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Bureau d'Enquêtes et d'Analyses
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"Investigation: A Shared Process"

Hands across the sea: Teamwork in the cause of aviation safety

Sébastien DAVID
Senior Safety Investigator, BEA, France

Sébastien graduated in 1997 as an engineer from the French National Graduate School of Civil Aviation and joined the BEA Engineering Department in 1998 to work initially on flight recorder readouts and performance studies. He then worked as safety investigator for the BEA and during his career with BEA he has participated in many major investigations as accredited representative, recorders, operations and human factors working group leader and Investigator-in-Charge. He also holds a CPL, has been type rated on Dassault Falcon 7X and holds a Masters degree in Human Factors.

Léopold SARTORIUS
Senior Safety Investigator, BEA, France

Léo joined the BEA Engineering Department in 2002 immediately after graduating as an engineer from the French National Aeronautical Construction Graduate School. He was initially deeply involved in the development of the BEA's in-house flight data analysis software, and since 2003 has participated in numerous international investigations as flight recorder, performance or systems group leader and as accredited representative. He was recently named head of the Flight Recorders and Avionics Systems division. He holds a PPL and has a Masters degree in Human Factors.

Zone Sud – Bâtiment 153
200 rue de Paris
Aéroport du Bourget
93352 Le Bourget Cedex
France
Tél. : +33 1 49 92 72 00
Fax : +33 1 49 92 72 03
www.bea.aero

On 27 November 2008, the Airbus A320 registered D-AXLA operated by XL Airways Germany crashed into the Mediterranean during approach to Perpignan airport in the south of France. There were no survivors among the seven aviation professionals on board. Apart from a few pieces of wreckage, most of the airplane sank within minutes. The flight crew had lost control of the aircraft while demonstrating - rather than checking - the functioning of the aircraft's high angle of attack protections.

The BEA launched a safety investigation that involved several investigation authorities from around the world. In accordance with French law, a parallel judicial investigation was conducted under the responsibility of an examining judge, working with judicial experts and the Gendarmerie.

This safety investigation clearly emphasized the need to coordinate and to share information, not only within the safety investigation team but also, to different degrees, with the judicial authorities. It also showed the need to take into account the right of the families of victims to be informed as well as media expectations. It illustrates that a safety investigation is a challenging experience, demanding not only technical skills but also effective communication in order to facilitate work with a large number of organizations.

Tail of the A320 D-AXLA

The inherent pressure linked to the accident

Over the years, a number of measures have been adopted under ICAO auspices to organize accident investigations and, since 1994, incident investigations. The general organization of safety investigations is codified and Annex 13 provides a framework for multi-lateral cooperation between States.

However, ICAO international norms and recommended practices leave scope for interpretation as they have to be transposed into national laws. The interpretations made by States are mainly driven by cultural considerations and this may result in slight differences in the way safety investigations are conducted. As ICAO Annex 13 cannot take into account all the challenges that have to be faced, notably during the first few days after an accident, safety investigators need to adapt to unique situations.

The accident airplane was owned by Air New Zealand (ANZ) and crashed exactly twenty-nine years after an ANZ DC10 hit Mount Erebus, in Antarctica. The Perpignan accident, which caused the death of five New Zealanders, generated very high media pressure in New Zealand that had an impact on the safety investigation.

In this context the request by TAIC, New Zealand's investigation authority, to participate in the investigation was accepted by the BEA. The TAIC Accredited

Representative asked for assistance from the AAIB and AccReps from the BFU, State of Registry and the Operator of the aircraft, and the NTSB, State of Design of the aircraft's engines also joined the safety investigation team.

As a result, five investigation authorities were associated with this investigation. The four AccReps were assisted by Advisers from:

- XL Airways Germany and Air New Zealand;
- Goodrich and International Aero Engines.

Air New Zealand livery and XL Airways Germany registration

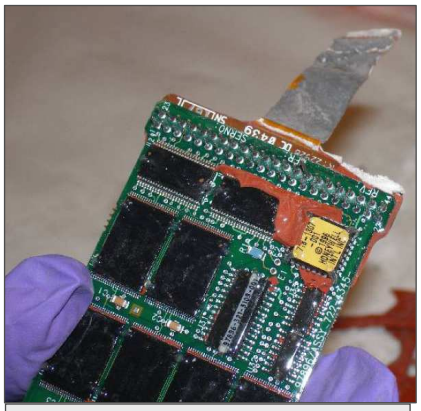
The BEA was assisted by Airbus, the DGAC and EASA, as well as the maintenance organization, EAS Industries. In the end, the safety investigation team was composed of about 25 people and numerous challenges appeared as soon as the investigation started, generated by external pressure.

If an aircraft accident in which people are fatally or seriously injured occurs in French airspace or territory, a judicial investigation is undertaken in parallel to the safety investigation. These two investigations have totally different objectives: the judicial investigation aims in the first instance to determine responsibility. In France, although these two investigations are independent, they have to work with the same factual information. Regular coordination between the Investigator-In-Charge and the judicial authority is then needed. The safety investigation must remain objective and totally impartial and must also be perceived as such, as defined in European Regulation n°996/2010 .

The Flight Recorders were found within three days of the accident and handed over to the BEA on 30 November 2008. Despite many attempts to read out both recorders using different types of independent equipment, we could not safely recover the recorded data.

FDR CSMU

The flight recorders' electronic boards remained in the custody of the judicial authorities, whose agreement was therefore necessary to perform any work on them. After much delay, they were finally examined in the manufacturer's facilities in the United States on 5 and 6 January 2009, in the context of an International Commission of Inquiry. Short-circuits and damaged components were discovered on the boards and eliminated, allowing full data recovery from both recorders. The recordings were of good quality and the whole flight was included. Nevertheless, the fact that it had not been possible to read out the data from the two recorders added some pressure on the safety investigation team and hampered the progress of the investigation.



FDR electronic board

Waiting for action via the International Commission of Inquiry could also have had an impact on aviation safety. In February 2009, the Flight Safety Foundation sharply criticized the interference of prosecutors in ongoing aviation accident investigations in Italy and France, warning that such interference impedes efforts to improve aviation safety and prevent similar accidents in the future. Article 12 of European regulation n°996/2010, which came into force at the end of 2010 for all European Union States, two months after the release of the Final Report, clearly takes into account this aspect by stating that if an agreement from the judicial authority is not obtained "within a reasonable time and not later than two weeks following the request, it shall not prevent the investigator in charge from conducting the examination or analysis" of the flight recorders.

Need for cooperation and technical partnership

Apart from the pressure linked to the media, the judicial investigation and all the organisations involved in the safety investigation, the context of the flight also made the investigation more complex.

During a typical scheduled commercial flight, the management and the conduct of the flight are well defined by procedures and teamwork. This accident occurred during a non-revenue flight, in the context of the return to its owner, Air New Zealand, of an A320 leased to XL Airways Germany. The leasing agreement specified that maintenance and painting operations would be carried out, as well as what was called a "test flight".

It was established in this agreement that the programme for these flights should be in accordance with "Airbus Check Flight procedures". However, it became clear that check flights of this type are not described in the manufacturer's manuals or documentation. ANZ submitted a program to XL Airways Germany of in-flight checks developed on the basis of the program used by Airbus for customer acceptance flights. The airplane transfer flight, in May 2006, for its delivery to XL Airways Germany was already based on this ANZ program, which was to be used during the flight before return to ANZ.

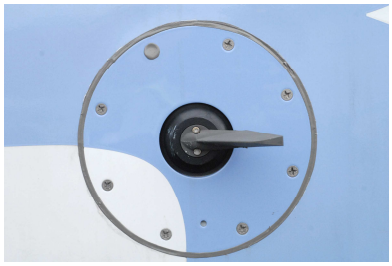
The flight crew consisted of two qualified pilots from XL Airways Germany. However, they did not have the training, experience and methods required to perform the planned flight program, even if this was not defined as a test flight. An ANZ pilot, who was in the cockpit, participated actively in following the programme of checks. This programme specifically included a check of the functioning of the high angle of attack protections, but was not identical to the Airbus programme concerning the altitude range at which this check should be carried out.

The maintenance and painting work had been carried out and checked on the premises of an approved EASA Part 145 workshop, EAS Industries. In order to eliminate the dust that had settled on the fuselage, a rinse with cold water was carried out three days before the accident without following the applicable procedure - and specifically without protections on the angle of attack sensors.

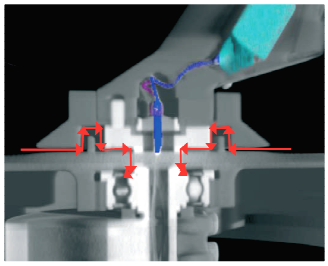
On 27 November 2008, the airplane took off at 15 h 44.

In France, flights of a specific nature are subject to advance permission from ATM services, without which the flight may be subject to real time modifications or may be refused. The official AIP request procedure was not followed, though the Captain had informally asked Perpignan ATC on the morning of the accident if the planned flight required specific airspace. The Perpignan TWR controller suggested that this was not necessary. However, during the flight, the French southwest ACC controller refused the requests from the crew to perform some manoeuvres, given that the filed flight plan did not include them. The crew then adapted the programme of checks in an improvised manner according to the constraints imposed by the flight plan and ATC.

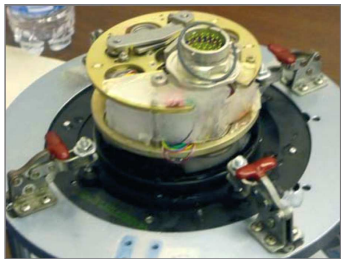
Two of the three Angle of attack sensors, located symmetrically on each side of the fuselage, stopped moving at identical values during cruise when water present inside the sensors' casing froze. It was later demonstrated that the application of a high-pressure jet of water onto an airplane without following the recommended procedure can allow penetration of a small quantity of water into an angle of attack sensor, and that this would be sufficient, when frozen, to block it.



Angle of Attack sensor on aircraft



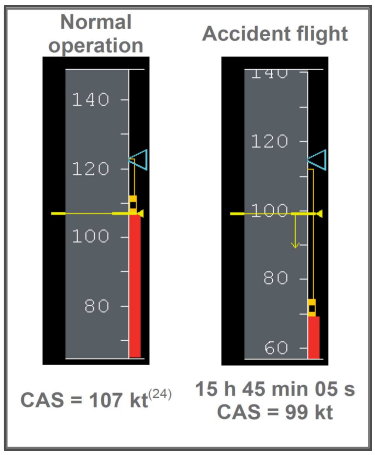
Route of water penetration following specific rinsing conditions



Amount of ice in the housing of the Angle of Attack sensor after the water exposure test

Water exposure test performed in the context of the investigation

At an altitude of about 4,000 feet during the approach the crew improvised the check on the angle of attack protections in normal law. However, the blockage of the two angle of attack sensors at identical values had inhibited the functioning of these protections and led to an erroneous display of the characteristic speeds identifying these protections.



The crew reduced thrust to allow the speed to decrease and, somewhat passively, waited for the protections to trigger. The stall warning eventually sounded, in normal law, at an angle of attack close to the theoretical stall angle of attack in landing configuration, indicating that the third angle of attack sensor was functioning at that time. The Captain reacted in accordance with the approach-to-stall technique, by increasing engine thrust and reducing longitudinal pitch.

Shortly after this, the flight control law changed from normal to direct. The autotrim system, which had progressively moved the horizontal stabiliser to the full pitch-up position during the deceleration, was no longer available. Under the combined effect of the thrust and the increase in airspeed, the airplane was subject to a pitch-up moment that the Captain was not able to counter. He did not make any inputs on the trim wheel nor commanded a sustained engine thrust reduction. He lost control of the airplane and, after having reached a pitch attitude over 50° nose up and having climbed about 1,000 ft, the airplane began to descend and eventually crashed into the sea.

Promoting a comprehensive systemic approach

For many years now a systemic approach has been adopted in the conduct of safety investigations in order to "identify the underlying causes in the complex air transportation system" (ICAO Circular 240-AN/144). The D-AXLA accident resulted from a combination of factors:

- latent failures, which existed since well before the accident;
- active failures, whether a few days before or in the last few seconds of the flight, during painting operations and planning, preparation, management and conduct of the flight.

The actions and decisions of the crew during the accident flight revealed in particular the following latent failures:

- the decision in 2006 to perform so-called "test flights" for the handover of the airplane within the framework of the leasing agreement;
- the decision to use a manual used by Airbus for A320 customer acceptance flights as the reference to draw up the programme described in the leasing agreement;
- a lack of training specifically adapted to this type of flight;
- a lack of regulations regarding non-revenue flights;
- a deficiency in the qualification process for on-board equipment.

The inappropriate rinsing of the airplane at the end of painting operations was an active failure that revealed a latent failure in the equipment qualification process. Indeed, it was noted that for impermeability tests, undertaken for the qualification of the equipment, the installation conditions could be different from those on the airplane. Even if this difference with real operating conditions was not a contributing factor in the accident, it certainly constituted a safety loophole.

Accidents seldom originate exclusively from errors by front-line operators but accident causation usually concerns a limited number of components in the air transportation system. For example, an accident can be qualified as an "operational accident" and the systemic approach consists mainly of finding the interaction of latent and active failures within the operational area. In the

case of the atypical nature of the D-AXLA accident (airplane of French design, equipped with American angle of attack sensors, operated by a German airline and owned by a New Zealand operator), the systemic approach to the investigation required continuous coordination between all investigation authorities and organizations involved in the safety investigation. It also required sharing all available information and regular consultations. The investigation authorities and the operators, manufacturers and regulators all had to work extensively. Accredited Representatives and their Advisers therefore all participated effectively during the investigation process and for the consultation phase and contributed to the quality of the Final Report.

Publication of the Final Report

Wishing to be as effective as possible, the BEA sent the draft Final Report for consultation and planned a three-day meeting with all the AccReps (without Advisers) at the end of the sixty days to discuss their initial observations. A few days after this meeting, an amended draft Final Report was sent to the AccReps who were asked to send their official comments as soon as possible. The aim of this shared process was firstly to ensure there was no misunderstanding in the draft Final Report or in the comments received by the BEA. This resulted in the Final Report being improved by consensus. Only one comment had to be appended to the Final Report.

This clearly demonstrates the need for technical *and* communication skills in order to facilitate work with an investigation team made up of a large number of international organizations. It demonstrates to the international community that a joint effort by all the investigation authorities involved (AAIB, BEA, BFU, NTSB and TAIC) benefits the cause of aviation safety. It also underlines the content, the recommendations and the lessons learnt from the investigation, compared to a report with many appended comments.

The consultation phase showed cultural differences between investigation authorities. ICAO Annex 13 does not clearly detail the exact consultation process. The BEA only provides AccReps with the Draft Final Report and only they make official comments. They may consult their Advisers before commenting. Nevertheless, this case showed that a State might relay others persons' comments on the Draft Final Report - such as from families of victims or lawyers.

Of course, families of victims also need to be informed on the progress of the investigation, which the BEA strived to do. This resulted in presentations on the conclusions of the investigation being developed by the BEA in coordination with the BFU and TAIC in order to be presented to the victims' families in Germany and in New-Zealand the day before the official publication of the Final Report.

It could easily be believed that when a Final Report is published, the safety investigation is closed. In reality, the issuing of safety recommendations represents the beginning of a new shared process, even for the investigation team. Follow-up necessarily implies that the IIC must be kept in the safety loop.

Four safety recommendations were issued in the D-AXLA Final Report. These dealt with non-revenue flights, equipment qualification, consequences of reconfiguration of flight control laws and approach-to-stall recovery techniques

and procedures. Of course, issuing a safety recommendation does not necessarily mean that action will be taken.

Regarding the recommendation on non-revenue flights, the BEA and the AAIB - after a serious incident that occurred during such a flight in England – took coordinated action in jointly demonstrating to EASA the need for better oversight of those flights.

Two years after the D-AXLA accident, EASA issued a Safety Information Bulletin on “Functional Check Flights”, an example of non-revenue flights, which was also the subject of a Flight Safety Foundation symposium and actions from aircraft manufacturers.