust and drag as required</i> 	<ul style="list-style-type: none"> • <i>Sustained application of right rudder during the upset.</i>
<p><i>The pilot monitoring is supposed to call out any deviations and any omissions throughout the recovery.</i></p>	<p><i>The pilot monitoring did not call any deviations until very late into the upset</i></p>

*There is a warning stating: **EXCESSIVE USE OF PITCH TRIM OR RUDDER MAY AGGRAVATE AN UPSET SITUATION OR MAY RESULT IN LOSS OF CONTROL***

SPATIAL DISORIENTATION

- Spatial disorientation is the divergence between the perceived orientation and the actual orientation in relation to the surface of the earth.
- Spatial disorientation:
 - is a normal consequence of the forces related to flying
 - is inevitable in case of the absence, or non-observance of precise visual references
 - may involve illusions in the pitch, roll or yaw axis.
 - is felt by most pilots at one moment or another
 - most often involves illusions of bank.

SPATIAL DISORIENTATION

Recovery from Disorientation

It has been estimated that when a pilot is subjected to disorientation in an environment that lacks external visual references, 10 to 35 seconds may be necessary for the pilot to recover completely from the situation.

Aggravating Factors to Spatial Disorientation

- Distraction
- The to and fro movement of sight between the interior and exterior of the cockpit
- Flight maneuvers
- Fatigue
- Medical condition

RECOVERY FROM THE UPSET

It is clear that the crew did not properly assess and respond to the upset as stipulated in the procedures. The circumstances surrounding this flight suggest reasons for failure to recover from the upset would be either lack of training and/or lack of situational awareness due to spatial disorientation

SAFETY RECOMMENDATION

4.2 Training

It is strongly recommended that all flight crew receive formalized upset recovery training.

THE END

