



BEA 80

Bureau d'Enquêtes et d'Analyses
pour la sécurité de l'aviation civile

1946 - 2026
80 years of service to air safety

Collective work led by Jean-François Grassineau (†), Bernard Adès, Sébastien Barthe, Ariane Gilotte, Jean-François Vivier.
With collaboration of Jean-Philippe Arslanian.

October 2026 : ebook Version 5.0

CHARLES DOLLFUS PRIZE

2025 Aéro-club de France literary prize - The history of civil aviation



By clicking on this icon, you can return to the e-book summary at any time.



By clicking on these icons distributed throughout this e-book, the reader can access additional content including in particular the investigation files published on the BEA website.

Collective work led by:

Jean-François Grassineau (†), Bernard Adès, Sébastien Barthe, Jean-François Vivier, Ariane Gilotte.

With the collaboration of Jean-Philippe Arslanian.

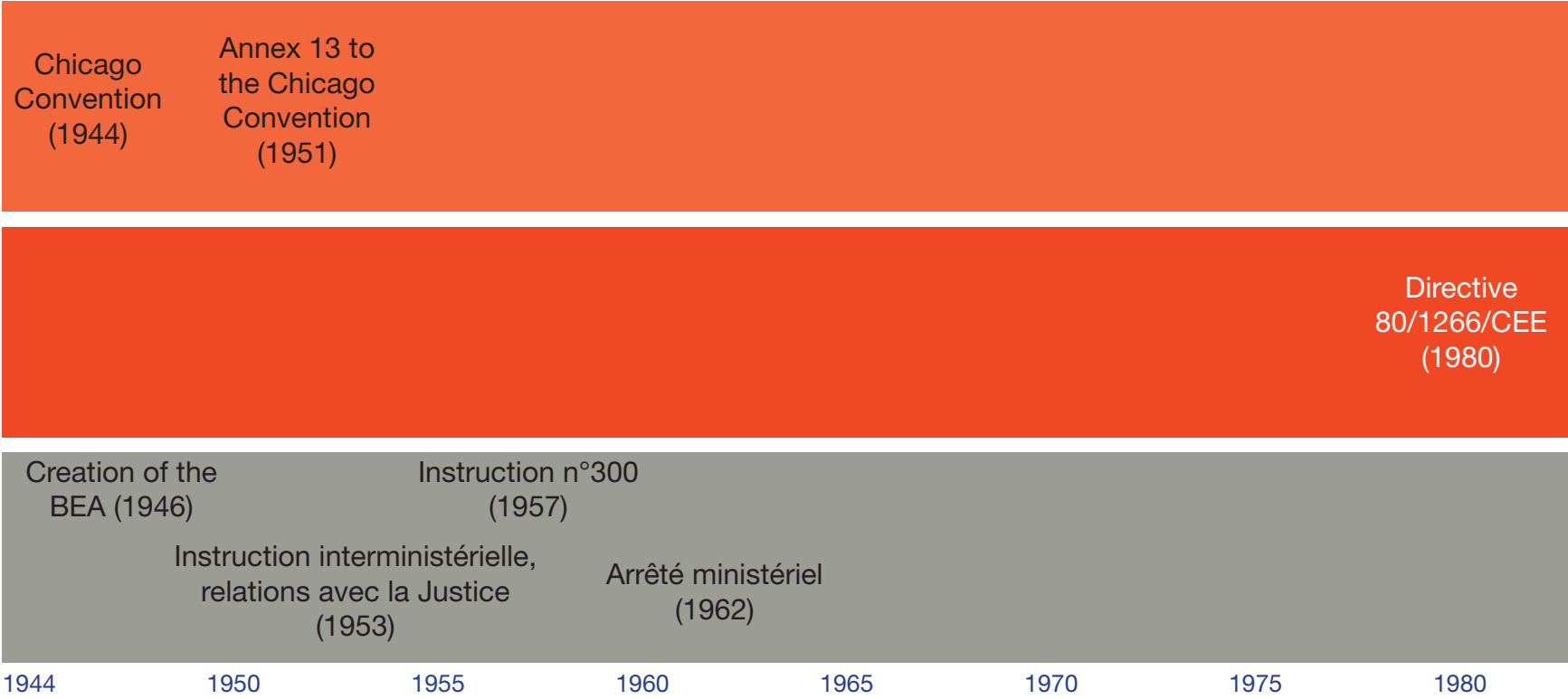
Design, layout, editorial support: Roger Gaborieau - Bleu Ciel Diffusion.

BEA 80

The logo for BEA 80 features the letters 'BEA' in a dark grey, sans-serif font. The '8' is in a bright orange color. The '0' is also in orange and contains a stylized orange airplane icon. A thin orange line curves from the bottom of the '8' and loops around the bottom of the '0'.

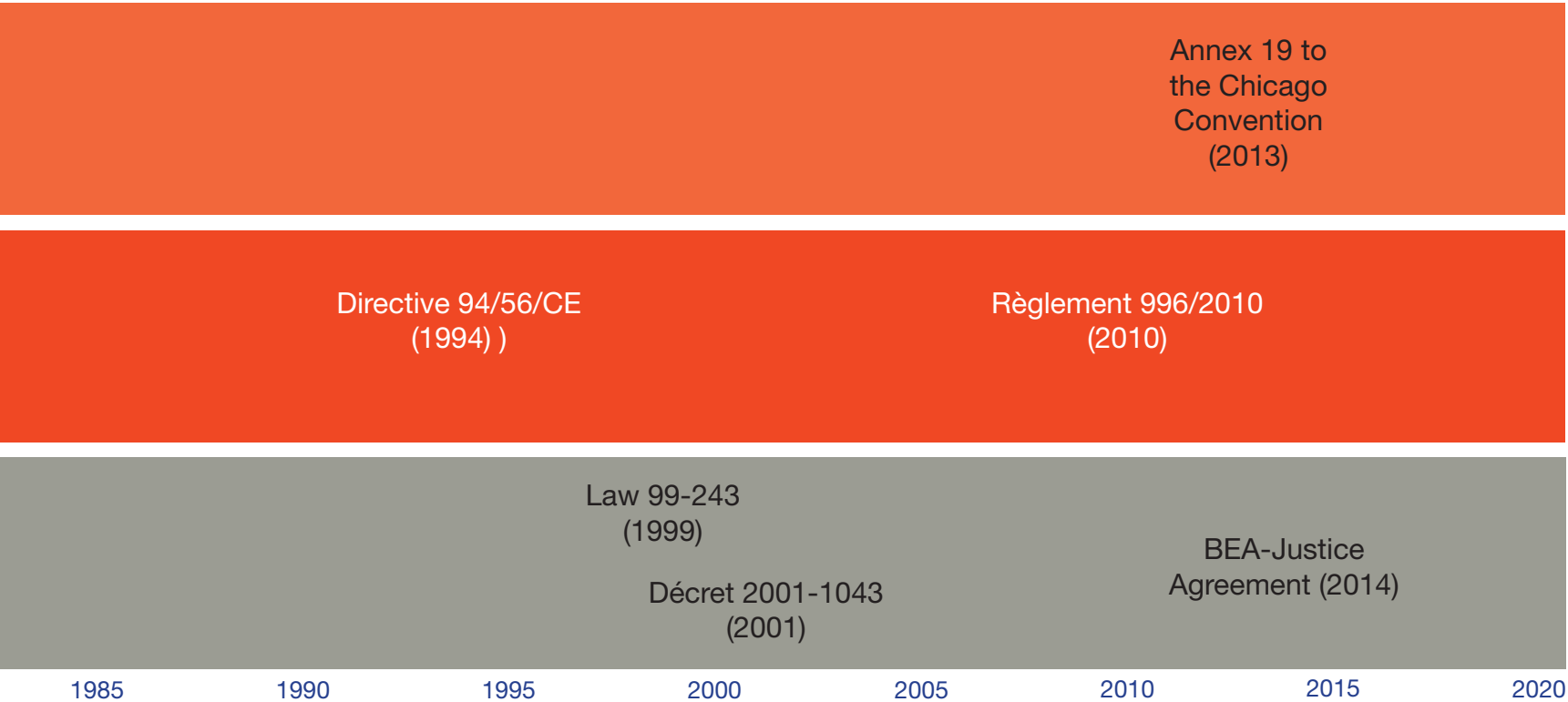
Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile

80 ans au service de la sécurité aérienne

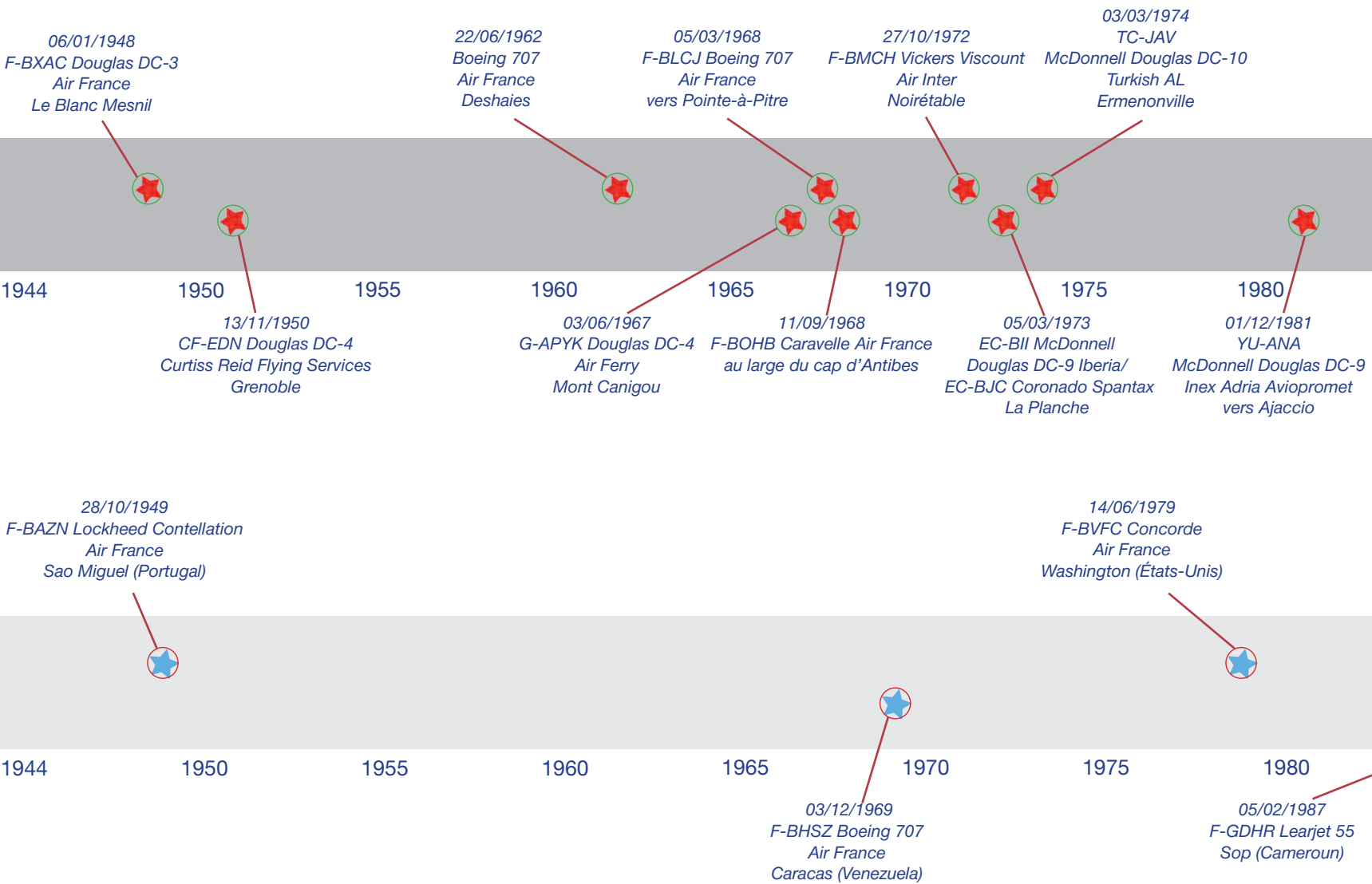


- Main international texts
- Main european texts
- Main national texts



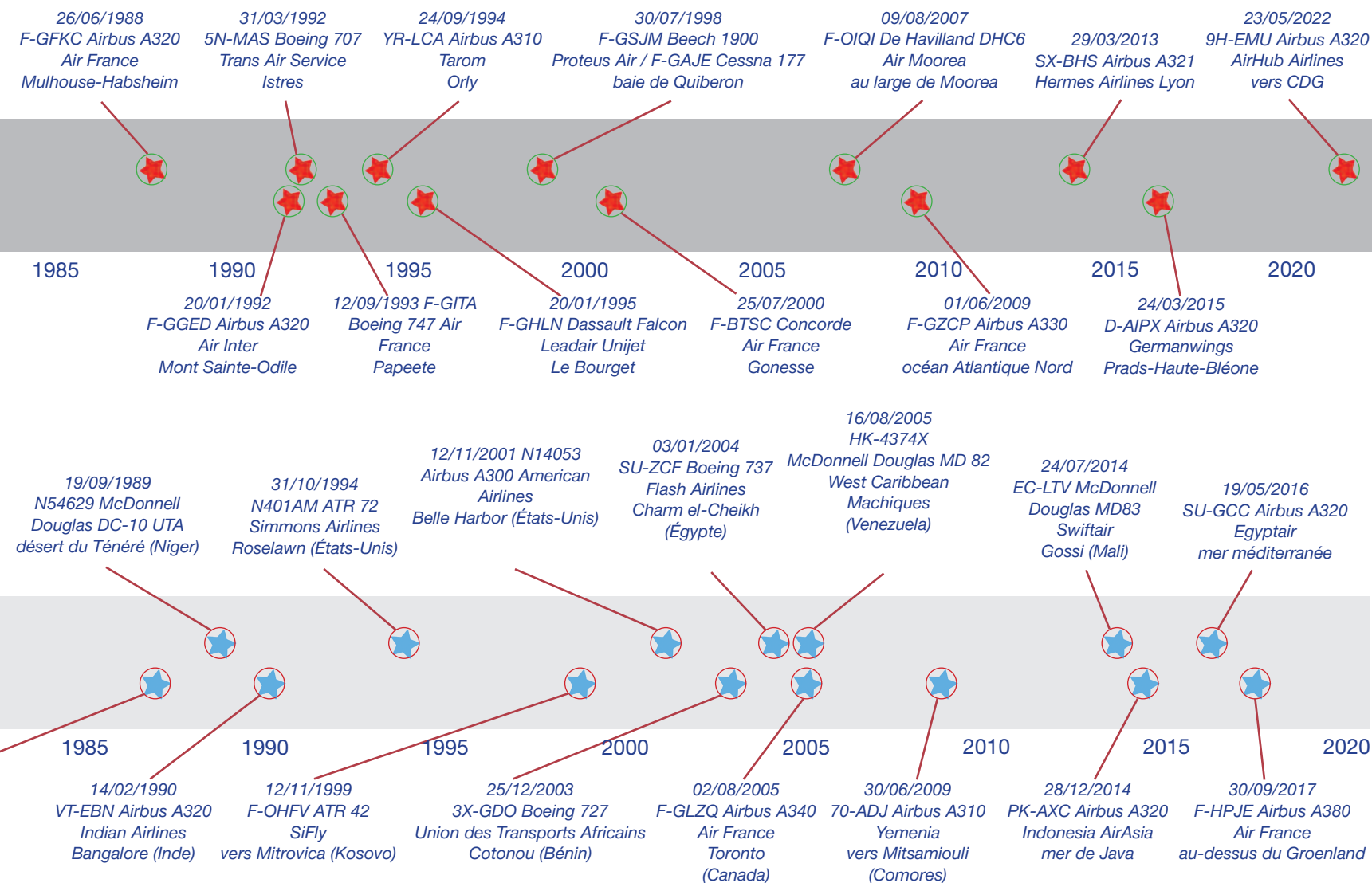


The available investigation reports can be accessed by clicking on the titles of each event mentioned in the timeline.



Selection of investigations conducted by the BEA.

Selection of investigations in which the BEA participated or for which it received an investigation delegation.



Contents

Introduction de l'édition du 80^e anniversaire , par Pierre-Yves Huerre	11
Preface , by Remi Jouty	12
Introduction A short history	15
A very long period of gestation	15
An air safety service	18
Chapter 1 The BEA takes shape	24
The 1990s, a milestone in the history of the BEA	31
The BEA's objectives	35
Preventing accidents	36
The public's need for information	36
The BEA does not assist the judicial authorities	37
The BEA's directors	38
The march towards independence	39
Chapter 2 Resources available to the BEA	46
Real estate	47
Financial resources	50
Human resources	52
Chapter 3 Technical resources for the investigation	54
The laboratory	55
Material analysis	58
Flight recorders	64
The appearance of the CVR	71
When the flight recorders talk	72
Revealed recordings	79
Chapter 4 The safety investigation	82
Three investigation categories	83
Category 1 investigation	83
Accredited representatives	84
Category 2 investigation	87
Category 3 investigation	93
Investigation resources	98
Human resources	99
Material and financial resources	99
Field investigators	106
Directive No. 300	108



Chapter 5 After the safety investigation	116
After the AF447 accident, an international working group	118
Chapter 6 General aviation	126
Specificities of general aviation	127
Poorly controlled activities	131
Importance of human factors in general aviation	133
Relations with sports federations	136
Chapter 7 The BEA and the judicial authorities	144
Difficulties of a double investigation	145
Ministerial directive of 3 January 1953	146
On the ground, friction persisted	147
European harmonization impossible?	158
Chapter 8 The BEA communicates with its partners	160
First missions: investigation reports and the Internet	161
From “Bulletin” to REC	161
When the media apply pressure	162
The era of professionalisation	165
Media frenzy and the investigation timeline	167
Chapter 9 The BEA and international cooperation	184
Inevitably international investigations	185
Collaborating with institutions	185
Collaboration between investigation authorities	186
Chapter 10 In search for flight AF447	192
Postface , by Pierre-Yves Huerre	197
Appendices	198
A few considerations about aviation safety, by Claude Abraham	198
Biography of former BEA directors from 1990 to 2023	200
Regulatory texts	203
Glossary	204
Bibliography and sources	209
Acknowledgements and photo credits	212





Introduction to the 80th anniversary edition

by Pierre-Yves Huerre,

Director since 2024

Over the past 80 years, the world of civil aviation, and in short, the world at large, has considerably evolved yet the BEA's mission remains the same: to improve civil aviation safety through its investigations. Since 1946, the BEA has investigated nearly 7,000 occurrences.

Today, the BEA is recognized worldwide as one of the major aviation investigation authorities; this is the result of a history that has been complex at times, yet always fascinating. This book tells that story through the firsthand accounts of those who played a part in it: directors, staff members, and partners alike.

The evolution described in this book is particularly evident in the major investigations the BEA has conducted throughout its history. Ultimately, however, the BEA's DNA lies in its ability to reinvent itself with every investigation it undertakes.

This 80th anniversary offers a wonderful opportunity to celebrate the dedication, passion, and hard work of the hundreds of men and women who have shaped the BEA and collectively helped make civil aviation an increasingly safe means of transport.

In 2025, this book received the Charles Dollfus Prize from the Aéro-club de France, awarded to the best work on the history of civil aviation.

Enjoy your read, and happy anniversary to the BEA!



Preface



By Rémi Jouty

Director of the BEA from 2014 to 2023

First of all, I'd like to pay tribute to Jean-François Grassineau, who, along with the DGAC's *Mission Mémoire* and the GIACRE, initiated the joint work with the BEA that has led to the publication of this book.

Jean-François Grassineau closely followed the technical and judicial investigations into the *Concorde* accident in 2000 (when he was Deputy Director of the DGAC). He was a fervent defender of the BEA, and very familiar with the subtleties and difficulties of the coexistence of a BEA investigation and a judicial investigation. In fact, he wished to write the chapter devoted to this subject himself. Unfortunately, his state of health did not give him the time to do so, and I would also like to thank the GIACRE alumni who gathered all the documents, illustrations and testimonies and brought the work to a successful conclusion after Jean-François Grassineau's death.

Throughout my career, and even before I joined the BEA, I have been struck by the fact that when two former BEA staff meet, they never fail to evoke, with undisguised pleasure, their memories and the moments that particularly marked them during their life at the BEA. This confirms that the BEA has a special place in civil aviation, and that the history of this service, like the stories told by its agents, deserved to be told. This has now been done with the publication of

this book, which has been eagerly awaited by all BEA agents, past and present, and by all those who have worked with this service. I am convinced that beyond this circle of insiders, this book will be of interest to many aviation enthusiasts, the BEA's mission - to explain an accident based on a wreckage and sometimes the famous black boxes - being both fascinating and still shrouded in a certain mystery even to this day.

After spending the last ten years of my professional life at the head of this organisation, what is my perspective of the BEA's history ?

First of all, I can appreciate just how far we've come, from the small BEA of the early days, with little or no resources, which had to strive to exist despite an uncertain administrative position and legal framework for this entity, which didn't even have an official name in its early days.

Since then, the BEA has naturally seen its resources grow, it has structured its methods and processes, documented its knowledge and technical experience to perpetuate them, and is recognized nationally and internationally. I have nothing but admiration for the BEA's former employees, who worked under difficult conditions, and I must thank them for their efforts and vision, which have enabled the BEA to become what it is today.

I note, however, that the need to understand air accidents, based on technical investigations, and to draw safety lessons from them in order to



prevent similar accidents from happening again, independently of any search for responsibility, was obvious from the outset, and quickly led to the need for a service dedicated to this activity.

Even today, the BEA is recognized by the public at large as well as its foreign counterparts, for the tenacity and determination of its investigators to conclude the investigation, whatever the difficulties. These qualities, which are part of its DNA, certainly stem from those difficult beginnings, and I hope that this book will contribute to perpetuating them.

This history also shows how difficult it is to strike a balance between safety investigations and judicial investigations, given that our country (like others, often with a Latin tradition) is still imbued with the need to find guilty parties after a disaster.

This book shows that this coexistence has often been difficult, sometimes violent, and that at the outset the proponents of the judicial investigation may have sought to deny the very existence of the BEA, or to reduce it to the role of simply providing technical examination and expertise for the sole benefit of judicial proceedings. Today, the BEA's mission - and the fact that it can be carried out separately from judicial proceedings - is accepted by all.

The BEA benefits from a clearer legal framework, thanks in particular to European regulations, relations with the judicial authorities have become more institutionalized and pacific, and mutual

understanding of the prerogatives, constraints and needs of both parties has improved. However, the coexistence of two investigations remains fundamentally delicate, and relations can quickly deteriorate on a particular case, particularly in the presence of high media exposure, which puts all players under pressure, or in the presence of exaggerated individual susceptibilities.

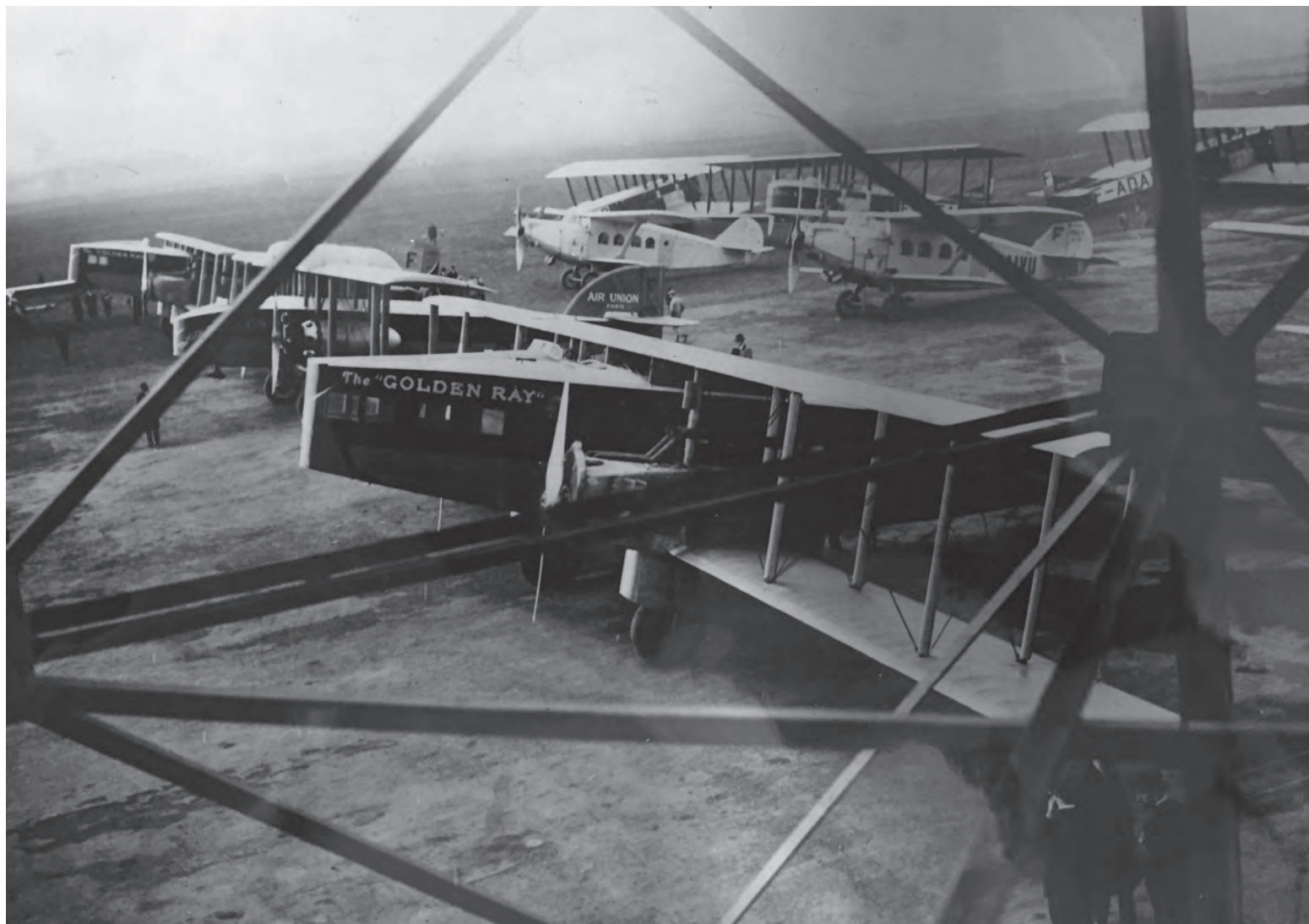
This book is largely based on testimonies and documents provided by BEA investigators, former investigators and directors. We would like to thank them all. At the risk of disappointing readers, the editorial committee had to make choices based on this material, so that the book reflects the different aspects of the BEA and its history in a balanced way.

Likewise, some accidents are not mentioned or only to a small extent, in favour of others that are more fully discussed.

Investigations into recent accidents are given little or no prominence, mainly because of a lack of hindsight and to avoid fuelling or re-fuelling sterile controversies...

The history of the BEA remains a very rich subject, and I hope that in a few years' time a Volume 2, or a new, expanded edition of the present work, will appear. I also hope that the publication of the present edition will encourage those who have not yet done so, to share their testimonies and documents for this future edition.





At the end of the 1920s The LeO-213 "*Golden Ray*" operated by Air Union in front of commercial airline aeroplanes departing from Le Bourget



Foreword

A short history...

Even before aeroplanes had made their first flights, the aeronautical industry, then mainly represented by balloon flights, felt the need to organise this new activity at international level to ensure the best possible safety. With the advent of the first international commercial passenger flights, safety became a matter for specialists, particularly when unfortunately but inevitably, accidents occurred. These experts built up a long history of safety investigations, culminating in today's Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile (BEA), whose international reputation places it among the most experienced. But structuring it was long and administratively chaotic.

A very long period of gestation

As early as 1905, the *Fédération Aéronautique Internationale* (FAI), based on the French non-profit-making associative model, laid down the principles of aviation regulations, notably for sporting events and records, and the promotion of safety measures.

While the First World War revealed aviation as a weapon of war, it was also the scene of rapid technical progress, and as soon as the armistice was signed, civil aviation turned to national and international public transport.

On 8 February 1919, Lieutenant Lucien Bossoutrot flew the first twelve fare-paying air passengers

in history between Paris and London aboard a Farman *Goliath*, a bomber converted into an “air limousine”. A new transportation revolution was underway. From then on it was possible to travel by plane on regular routes, governed by timetables and managed by commercial companies called “airlines”. These companies were committed to providing passengers with regular, comfortable and safe flights.

For his first flights over the Channel, Lucien Bossoutrot would fly at 2,000 m, an altitude that would enable him to glide back to land in the event of engine failure. The *Goliath* was designed



to hold a level flight attitude should it lose one of its two engines. Flight safety thus became an integral part of the “scheduled flight” culture, and one of its major concerns.

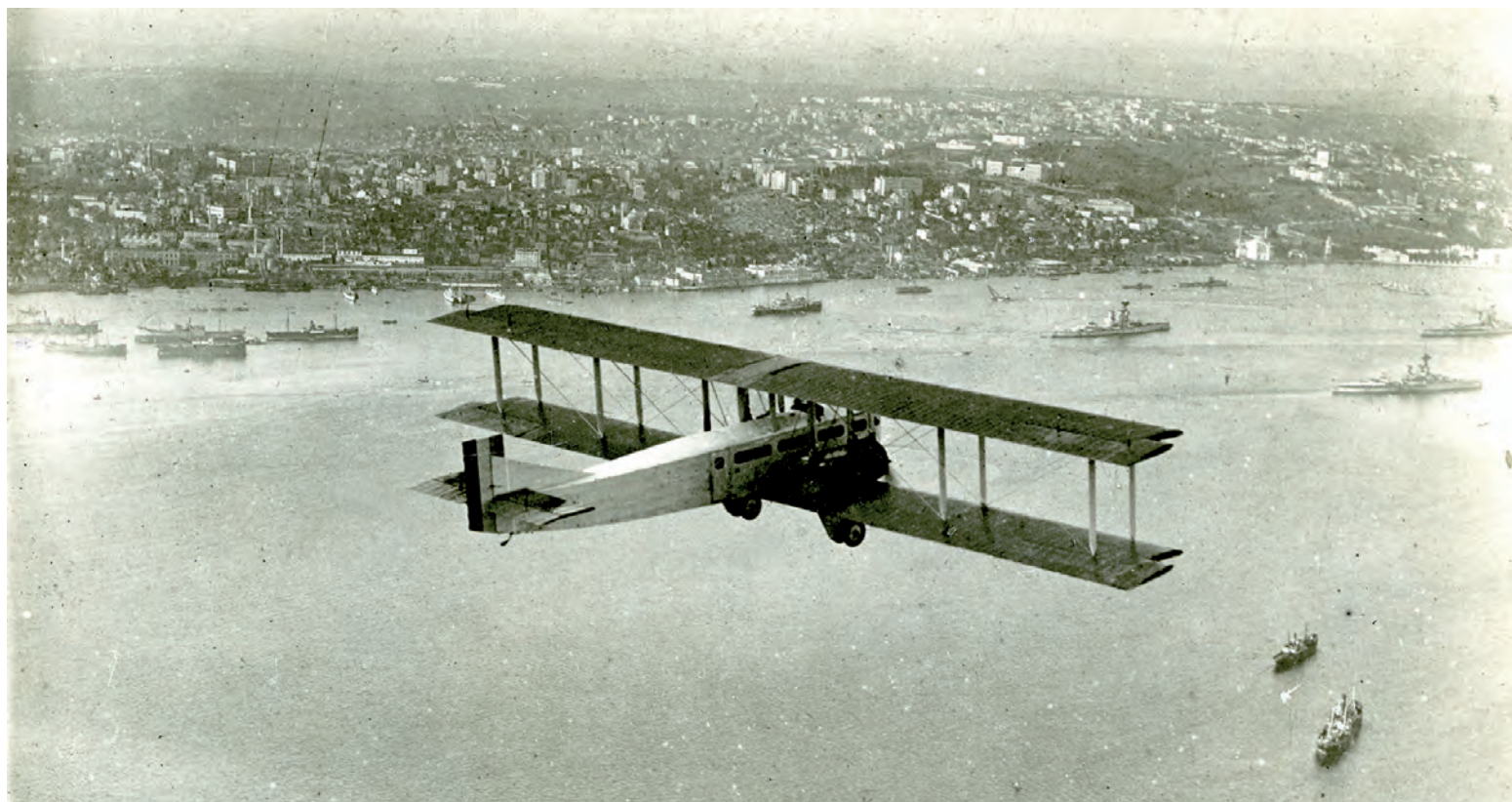
Airline companies, often spin-offs from the actual manufacturing companies, flourished, opening up new routes and dramatically multiplying the transport offer over the following years. At the same time, they organised themselves to defend their interests, and five of them joined the first International Air Traffic Association (IATA) in The Hague (Netherlands) in 1919.

The States concerned by this new form of public transport also worked together to establish the common ground rules to be adopted in

order to guarantee a degree of harmony and security for this activity. On 13 October 1919, an international meeting was held in Paris, leading to the creation of the International Commission for Air Navigation (ICAN). This was to become the embryo of the International Civil Aviation organisation (ICAO) after the Second World War.

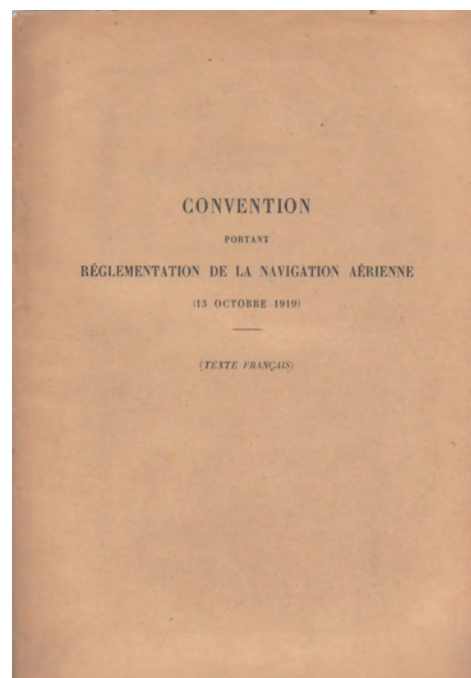
The development of commercial aviation now benefited from rules applied by all signatories to guarantee the highest level of safety for passengers, whose numbers were constantly increasing, despite the fact that seat prices meant that flights were reserved for a social elite.

1919. Lucien Bossoutrot's *Goliath* Farman arriving on the British coast



Unfortunately, the first accidents also occurred and enthusiasm had to face reality: engines, which had made great progress during the war, still gave cause for concern, aerodynamics and structures still suffered from numerous defects, on-board equipment was still basic and flight instruments were not yet capable of coping with marginal or adverse weather conditions, and the training of professional pilots was mainly inherited from military schools.

Air transport was built step by step, with the risks inherent in any new development. The growth in the number of flights gave rise to the first air traffic accidents, and with them the first safety investigations.



First convention on air traffic regulations dated 1919

1921. Laurent-Eynac¹ raises awareness about air accidents



Mr. Laurent-Eynac,
First Minister of Air.

On 25 April 1921, Mr Laurent-Eynac, Under-Secretary of State for Aeronautics and Transport, sent a circular to prefects on what to do in the event of an air accident: *“Investigations into aviation accidents are particularly important for the lessons that can be drawn from them. The dissemination of these lessons in the departments and services concerned will help to reduce the number of such accidents and, by the same token, improve air travel. Every serious accident must be the subject of a very serious investigation, designed to determine, if possible, the cause and responsibility. This investigation must be immediate and as thorough as possible.”*

The operator pays for the investigation

A list of operations to be carried out pending the arrival of the investigator was listed. The circular also stated that the costs incurred as a result of the accident were to be borne by the aircraft owner: *“Expenses resulting from the execution of the prescribed measures will be borne by the ministerial departments concerned, to which the files will be forwarded by the prefectural administrations. Expenses relating specifically to aircraft belonging to private individuals or air navigation companies may be reimbursed to the State by payment to the Treasury on the basis of repayment orders issued by the Director of the Air Navigation Service.”*

1. Victor Laurent-Eynac: A former officer in a bombing squadron during the First World War, this French politician became the first Minister of Air in October 1928, when the Ministry was created.

An air safety service

On 7 April 1922, the first air collision in the history of civil aviation occurred on the Paris-London-Paris route, between a Farman F.60 *Goliath* belonging to Grands Express Aériens, which had taken off from Le Bourget bound for Croydon, near London, and a De Havilland DH.18 belonging to Daimler Airways, following the opposite route. Flying in fog at low altitude, following ground references, the two aircraft collided near Beauvais, killing seven people, including three passengers on the French Farman. An investigation commission was appointed to determine the precise circumstances of the accident and to draw lessons from it.

1922. Le Bourget
Passengers
boarding the
Compagnie des
Grands Express
Aériens *Goliath*.



Subsequently, to avoid the risk of another collision of the same type, two routes were created to the same destination, one for the outward journey, the other for the return.

This unfortunate affair precipitated the publication of a decree dated 10 July 1922, which created the first airway in France. The first article of the decree stated: *"Do not approach the defined route between Écouen and Abbeville by more than 100 meters, as for main road No 1 from Paris to Calais, each aircraft must keep this road on its LH side."* Next came the creation of an "outbound" and a "return" corridor to the same destination, to separate traffic.

The principles of the safety investigation, already formulated by Laurent-Eynac the previous year, were complied with: understanding the causes of an accident and proposing solutions to prevent it from reoccurring. Their implementation would be the mission of an air safety service attached to the civil aviation administration.

The first commercial aviation accidents justified the creation of a group of experts, first attached to the Ministry of Air, then to the General Technical Inspectorate of Air from 1934 onwards. This forerunner of today's BEA illustrates the hesitant move towards the creation of a specialized body. Before the Second World War, the Ministry of Air's safety service was headed by Mr Brunat. After the Liberation, when the SGACC¹ was created, it was entrusted to Maurice Bellonte, an aviator who had distinguished himself alongside Dieudonné Costes on the first East-West crossing of the North Atlantic. Before the creation of any investigation body, he carried out the investigations taking as a reference, the Directive of 4 November 1946, which set out the

1. SGACC: *Secrétariat général à l'Aviation civile et commerciale*, which in 1976, became the DGAC, the French civil aviation authority.





1922. Le Bourget Crowds flock for the departures for London on the Grands Express Aériens Farman Goliath.

provisions to be taken.

This directive was based on the measures being studied by OPACI, the provisional agency of the United Nations within the framework of the Montreal Convention, responsible for drafting Annex 13 to the Convention on International Civil Aviation, which met in Chicago in 1944.

Gradually, investigative methods were put in place to find the causes of the accident. Tables were produced, statistics compiled, and directives drafted and updated to guide investigators in their work. A classification of accidents was drawn up, based on the one used between the two world wars.

In his 1947 report, Charles-Henri de Levis-Mirepoix states: *"This is where precision is needed before any analysis. For example, when a classification table, which we have before us [this is a pre-war table] puts mid-air collisions, acrobatics, engine failures and poor ground conditions on the same level, there is confusion between causes and circumstances: collision is the nature of the accident, the causes of which may be poor visibility, inattention, etc."* The methodology, the analysis techniques took

A centralised air safety department as early as 1929

Charles-Henri de Levis-Mirepoix, the civil aviation inspector general, in a study on air safety¹ presented to the 3rd national civil aviation congress held in Paris between 1 and 5 April 1947, traced the history of the air safety body in France since 1929.

He indicated that from September 1929 until the Armistice, there was a Service Central de la Sécurité Aérienne (centralised air safety department), directly attached to the Ministry of Air, then from 1934, to the General Technical Inspectorate of Air. This department was responsible for centralising all questions relating to air safety, both military and civilian, and took part in investigations following accidents, presided over technical investigation commissions, compiled accident statistics in order to draw lessons from them, and proposed to the Ministry's departments, the measures to be taken to avoid or reduce the recurrence of accidents whose causes had been determined.

- *It carried out overall studies to enhance safety and improve equipment.*
- *It took part in examination commissions for new equipment.*
- *It received reports and statistics from Bureau Véritas.*
- *It had technical contacts in all the aeronautical formations and in each of the transport companies, an inspection and investigation body, a statistics body and a research body.*

Its proposals for studies, new projects or major measures were periodically submitted to a higher commission chaired by the Minister. Created and supported by Mr. Laurent-Eynac, this department made a valuable contribution to air safety, notably through its commitment to research. As early as 1930, France had already grasped the international aspect of the problem, and it was in Paris that the first International Air Safety Congress was held. (...)

Since the Liberation, as a consequence of the new ministerial structures, the military and civilian sectors were separated. The safety department of the General Secretariat for Civil and Commercial Aviation was still relatively small; it had no statistics under its control, and reported to both the Air Transport and Air Navigation departments. It had recently been decided to reinforce its administrative status, resources and personnel."

1. *Étude sur la sécurité aérienne*, Civil Aviation Secretary General newsletter No 30, dated 20 October 1947.

1931. Accident to the *Trait d'Union II*: the press raises questions...

On 12 September 1931, the crew, Marcel Doret, Joseph Le Brix and René Mesmin were attempting to beat a long distance record when their engine failed over the Urals, the aircraft was over the maximum weight limit due to the weight of the fuel being carried.

After losing altitude, the Dewoitine D-33 christened *Trait d'Union II* crashed. Only Marcel Doret, who was able to parachute out, survived the accident.

The investigation concluded that the aircraft lost speed following a long, full-throttle climb in the rain, with no visibility, interrupted by a power loss with vibrations according to an official press release.

On the publication of these conclusions, the weekly magazine *Les Ailes* (No. 538, 8 October 1931) protested against the absence of the safety department,

asking whether the safety department had not been kept out of the investigation.

"Does this department exist or not? If it does exist, why was it not represented

on the "*Trait d'Union*" investigation commission?

The composition of the commission charged with investigating the causes of the "*Trait d'Union*" accident calls for a few remarks that are still relevant today.

The commission included an aircraft specialist and an engine specialist. But why did they not include a specialist in accident investigations?



Marcel Doret,
head of the crew
And unique survival from the accident
to
the "*Trait d'Union II*".

Those who live in the aeronautical world know how difficult the search for the causes of an accident can be where, more often than not, the smallest detail has the greatest importance. The value of the personnel entrusted with such a task lies above all in their experience.

All the "Polytechnique" courses put together are not enough to train the perfect investigator. Only practice, complete technological knowledge of the equipment, almost daily confrontation with the facts, habit in a word, are likely to produce tangible results in this training. Our first Minister of the Air understood this when he created the centralised air safety department. His successors left it in place. So, apparently at least, they understood its importance. (...)

To give the investigation staff greater freedom and independence in their conclusions, Mr. Laurent-Eynac felt it necessary to attach the air safety department to his Cabinet. Investigations were thus carried out by staff who were independent of users and technical departments. (...)

Why were these principles lost sight of in the particular case of the "*Trait d'Union II*"? And why did the commission only include representatives from the technical department? (...) To ignore the very principles that presided over the creation of the air safety department and the investigation commissions is to risk severe criticism."

The journalist used the terms freedom and independence, which will be among the fundamental principles of the safety investigation. We will come back to these notions later in the book.



Article from the weekly magazine *Les Ailes* No 538, of 8 October 1931.

shape over time. Texts started to steer and organise investigative work and relations between those working on the ground. This was notably the case with Directive 300 IGAC/SA of 3 June 1957, which was to be a benchmark for over forty years. But the investigation service, created within the SGACC and from 1946, placed under the authority of Maurice Bellonte, a pioneer of the North Atlantic crossing, struggled at first to find a parent administrative framework and even an official name. Several names can be found at this time, and perhaps even several entities.

For example, the investigation commission into the accident to the DC3 registered F-BAXC (6 January 1948) included the Head of the Safety Investigations Department of the SGACC and the Head of the Accidents Unit of the Air Navigation Directorate. In the decree setting up the investigation commission into the accident to F-BAZN in the Azores in November 1949, Maurice Bellonte is given the title of Head of the “Accident Investigation and Safety” section of the Navigation and Air Transport Directorate.

The term “*Bureau Enquêtes-Accidents*” (BEA) seems to have originated in informal common parlance to designate the investigators. It was first used in the report on the accident to a Canadian C-54 on 13 November 1950, when the investigation commission was chaired by the Head of the “*Bureau Enquêtes-Accidents*” in the Civil Aviation General Inspectorate.

However, the position of the BEA remains unclear. On 7 April 1951, a memo from René Lemaire, General Secretary for Civil and Commercial Aviation, was published, entrusting Mr. Girardot, Chairman of the Air Safety Section at the IGAC, with the “*Service Enquêtes-Accidents*” (Accident Investigation Department). A decree dated 16 January 1952 tasked the IGAC with investigating civil aviation air accidents and drawing lessons from these. In a decision dated 13 February 1953, René Lemaire specified that the civil aviation's responsibilities for technical investigations following air accidents are entrusted to a “*Bureau d'administration centrale*”, placed under the immediate authority of the Secretary General of Civil and Commercial Aviation. This decision, contrary to the provisions of the 1952 decree, does not appear to have led to any structural changes.

In a note from the SGACC, dated 3 November 1958, the author

1946. A recommendation adopted for the Douglas DC-3

On 3 September 1946, the Air France flight from Copenhagen bound for Paris crashed. There were no survivors among the occupants of the Douglas DC-3, resulting in a death toll of 22 souls. The safety department opened an investigation and concluded that a fuel line had ruptured, causing a fire. The findings were immediately acted upon by the SGACC and the technical department in the form of recommendations for modifications to the fire detection and protection system on the DC-3. These were immediately imposed in France, and adopted by the USA shortly afterwards.



One of the first civil Douglas DC-3s registered in France.

- unfortunately unknown, but probably the Secretary General - suggests entrusting the supervision of the *Bureau Enquêtes-Accidents* to the High Council for Infrastructure and Air Navigation which, in accordance with the provisions of article 3 of 16 January 1952, coordinated the action of the members of the General Inspectorate.

However, the same author notes that in article 7 of the interministerial directive of 3 January



1953 relating to the coordination of the judicial investigation and the technical and administrative investigation in the event of an accident, signed by ten ministers, technical investigators are defined as the representatives of the *Section de la Sécurité Aérienne* of the Civil Aviation General Inspectorate, appointed by name by the Minister of Public Works and Transport to carry out the special investigation. The author of the note therefore concludes that the technical investigation¹ is carried out by the Inspectorate's Air Safety Section. *It therefore seems essential that the Bureau Enquêtes-Accidents be attached to the Air Safety Section of the IGAC.*

The absence of an organic text officially defining both the status of the BEA and its hierarchical position within the civil aviation administration contributed to keeping the BEA in a certain administrative limbo. This did not prevent the few experts who made up the BEA from pursuing their missions and consolidating their experience and expertise.

The Chicago Convention and its Annex 13

In 1944, as the end of the war approached, it became essential to draw up regulations for future international civil aviation commercial routes. Considered obsolete, the first international convention, the CINA, signed in 1919, was ratified by only 37 States and did not include the USA, as it had been conceived under the aegis of the League of Nations which the USA had refused to join.

In December 1944, the grand ballroom of Chicago's Stephens Hotel welcomed representatives from 54 nations, who were charged with drafting and signing a "Convention on International Civil Aviation", also known as the "Chicago Convention". Its implementation was entrusted to the Provisional International Civil Aviation organisation (PICAO), a specialized agency of the United Nations, which became ICAO (International Civil Aviation organisation) in April 1947, the date of application of the convention. The latter has issued a number of Annexes, including Annex 13, which governs the investigation of aviation accidents and incidents. The twelfth revision of this Annex was published in July 2010.

This Annex, drawn up by the Montreal Assembly in June 1946, is a veritable bible for investigators. In addition to a certain number of general points, it defines what the investigation must investigate, and the responsibilities of the State of occurrence and of the other States participating in the investigation. From 1951 onwards, Annex 13 became the reference for civil aviation accident and incident investigation services worldwide. Many of its provisions are to be found in the regulations of the various States. This is particularly true of European regulation 996/2010.

1. The term "technical investigation" was replaced by "safety investigation" on the publication of the decree of 2001.

Perspective



Paul-Louis Arslanian,
Director of the BEA from 1990 to 2009:

Annex 13, concepts and methods for all the world

"Investigations have been carried out from the very beginning of aviation, as there were accidents from the outset.

And, just as today's aircraft are very different from those first aircraft, safety investigations have evolved considerably since the early days, while continuing to comply with a number of fundamental concepts which, in my view, are inseparable from their effectiveness. These concepts, along with the associated procedures, can be found in Annex 13 to the Convention on International Civil Aviation, the bible for all investigators the world over, even when the accident is strictly national.

Reading successive editions of Annex 13, or even just the introductory pages of one of the latest editions, is highly instructive. It shows the gradual enrichment of the concepts that should guide States and aviation professionals in dealing with accidents, and then with certain incidents, with a view to ever-better air safety. But right from the first edition of 1951, the tone is set, the objective is clear, the concepts are there, both realistic and terribly ambitious.

Before quickly analysing these concepts, allow me to digress for a moment. The investigation, especially after a disaster, is fundamentally different from other civil aviation activities. Firstly, it cannot be programmed: no one can say where or when the next accident will take place, nor can they predict its nature or scale. Secondly, it takes place in a context - both human and economic - of urgency, destabilization and uncertainty, not to say fear, which will encourage aggressiveness, mistrust and more or less improvised reactions from all sides. The aim of Annex 13 becomes clear: to enhance safety by making the best possible collective use of the lessons learned from malfunctions, by laying the foundations for unrestricted cooperation between the various safety players within the framework of a joint investigation.

As I have said, the concepts and practices we all share have been continuously enriched, and France has made a major contribution to this. Unfortunately, I won't be able to mention all those who have contributed to this process over the years, but I would like to mention at least one name, that of Michel Vigier. An IPEEAC who spent virtually his entire career with the early BEA, Michel Vigier not only worked tirelessly to explain and draw lessons from numerous accidents, he also trained other investigators, developed investigation methods and, above all, had a real influence on the drafting of the first Annexes and the more technical accompanying texts (the investigator's manual, in particular). Michel Vigier worked hard to establish what I would call a modern, professional investigation, and we owe him a great deal.

Let's move on to the concepts that govern our investigations. This is only a summary, of course, but I believe it will shed some light on the BEA's actions and developments. First of all, the obligation to inform and investigate. The Chicago Convention states that States have an obligation to investigate accidents occurring on their territory to aircraft from another State, involving that other State and communicating the report to it. Annex 13 clarifies and supplements this obligation by providing for the immediate notification of accidents and certain incidents involving civil aircraft, whatever the location, followed by the opening of an investigation and the issuing of the report. It indicates that the investigation is (generally) led by the State of the occurrence, and that certain other States are associated with the investigation and consulted on the report. These are essentially the State(s) responsible for the manufacture and operation of the aircraft and, on request, any State with nationals on board.

Make no mistake, the challenge is immense. Even today, too many occurrences escape proper investigation, and too many reports remain confidential even though they contain potentially useful safety information. Of course, some people have access to it, and we can hope that security measures are taken, but my deep conviction, after all these years of investigation, is that only freely shared information can truly benefit everyone. Otherwise, the right hand doesn't know what the left hand is doing... and, in any case, we quickly forget.

Hence the second rule, which is essential for the climate of trust that must underpin exchanges between investigators, as well as with their industrial partners and those involved in the occurrence: the investigation does not aim to apportion blame or liabilities.

This rule is worth noting. It does not say that there are no faults or

responsibilities - that's obvious - or even that we shouldn't look for them, which is already less obvious, although totally unrealistic from a human point of view. Quite simply, the search for and determination of possible faults or responsibilities is not and should not be part of the safety investigators' mission. This task falls to other organisations, just as legitimate as ours and with equally essential missions, with whom coordination will be necessary since we're working on the same occurrence. Rest assured, this is quite possible when there is willingness on both sides, and when everyone understands and accepts each other's objectives and constraints. Otherwise, of course, we risk a showdown.

Over time, I've come to see another benefit of this rule... I'm convinced that it has encouraged, if not brought about, the broadening of the search for the causes of accidents to include weaknesses in the system as a whole, and aviation safety has benefited as a result.

Another concept introduced by the Annex, over and above the common approach, is that the investigation is conducted in the same way, whatever the country or circumstances of the event, up to and including the organisation of the final report. This concept makes it easier - to put it mildly - to work together from the outset, and guarantees mutual understanding. I'll take as an example the model which the investigation report must comply with. The distinction it introduces between establishing the facts, analysing them to understand and explain them, drawing conclusions from them and making recommendations facilitates coherent action between investigators, prevents them from being tempted to embark too soon on the search for an explanation, and limits the risk of disagreement over method or conclusions.

There is one remaining concept to which I shall return to at length, but which I had to mention to complete this overview, and that is the notion of the independence of the investigation. This concept, whose possibilities I hope to demonstrate, seems to me to be quite far removed from the usual meaning given, namely "being able to do what I want". For me, it means "being able to do what I must".



Chapter 1

The BEA takes shape



A British Vickers *Viscount* at Paris-Le Bourget airport in the 1950s.
The BEA installs its offices on the Le Bourget site in 1994.



On 11 July 1962, the French *Journal Officiel* published the ministerial decree of 20 June 1962 regarding the organisation and responsibilities of the *Bureau Enquêtes-Accidents* of the Civil Aviation General Inspectorate.

At the time, there was no mention of “civil aviation incidents”, a concept introduced later.

Its composition was also described: a group of experts for investigations concerning equipment, a group of experts for investigations concerning operations and an administrative section. Its remit was detailed, in particular as regards the dissemination of information concerning accidents and the fact that it assisted the Chairman of the Air Safety Commission, for whom it acted as secretary.

This *Bureau Enquêtes-Accidents* was placed under the authority of the Chairman of its Safety and Air Navigation Section, which directed and controlled its activities¹. At this stage, it should be noted that the former BEA, attached to a General Inspectorate, an instrument of the Minister of Transport, had no legal independence from political power, apart from the fact that, in practice, the desire of successive BEA managers, as well as certain heads of the IGACEM² meant that a relative functional independence was gradually established.

The “Office” was headed by Maurice Bellonte,

1. Art.1 of the Order of 20 June 1962.

2. IGACEM: Inspection générale de l'aviation civile et de la météorologie (Civil Aviation and Meteorology General Inspectorate), meteorology having been added to the IGAC in 1983.

a famous aviator and experienced investigator, until his retirement in 1961. Maurice Bellonte was not replaced, and the staff, still within the Aviation Safety section, came under the direct authority of successive section presidents, Messrs Mouchez, Grenier and Bénard. When the latter retired on 13 June 1969, the head of the IGAC decided to temporarily place the *Bureau Enquêtes-Accidents* under his direct authority. He relied on Paul Guillevic, whom he officially appointed head of the BEA in 1972.

At that time, Mr. Guillevic and Mr. Courtonne were respectively responsible, at least in theory, for the “Operations” and “Equipment” cells, but in practice Mr. Guillevic took the role of Head of the Accident Investigation Office, which was why Mr. Lemaire, in the decision of 13 June 1969, entrusted him with the coordination of all matters entrusted to the Bureau Enquêtes-Accidents, without giving him the title of Head.

*Mr. Courtonne's imminent retirement and Mr. Guillevic's undisputed authority enabled the Secretary General to take a decision on 31 July 1972, appointing Mr. Guillevic Head of the Bureau Enquêtes-Accidents. The situation remained unchanged until Mr. Lemaire's retirement on 17 April 1974.(...) It did not seem appropriate to place the Bureau Enquêtes-Accidents under the authority of the Chairman of the Safety and Air Navigation Section.*³

3. Memo from Mr. A de Vaucelles, IGAC secretary general dated 10 May 1974.



Compared to what it is today, the BEA of the time was a small, “craft industry”, with a staff of around fifteen specialists and no major resources, where resourcefulness reigned, driven by the genuine passion of its members for their profession.

Opening a safety investigation into an aviation accident requires the mobilization of both human and financial resources. Men and women

devote all their time and energy to it, for varying lengths of time, depending on the difficulty involved. Sometimes during a relentless series of occurrences, investigators have to work on several sites simultaneously. For the BEA, it's a question of finding the necessary funding to carry out the investigation. These resources can sometimes be exceptional, when it's a question of searching

Perspective

Paul-Louis Arslanian: **the BEA and the General Inspectorate**

For a long time, the history of the BEA was confused with that of the General Inspectorate. It's a complex story, like that of French aviation, punctuated by crises and changes. And a fascinating story too, both in terms of the continuity of the approach that led to an “investigation action” becoming an organisation, and in terms of the ability of the people and structures to adapt to changing circumstances.

For many years, the handling of accidents was shared between various entities, but based on a principle that changed little: the handling of air disasters was the responsibility of investigation commissions appointed on a case-by-case basis by the Minister and generally chaired by an Inspector General, with the Air Navigation Section of the General Inspectorate providing support to the commissions and ensuring continuity of follow-up, while minor events were handled by local Civil Aviation departments and, in parallel, by the Air Transport Gendarmerie.

The files were sent back to the central administration, where a team gradually structured itself, and was known as the Accident Investigation and Safety Office, its administrative name at the time, first in the Air Transport Division and then, in 1951, in the General Inspectorate, merging with the commission support staff.

This new Bureau Enquêtes-Accidents gradually gained in strength and autonomy within the General Inspectorate. For me, two men have marked this evolution under the authority and guidance of the Chairman, René Lemaire.

Firstly, Maurice Bellonte, whose prestige and experience enabled the BEA to assert itself as an entity, and secondly, Paul Guillevic, whose reflections and proposals gave the BEA the position and prerogatives it would retain until the law of March 1999. It should be noted that the BEA had no direct head during the long period between Maurice Bellonte's departure and Paul Guillevic's appointment.

This BEA enjoyed considerable freedom of action, with the active support of successive heads of the General Inspectorate. It carried out

numerous investigations directly, always with the contribution of the DGAC's regional structures, and represented France in investigations conducted by foreign authorities. It benefited from the technical support of three major Armament and Civil Aviation departments, CEV flight test centre, CEAT and STNA, and the operational support of the OCV. The investigation commissions still existed, but with the BEA taking an increasingly bigger role.

It is within this framework that Jean-Pierre Bonny, Robert Davidson and myself continued to develop the BEA and its resources.

Bonny obtained the assignment of young engineers, and this regular influx of young people, far from being a handicap as some had feared, was a major asset in the BEA's development. He also clarified the BEA's relations with the judicial authorities, putting an end to a certain confusion between the functions of a safety investigator and those of a judicial investigator. Davidson placed emphasis on the publication of BEA reports. Faced with two major cases - the controversy surrounding the Habsheim disaster and our involvement in the Cameroon investigation into the disaster that claimed the life of Michel Baroin - he launched a major reflection on the structure and adaptation of the BEA's powers. This reflection convinced us that only a law could bring about the changes that had become necessary. I finally achieved this objective in 1999, when I had to transpose a European directive, with the support of the Minister and the General Inspectorate under the chairmanship of Alain Monnier, and the DGAC, in particular Jean-François Grassineau. I also received strong support from the National Assembly and the Senate, and in particular from the two rapporteurs, which led to the unanimous adoption of the law by both chambers.

With the decree of 2001, it was the end of a great story and the beginning of a new one. The BEA, now fully grown, had become autonomous.



for wreckage that has fallen into the sea or on a site that is particularly difficult to access, and in a distant country.

Today, the BEA has its own resources that can be put to immediate use. But in the past, it has had to deal with situations where both personnel and financial resources were lacking. A time when methods that would work in the future had to be invented ...

Even today, however, while the BEA has its own resources in terms of premises, staff and day-to-day operating budget, releasing funds for an out of the ordinary investigation remains dependent on voluntary contributions from manufacturers, airlines and the State.

The small BEA team of some fifteen people in the 1960s and 1970s was confronted with the growth in air traffic, the democratization of mass transport and the opening up of vacation destinations to almost everyone.

France's well established aeronautical industrial tradition and the increasing size of the worldwide civil aircraft fleets, for which our country assumes the missions of manufacturer state (State of Design and State of Manufacture), mean that the BEA has intervened in numerous investigations abroad. This is particularly the case when an accident occurs to an Airbus.

This expertise has followed the upward curve of the manufacturer which has nibbled away at the market share of its main competitor, the American Boeing, until it is now on a par with the latter, and in some years has even overtaken it, in terms of worldwide sales.

At the same time, as aeroplanes became increasingly complex, there was a multiplication of required skills required, and the BEA found itself

(Continued on page 28)

Perspective



Jean-Pierre Bonny,
Head of the BEA from 1980 to 1986:
When a computer came under office supply

Jean-Pierre Bonny had first hand experience of just how difficult it was to modernize his department, due to both the inertia of the Administration and the limited resources

available. Nevertheless, he was able to innovate with the acquisition of one of the first desktop computers in order to compile valuable information for his mission:

"A prerequisite for the publication of statistics is to have a memory holding the data collected. When I arrived at the BEA, this data was recorded in a large register that was very poorly kept, and for a very good reason: we couldn't find anyone willing to do this difficult job. As soon as someone new arrived and we put them to the task, they fell ill. What's more, we then had to extract the data, again by hand, which was very time-consuming and error-prone. Computers were becoming more and more widespread. But the Administration hadn't reached that point yet! To acquire equipment of this kind, a report had to be submitted to a certain commission, which very rarely gave the go-ahead.

So I decided to "take the bull by the horns" and, parodying the monk who christened a magnificent roast "carp" in order to eat it on a day of Lent, I christened the computer "office supplies" and bought an Apple Macintosh, one of the first models made by the manufacturer. Curiously, no one noticed or asked me a single question on very regularly receiving these new statistics, which were more complete and better presented than the previous ones. "Great hypocrisy" is not unknown in the Administration, no-one could be oblivious to the fact that the paper came straight out of a computer printer!

By computerizing the office, I became the first of all Civil Aviation department heads to have a computer. This enabled me not only to publish statistics on recent events, but also to set up a data bank, very useful in the event of an accident, to look for antecedents of all kinds, whether concerning equipment or people. At last we were starting to work effectively and intelligently! I recently noticed that the BEA is now fully computerized, and even linked to the computers of its British and American colleagues. We've come a long way! But I'm proud to have been the first to go down this road, despite the almost total absence of financial resources and foolish opposition from my superiors."





In her own words

Anne-Marie Blanc **Forty years in the BEA's secretary office**

Anne-Marie Blanc spent most of her career at the BEA. From 1968 to 2007, she experienced the evolution of the office on a daily basis.

"Before joining the BEA, I worked for the STNA. Then I got pregnant and when I went back to work, I was assigned to the BEA. I arrived in a technical environment, full of hustle and bustle that suited me perfectly. We did what came along on a day to day basis. You'd leave the office without knowing what you'd find the next day. We planned ahead, but it wasn't certain that we'd do what was planned.

That said, I didn't deal with all that at first. I was a filing clerk. I distributed the accident reports that came in from the districts. When something went wrong, the districts would make their initial reports, which would then be forwarded to the BEA, and I would classify the accidents. I did it on my knees, in the corridor! The timer stopped every three minutes - it was bliss! Two months before my arrival, there was the Piton de la Fournaise accident, with an investigation commission, and on 11 September 1968, the Caravelle Ajaccio-Nice accident, with another investigation commission!

In all, there were between twelve and fifteen of us. The secretary's office was composed of Jeannine Tsiboula and Evelyne Malpot. I'd passed the typist's exam, so I was an office worker.

Evidence of the rapid evolution of air traffic, Le Bourget airport just a few years apart.

Above, in the 1950s, a few propeller-driven aircraft are waiting on the apron. In the background, the countryside that would soon be home to Paris-Charles de Gaulle international airport.

Below, some ten years later, jets have taken their place and are multiplying routes and destinations. The French aeronautics industry is on the rise...



I only became an assistant at the end of my career when I held the position of administrator. I was an administrator before I left the Convention premises. But I did very little administrator work. However, the administrator function became more important at Le Bourget. I spent the rest of my career at the BEA. That's almost 40 years of service.

I was in charge of sending out reports, distributing a few letters and doing all the filing. Of course, I answered the phone. Filing was a terrible thing. When you came in, you couldn't see me behind the pile of documents on the table. We received reports from the districts. Depending on what had happened, the report would be of interest to SFACT, DNA, OCV, the met office and the air base management. When I arrived, the head of the BEA was about to leave. Then Colonel Bénard arrived.

The BEA had two sections: the investigations section and the examinations section. It was under the authority of the Inspectorate. Mr. Hoerteur was an inspector who oversaw the BEA from a good distance. Michel Vigier, investigator and General Secretary, was there when I arrived.

All the people I'm about to mention were investigators: Jean Conchard, Louis Guéritot, Raymond Auffray, Bernard Mangane, Paul Guillevic, Noël Laval, René Mercier, Francis Izern, Oleg Drobycheff and Rémy Courtonne. The investigations section included Paul Guillevic and the two secretaries. In the examinations section, there was Rémy Courtonne and myself. We weren't two clans. If there was an accident or a problem, whoever was qualified would deal with it. All accidents or incidents triggered an investigation and very often an examination (at the powerplant test centre (CEP) in Saclay or the CEV flight test centre in Brétigny).

Depending on the magnitude of the event, investigators would be dispatched. They were not really assigned to one section or another.

At the end, it was more or less the same, but, for example, the investigator who specialized in helicopters was in charge of this field. However, there was already on-call personnel. I drew up the on-call rota and sent it to the DGAC. After Mr Bénard left, Mr Guillevic took over as head of the BEA and brought everyone together. Mr. Courtonne was a little more involved in the examinations in certain cases, but there was only one BEA and one secretary's office..

With Mr. Arslanian, I really became an administrator, while continuing my secretarial duties. Mr. Arslanian wanted me to continue welcoming foreign delegations, ordering meals, picking them up, etc. I was also in charge of the order forms drawn up by the sections. This had taken

a serious turn: there was one logistics person and one investigations person. Downstairs were the laboratories, which had started to develop with Mr. Davidson.

Before Mr. Davidson, there were practically no labs. I was even called in to listen to the tapes with the other investigators. They were small parts of the tape, I think I'll remember the words I heard during the crash involving the Caravelle F-BOHB, on the Ajaccio-Nice flight in 1968 for the rest of my life.

Mr. Drobycheff was there, along with two or three other people. He really wanted me to understand what it was all about. I'd listen to short extracts, then we'd note down what we'd understood and exchange ideas. In the same way, when we received district information reports or gendarmerie reports, I was asked to look at them. It was quite difficult...I'd look at the photos taken by the gendarmes or the districts. Sometimes it wasn't a pretty sight. Now and then I was asked to read the reports to understand. When I didn't understand, I'd say so and an investigator would explain. Brilliant training!

The Caravelle Ajaccio-Nice accident particularly struck me. When you hear Our arse is on fire! Our arse is on fire! you wonder what that means on a plane. That's when the guys explained to me that there was a fire at the rear of the aeroplane. I'll remember that for the rest of my life.

I also kept the register. Well, register sounds rather grand. When I arrived, there was a notebook in landscape format in which we wrote the date, the type of aircraft, the name of the pilot, the number of dead, the number of injured, two or three lines on the circumstances of the accident, the name of the investigator and the location. I thought that was pretty good. Often, in fact, I was asked to research previous accidents, and it was convenient to look them up in the notebook. It was good because some very old accidents were noted there. There were two or three very old accidents. So I kept the notebook and continued to record accidents in it. Despite the advent of computers, this notebook has been very useful to some...

Then I stopped at some point, but I can't say exactly when. When I saw that every accident was being entered by the computer guys, it became pointless for me to do it. I wrote down little things for myself. I always had it handy, should Mr. Arslanian ask me for information about a past event..."



1972. Accident to the Air Inter Vickers Viscount 724 F-BMCH at Noirétable

On 27 October 1972, an Air Inter aeroplane on the Lyon - Clermont-Ferrand route crashed 30 km from the destination airport, killing 68 people (63 passengers and 5 crew). The apparently normal approach procedure was offset by 30 km to the east.

The investigation commission concluded that the accident was the result of a navigation error made at night in stormy conditions, in the vicinity of a cold front, with the crew convinced that they were overhead Clermont-Ferrand. It accepted the possibility of an inconsistent radio compass indication, which nevertheless presupposed that the radio compass subsequently showed consistent variations

in position, but did not explain why the crew did not check the point from which they started their descent.



Rescue workers arrive at the scene of the disaster



Reaching a wreckage in a difficult environment sometimes requires exceptional means and strong motivation for the job...



obliged to call on increasingly specialized experts. One of the greatest concerns of successive BEA directors has been the recruitment of new investigators, both in terms of numbers and new specializations. Paul-Louis Arslanian was the director who recruited the most new staff.

His determination to build a great BEA, combined with his skills of persuasion, enabled him to increase the BEA's workforce from around 15 people to 50, then 100, reaching a peak of 125 in the early 2000s. The aim was to respond to the ever-increasing number of missions, the extension of these to include incidents, and general aviation, swollen by the arrival and subsequent proliferation of microlights.

However, building effective teams takes more than just snapping fingers. As Jean-Pierre Bonny, who was in charge of the department in the early 1980s, points out, candidates are not jostling each other at the door of the BEA.

The job involves constraints that are not very compatible with personal and family life, the working environment is often very hard to bear, and the pressures often stressful to manage...

As for the resources available to investigators in the 1980s and 1990s, they were not yet up to the task: low travel allowances, unsuitable vehicles, personal protection that was no less unsuitable, an embryonic laboratory that had to draw on the experience of other establishments...



1990s

a milestone in the history of the BEA

The BEA was struggling to find a momentum due to the lack of recognition of the importance of its role within the civil aviation administration and with respect to the political authorities.

There were a number of reasons behind the BEA's evolution in the early 1990s, including the appearance of a "political" dimension in France, with the rise of the European aeronautics industry, notably Airbus, which in terms of Annex 13 was considered to be French, and the occurrence of accidents abroad involving French equipment.

A powerful and competent BEA was needed to ensure that these foreign investigations presented in a balanced way, the possible contribution of the equipment involved in the accident. Then, three accidents involving the A320, the flagship of French and European industry (Habsheim in 1988, Bangalore in 1990, Mont Sainte-Odile in 1992) led to the adoption of regulations, first at European level, notably Directive 94/56, then at national level with the implementation laws (in

France, this will be in 1999).

The number of missions carried out by the BEA increased, firstly as a result of the development of commercial air traffic, and then of the European aeronautics industry. With Airbus taking a major share of the market, the number of incidents and accidents coming under a "manufacturer occurrence" increased.

At the same time, the processing of accidents had become considerably more complex, with the arrival of digital technology in on-board systems, air traffic control methods and aircraft maintenance regulations. These new skills required new, highly qualified specialists.

A second factor was the growing power of European politicians. For example, the European Commission took up the issue of air safety investigations and the conditions under which they should be carried out. The Commission stipulated that the investigations must be carried out completely independently of any power or partisan interest. A European directive to this effect was produced in 1994.

(Continued on page 32)

In his own words

Paul-Louis Arslanian: A name to shape a policy

"In 2001, with the promulgation of the decree, both the status of the BEA changed - it became a Service with national competence, under the authority of a director - and its name. The name change from Bureau Enquêtes-Accidents to Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile was one of the changes that gave me the most trouble, not to obtain, but to find.

For sometime I had had reservations about the name Bureau Enquêtes-Accidents, which seemed to me to be laden with negative connotations. The word Bureau, which in France denotes a subordinate structure incompatible with independent action, was still the most acceptable of the three, thanks, for once, to the influence of English. The word Enquêtes was too restrictive and had an unwanted police connotation.

Finally, the word "Accidents" had also become restrictive : I had obtained that the BEA's perimeter would include Annex 13 incidents, and this word brought us back to the past, whereas I wanted every BEA agent to be convinced that their action was aimed first and foremost at improving the future.

That said, what name could I choose ? All the staff were attached to the BEA acronym, and we were known both internationally, and favourably, by this acronym. So we had to keep it. It gradually occurred to me that by adding a word to complement the word Enquêtes, we would be able to keep the acronym. Analyses was the obvious choice, especially as it also solved the problem of the word Accidents. Finally, by adding the objective of our action, without including it in the acronym, I had our new name and our roadmap."



Perspective

Jean-Pierre Bonny,

"Managing a department that was continuously understaffed !"

When I arrived at the BEA, I was delighted to find a department all my own, with a team of around fifteen investigators, four secretaries and a driver. In fact, the big novelty was that I had a car. Strictly speaking, it wasn't a car provided with the position, but a means of getting to accident sites as quickly as possible or, at any hour, to an airport to catch an aeroplane bound for the country in which an accident had occurred. Don't get the idea that this was a modern, comfortable car. It was an old Renault estate car with almost 200,000 km on the clock, which would soon need to be replaced...when credit was available!

When that blessed day arrived, all I could get was a Peugeot 104 (equivalent to an Austin Metro), a car that could not have been more ill-suited to the job, which often required a four-wheel-drive off-road vehicle. When I had the opportunity to see how my American colleagues were equipped, I realized that France was still several centuries behind the times, and that it was far from having measured the extent of the responsibilities incurred by a country that wanted to be a major aircraft manufacturer and air carrier.

It took me several years to make those concerned understand that the BEA was effectively part of the manufacturer's system, in helping to advance safety and thus the reputation of the equipment.

In the field, the BEA is today equipped with functional means...



Our involvement in all accidents involving French-built aircraft, whether aeroplanes or helicopters, and in all accidents to aircraft registered in France was one hundred percent. At this time, France had manufactured and sold more than 2,000 helicopters, which meant we had a lot on our plates - with sometimes quite tricky work!

Just think what happened to the Airbus sales, sold in huge numbers all over the world! But that wasn't all. We were also involved in all accidents occurring within the territory of the French Republic, including overseas territories.

Finally, we had cooperation agreements that took us to certain former colonies and French-speaking countries. In fact, I was to increase this perimeter even further by signing a memorandum of understanding with the Republic of Malta.

What's more, as soon as France began to produce or co-produce engines, any accident involving an aircraft equipped with one of these engines would concern us. For example, when an accident to a Boeing operated by a Madagascan company and fitted with a French engine occurred in China, I sent two investigators to the scene. With the very rapid development of air transport, we had no time to get bored, especially as there were few volunteers who wanted to come to the BEA. So I was always short-staffed. I think the engineers dreaded two things: working before the corpse had been removed, which was pretty taxing, I admit, and being called away to the other side of the world with two hours' notice... or less. In any case, I was permanently short of several investigators. I had to make do... or rather, without!

In addition to all these major accidents, there were the serious incidents that could have led to an accident, what the Americans call "near accidents", as well as the multitude of accidents involving light aircraft, gliders and, soon, microlights, which concerned us just as much as other aircraft. There were several hundred such accidents a year, which was to motivate me, a few years later, to carry out a study aimed at reducing their number. I remember that the collision with terrain due to poor visibility was the most frequent occurrence. How many times had

Perspective



Guillaume Adam Cohesion between investigators

I joined the BEA shortly after the accident to the Roselawn (USA) ATR in October 1994. My internship study at the BEA was about statistics and I was trained by two investigators, Jean-Paul de Villeneuve and Claude Azibane, an investigator originally from Météo France.

At the time, the BEA had just moved to Le Bourget. We were eight investigators. So we can see how things have changed. My memory may be failing me, but Airbus sales were in the hundreds a year. Around 100 or 200, not more. Not like today, with 1,000 aeroplanes sold a year. There was a very strong sense of cohesion among the investigators. Because there were not many of us, we very quickly became involved in major cases, not least because of our role as an accredited representative of the State of Manufacture."

Accident to the Fokker 27 registered I-MLVT
on 25 October 2013 in climb from Paris-Charles de Gaulle



I "preached" in front of pilots' associations that young people should be taught to know when to turn around when faced with adverse weather conditions? It didn't matter if jokes were made about them. It was better to laugh than to cry! But my words were always in vain, and I can see that even today, nothing has really changed in the mentality of private pilots in this respect.

We were also called in when an accident occurred to an aircraft that didn't meet any of the above criteria, but was carrying a large number of French passengers

This type of accident involved us less than others, but at the request of the victims' families, we had to "do something"...

Following the accident involving the Boeing 747 flying from New York to Paris in July 1996, which exploded in flight after taking off from Kennedy Airport, the opinion of French experts was sought because of the large number of French victims. All this meant several hundred interventions a year, and it's fair to say that we didn't have a quiet weekend. For my part, I was often mobilized at home by my telephone, waiting for a call that was always possible, and I had even installed an answering machine that I could consult remotely. What's more, like my two on-duty engineers, I carried a "Eurosinal" device in my pocket which we we called the "bip-bip", and alerted me if someone was trying to reach me.

After a large amount of freedom in the Inspectorate, it was back to a certain form of slavery. But how good it was to feel useful and for something essential! Which used to be quite rare at the General Inspectorate!

Perspective



Jean-Luc Bénese,
Secretary General from 2001 to 2014

The choice of a new status

For my part, I drafted several bills and decrees to establish the BEA as an independent public authority (like the Financial Markets Authority at the time), i.e. an independent administrative authority with legal personality. This was to give it a legal independence, which would have better guaranteed its functional independence (in the eyes of our American partners, for example, given their legal tradition),

and to give it the possibility of bringing proceedings against and sanctioning any prejudice to the integrity of the investigation and evidence.

But this was a costly solution (for example, the independence of assets generates tax obligations and an additional management activity) and, above all, this status would have isolated the BEA from the DGAC, broken the joint working relationship and probably, in the long term, would have led to the BEA giving "orders" to the DGAC, which was a significant risk. This status solution was therefore abandoned."

Law No 99-243 of 29 March 1999 on technical investigations into civil aviation accidents and incidents transposed this European directive into French law.

The investigation must be carried out by a specialized permanent body. This permanent body must act in complete independence, and neither receive nor seek instructions from any authority or organisation whose interests might conflict with its mission.

"This law," says Jean-Luc Bénese, "could have been complied with by creating a new "BEA" with the status of an independent authority. At the time, however, the status of independent authorities was already being heavily criticized, notably by the Council of State, which saw in it the dismantling of missions of general interest that should exclusively fall to the executive."

It was decided that the BEA would be:

- a category 1 department of national competence (i.e., reporting to a minister rather than to a

director of a central administration), with its own budget within the civil aviation annexed budget, and autonomy in the recruitment of its staff;

- "placed under" the head of the IGACEM *intuitu personae*, and no longer "attached to" the IGACEM, and would have guarantees of functional independence concerning in particular:

- the appointment of its director by the Minister on the recommendation of the head of the IGACEM (the Minister can only appoint a person proposed to them),
- the existence of a seven-year renewable mandate for the Director,
- the Director's exclusive power to determine the scope and methods of each investigation, and to accept delegation of an investigation from another State or to delegate an investigation to another state.

These aspects were reflected in Decree No 2001-1043 of 8 November 2001 which defined the BEA.

In 2010, Regulation (EU) No 996-2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation was published and became mandatory under national law, being directly applicable¹. It set out that:

- each EU country must ensure that safety investigations into serious civil aviation accidents and incidents are carried out, without external intervention, by a permanent national authority responsible for civil aviation safety investigations;
- each safety investigation authority is functionally independent of any other party or authority that might conflict with its mission or influence its

1. N.B. Like the aforementioned directive, it does not have to be transposed into national law.

objectivity;

- each safety investigation authority must be able to conduct the entire safety investigation independently.

EU countries must provide their safety investigation authorities with the means and funding - notably a budget - necessary to exercise their responsibilities independently and to obtain sufficient resources;

- in particular, safety investigation authorities must have at their disposal, qualified staff and appropriate facilities, including offices and hangars for the storage and examination of aircraft, their contents and their wreckage;
- this regulation also defines the powers of investigators and reiterates the necessary balance between the safety investigation and the judicial investigation, by no longer subjecting, as was the case with the 1999 law, the safety investigator's power to gather evidence to the "goodwill" of the judicial authority¹, in line with the BEA's statute resulting from the 2001 decree.



... On French ground and abroad



The BEA's objectives

Air transport is reputed to be the safest means of travel in the world, in terms of deaths per kilometre covered. Manufacturers, operators and States make up a complex operational chain within which the slightest breach in safety is tracked down. Passenger confidence is at this price: *"Aviation is one of the few human activities in which business is coupled with virtue. No virtue, no business."* emphasizes Daniel Soulez-Larivière, a lawyer specializing in aviation law². Nevertheless, aviation accidents occur, attracting a great deal of media coverage, with their sometimes dramatic aspect because of the number of victims shocking society.

Every possible means must then be deployed to prevent the accident from reoccurring. The BEA is responsible for providing technical and human responses to accidents, following an investigation

In the field, the investigators must be able to access the accident site and work in an independent and objective way

1. See "The BEA and the judicial authorities" chapter
2. In *Air & Cosmos*, No 2718 of 15 January 2021.



1974. Accident to the Turkish Airlines Douglas DC-10 registered TC-JAV at Ermenonville

On 3 March 1974, the aeroplane, on a flight from Istanbul (Turkey) to London (UK), via Paris, crashed in a forest in the Île-de-France region, eight minutes after taking off from Orly, killing 346 people (334 passengers and 12 crew). It is France's worst air disaster to date.

The investigation commission concluded that the accident was caused by the in-flight ejection of the left rear cargo door. The sudden depressurization that followed damaged the flight controls (empennage), making it impossible for the crew to recover control of the aircraft. The safety investigation also revealed that a similar accident had occurred in Canada nineteen months earlier involving a cargo aircraft, but without effective corrective action being taken.

- France's worst air disaster in terms of the number of victims
- An earlier case two years before
- Emphasizes the importance of implementing the recommendations of investigative bodies

The accident to the Turkish Airlines DC-10 left a deep impression on public opinion because of its catastrophic human consequences.



and issuing recommendations to manufacturers, operators, commercial airlines, certification authorities and air navigation authorities.

Its mission is the “safety” investigation. It has the staff, resources and special status (convention, laws and regulations, etc.) to intervene anywhere in the world if circumstances call for it.

Preventing accidents

The analysis of the facts by expert investigators is carried out as a team, due to the many technical and human fields involved in aviation operations.

The BEA cannot and must not impose measures to be taken following the conclusions of the investigation, but it does issue recommendations. These are generally followed by the manufacturers (see Chapter 5).

The public's need for information

“Public air transport is founded on the trust placed in it by passengers...” writes Daniel Soulez-Larivière.

Flying on an airliner means putting your life in the hands of a human chain (designers, manufacturers, operators, maintenance personnel, flight crews, etc.).

This trust often offsets the anxiety felt by a large proportion of passengers at having to travel in an element that is unnatural to man. What's more, the complexity of aircraft, their operation, and the navigation and air traffic systems is beyond the comprehension of the general public. When an accident occurs, the public has many questions, and wants to understand “what went wrong” in the aviation chain. The safety investigation aims to answer these questions.

The BEA, which originally addressed the aviation industry, must now also respond to the public and



its opinion leaders, the press and social media.

The BEA does not assist the judicial authorities

While the safety investigation answers the question “why?” it does not answer the question “who is responsible?” In France, the judicial authorities are responsible for investigating the possible errors and responsibilities. To this end, it carries out its own investigation, under the authority of an investigating judge and led by the Gendarmerie des transports aériens (GTA) - the air transport police.

The risk of competition, or even conflict, between two investigations pursuing different objectives, became apparent as soon as the judicial authorities began to play an increasingly important role in air accidents. Over time, the BEA had to gain its independence and freedom of action.

Very quickly, with the judicial authorities, the BEA was constrained as the 1953 interministerial directive no longer provided a sufficiently modern framework for its missions. Its managers, those of the Inspectorate and those of the civil aviation authority (which succeeded the Secrétariat général à l'Aviation civile in 1976) became aware of the difficulties encountered by investigators in carrying out their duties. In 1985, the head of the IGACEM proposed a draft decree to the Minister of Transport, with the aim of clarifying the operating framework of the BEA, but this was not followed up.

In June 1988, an Air France Airbus A320 accident at an airshow in Habsheim killed three people. In January 1992, the Air Inter Airbus A320 accident on Mont Sainte-Odile killed 87 people. These two major accidents for the BEA once again raised questions about examinations and relations with the judicial authorities (see Chapter 7).



The search for the technical causes of the accident is the mission of the BEA's investigators.



The heads and directors¹ of the BEA since 1972

In 1951, the BEA, headed by Maurice Bellonte, was part of the Air Safety section within the IGAC, then chaired by Marcel Girardot. Maurice Bellonte is an aviator famous for having made, with Dieudonné Costes, the first east-west crossing of the North Atlantic Ocean; recruited by the SGACC at the Liberation, he subsequently carried out numerous investigations. Maurice Bellonte was not replaced when he retired in 1961, and this situation lasted until July 1972.

1972 to 1980	Paul Guillevic	
1980 to 1986	Jean-Pierre Bonny	
1986 to 1990	Robert Davidson	
1990 to 2009	Paul-Louis Arslanian	General engineer from the <i>Ponts et Chaussées</i> (Civil Aviation) and <i>Ecole polytechnique</i> graduate. After various positions at the DGAC and in the office of the Minister of Transport, he joined the BEA in 1986.
2009 to 2013	Jean-Paul Troadec	General engineer from the <i>Ponts, des Eaux et des Forêts</i> and <i>Ecole polytechnique</i> graduate. He held various posts at the DGAC before spending some time at EPSF, the national rail safety authority.
2014 to 2023	Rémi Jouty	General engineer from the <i>Ponts, des Eaux et des Forêts</i> and <i>Ecole polytechnique</i> graduate. He managed the BEA after serving as deputy to the Director of Aviation Safety and heading the BEA's Investigations Department from October 2006 to the end of December 2008.
Since 2024	Pierre-Yves Huerre	General engineer from the <i>Ponts, des Eaux et des Forêts</i> , he was head of the North Air Navigation Service, Deputy Director for Planning and Strategy in Paris, Director of the West DSAC and Head of the Light and General Aviation & Helicopters Mission reporting to the Director General of the DGAC.



The BEA's directors from 1990 to today
From left to right, Jean-Paul Troadec, Pierre-Yves Huerre, Rémi Jouty and Paul-Louis Arslanian.

1. Decree of 8 November 2001



The march towards independence

From time to time in performing its mission, the Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile will inevitably encounter attempts to exert pressure. An air accident brings into play many interests, sometimes obvious, sometimes more hidden, and it is not uncommon for the representatives of these interests to seek to influence the conclusions of the investigation in a way that will absolve them as much as possible of responsibilities that are difficult to assume.

To remain outside these zones of influence is to assert one's independence. *"But what kind of independence are we talking about? The investigator's, the department's? And in relation to whom? From the administration, the judicial authorities, the political sphere, the manufacturers or the institutional players involved in the accident?"* asks Paul-Louis Arslanian, undoubtedly the main driving force in affirming this independence. In the testimony that follows, he asks himself these questions, providing the answers that were his own during his term of office. He uses examples to illustrate the positions he had to take in certain circumstances.



Before him, Jean-Pierre Bonny, also former head of the BEA, had to battle against attempts to exert pressure, particularly from the legal world. For his part, he emphasizes the need to separate the activities of investigators from those of judges. In fact, he had to put an end to requests from the judicial authorities, who employed BEA investigators as experts for them. A rupture that has never been

called into question since...

Jean-Pierre Bonny also cites another type of pressure, that induced by rumours. As soon as a report is not published, those he calls "people who believe they are well-informed" can put forward their explanations without the investigators being able to challenge the seriousness of their work.



Perspective

Paul-Louis Arslanian

Doing our job in complete independence

"It seems to me that the changes I have described were constantly guided by the quest to ensure that the BEA is always better adapted to its mission. While our mission has never changed, the development of aviation and user expectations in terms of safety constantly pushed the challenges and stakes for our country upwards. We had to deal with an ever-increasing number of accidents and incidents, and increasingly complex investigations, while at the same time being ready to intervene immediately and with the necessary resources, anywhere and at any time, to deal with any disaster, even one whose probability is so infinitesimal as to appear impossible and yet... The accident to Concorde in Gonesse (2000) and to flight AF447 (2009) are sad proof that the impossible is always possible.

To carry out a proper investigation, you need to be able to intervene quickly, to have the means to protect the remains of the aircraft from contamination, and to have access to witness statements and useful documents. You also need to be able to properly process the data and documents collected, and to understand and analyse the results. And finally, you need to be able to disseminate the information widely, so that all those who can make use of it have access to it. All this requires ever greater skills, resources and tools. It also requires a great deal of freedom of action, and the ability to make decisions in close collaboration with the investigators - in a word, a great deal of autonomy. It is in this dual direction that the BEA steadily evolved since its inception. I'll try to illustrate this with a few examples.

The key issue in the controversy following the Habsheim accident to the A320 in 1988 was the conformity of the on-board recordings. As was customary at the time, the recorders recovered from the aircraft were handed over to BEA investigators by the judicial authorities, and entrusted

to the then DGAC, who was returning to Paris. Given the urgency of the situation, the DGAC handed over the FDR directly to the CEV flight test centre and the VDR to the STNA. It was these two departments which carried out the read-out at the request of the BEA. It was at this point that confusion unfortunately set in, due both to the sense of urgency and to everyone's desire to understand what had happened as soon as possible. The read-out began immediately, without notifying the BEA and without waiting for an investigator to arrive. The CVR was listened to by DGAC executives, the parameter listings were sent to the DGAC, and their examination began immediately in its office.

Of course, everyone acted with the utmost integrity, no one tried to influence the interpretation of the facts in any way, and the setting up of the investigation commission made it possible to get things back under control, but the damage had been done. The controversy was fuelled by these shortcuts, this confusion of roles, the victims lost confidence in the investigation, everyone focused on the long legal proceedings, the successive trials, and safety became the poor relation in this case.

Several developments resulted from this affair. The need to have enough experienced investigators to ensure our presence wherever investigative acts took place. The reinstatement of recorder read-out and analysis work by the BEA (later, because some judicial players were trying to restrict our access to the work requested from CEAT or to the results of these examinations, I also reinstated part of the workshop examination of wreckages). A clearer distinction between BEA agents and DGAC agents which led to the regulatory provisions that we know, but also to the installation of the BEA on its own premises.



Even for the logistics aspect, it became clear that we needed to control the management of our resources, otherwise we'd run into delays or be handicapped in carrying out our investigations. This was the case for the management of travel abroad, which for a long time had been handled by the DGAC. At the end of December 1996, for example, I had to send two investigators to Mexico. A member of the DGAC cabinet refused my request for an upgrade, which took into account a particularly arduous journey, followed by an on-site investigation on arrival. The effectiveness and safety of tired investigators seemed to me to be compromised, so I had to impose my position, but it wasn't easy... I also sometimes had to charter ships to recover recorders at sea. There aren't many suitable ships in the world, they're very busy too, and it usually takes them several days to arrive on site because of the distances involved. Given the short range and limited transmission time of the transmitters attached to the recorders, I had to move fast every time, without being hampered by administrative procedures that weren't designed for emergencies...

Being reliant on the DGAC or the Ministry for the dissemination of information during the investigation and the publication of reports was also a handicap. On the one hand, it cast logical doubt on our authority to carry out investigations, and on the other, it could be seen as a deliberate lack of transparency. This was detrimental to building confidence in the BEA's conclusions and recommendations. But safety cannot be achieved without everyone's support, otherwise the residual failure rate will remain high, influenced by the famous "not seen, not caught" attitude.... So, here too, we had to transfer these responsibilities to ourselves, which led to regulatory adjustments and resulted in total independence in the publication of reports and information briefings. The final turning point came with the investigation into the Concorde accident. Alain Monnier, head of the

Inspectorate, chaired the investigation commission; at its first meeting, we had to improvise a press conference in front of the large number of journalists who had turned out for new updates - rather than speaking, he decided to emphasize the role of the BEA and let me take the floor.

I would like to make one comment at this point. To succeed in this new challenge, the legal right to inform, and even to be the only one that informs, was not enough.

Independence without expertise never lasts very long. We had to be even more rigorous in our investigations, continuously separating established facts from ongoing investigative actions and mere supposition, and not communicating haphazardly, so as not to run the risk of misleading anyone. I had to learn how my new press contacts worked - they are essential partners when it comes to providing information - so as to take into account their own constraints. Of course, we had no business getting involved in polemics of any kind, nor confusing communication providing information with promotional communication - it was neither our role nor to our advantage, and I was careful to avoid such mistakes.

I've used the word "independence" a lot. It's a fundamental concept, as I've already said, but it's sometimes misunderstood. Everyone immediately sees it as total freedom of action and speech, and that's true, but within the strict framework of regulations and respect for the missions of everyone else. I have to say in passing that all the ministers and director generals I have worked with have truly respected this necessary independence. Mr de Robien even told me one day that, as Minister of Transport, he considered himself the guarantor of the BEA's independence. By way of illustration, during the investigation into the Gonesse disaster, it very quickly became clear to me that, far from returning the aircraft to service as quickly as everyone wanted, it would be



better to suspend its certificate of airworthiness until a satisfactory level of safety had been re-established. A safety recommendation was therefore drawn up, and I presented it to Mr. Gayssot at a meeting. I was prepared for a showdown, as this recommendation went against what I knew he wanted. Well, I was surprised... Not by the support of Alain Monnier, Jean-François Grassineau and René Gaudin, then head of SFACT, which I had expected, but by the Minister's confidence. Without even asking for an explanation, he replied something like "if you think it's the right thing to do, go ahead, we'll comply with your recommendation as soon as it comes out".

We often forget that independence from ourselves is just as important - the investigation must not be influenced by our opinions, sympathies or previous stances taken, in short, nothing must compromise our neutrality. This imposes certain constraints and precautions on us, particularly when it comes to drafting safety recommendations. But a potential difficulty exists insofar as a good investigation requires the involvement of experts, in particular from the aircraft manufacturer and operator, alongside the investigators.

This is necessary if we are to work quickly and efficiently, and to permit the implementation of satisfactory provisional safety measures but we are aware of the risks of interference that this presents. That's why this association is very clearly defined and managed to avoid any mishaps, whether in the course of the investigation, in the drafting of its conclusions and recommendations, or in communication - I was thus led in 2008 to exclude the experts of a foreign air operator whose president had expressed an opinion on the progress of the investigation, without consulting the BEA of course. In any case, the best guarantee of investigation independence, in every sense of the word, is the involvement of investigators from other countries, which is almost systematic when it comes to commercial air

transport accidents. Not only are foreign investigators fully associated with the investigation work and the drafting of the report, but they also have the opportunity to add their comments to the report in the event of diverging views. I'll take just one example, the investigation into the accident to an ATR in the USA, where major differences in the analysis emerged between the American and French teams. The NTSB in charge of the investigation, as the accident had occurred on its territory, not only published our comments at the same time as its report but, as the said report had to be solemnly presented to the American press, it accepted and facilitated the additional information briefing I had organised with the support of our embassy.

In conclusion, and to sum up my presentation, there are three complementary requirements for effective, complete and useful safety investigations: firstly, the entity in charge must be capable of carrying out its investigations, which implies expertise, means and organisation; secondly, it must be able to act without hindrance or restriction in its investigations and in the dissemination of their results, which implies genuine functional independence; finally, it must be totally neutral and objective in its approach and conclusions, which implies absolute independence from any preconceived ideas or considerations that are not strictly safety-related.

These requirements are perfectly summed up in paragraph 5.4 of Annex 13, which states that the accident investigation authority shall have independence in the conduct of the investigation and have unrestricted authority over its conduct."



Perspective

Jean-Pierre Bonny

Attempts to apply pressure

In his colourful, direct language, Jean-Pierre Bonny recalled, a few years ago, attempts to exert pressure on him during his time as director of the BEA. The source of this pressure is sometimes surprising...

"In addition to pressure from the media, there is also pressure from aircraft, engine and on-board equipment manufacturers... not forgetting pressure from flight crew unions, if the latter are a priori implicated, and from air traffic controller unions when the latter's actions have not been absolutely clear-cut, which is almost always the case.

In fact, control messages are very brief, to give all the traffic time to intervene, and they are transmitted using radio equipment that is far from high-fidelity technology. What's more, they are almost always exchanged in a language that is not the mother tongue of one or both of the protagonists. As a result, they are sometimes at the very limit of being understood!

But the strongest pressure came from the victims' beneficiaries, whose interests depended on the person responsible for the accident. This pressure was always strongly supported by the press.

Despite all the above, we always managed to find one or more plausible explanations for each accident. But which of them was the right one? This point was fundamental for the judge, since his decisions, particularly in terms of compensation, would depend on it. For us, it was less important.

Indeed, as soon as a cause of an accident was identified, it meant that actions had to be taken with respect to the equipment, the training of personnel or the navigation procedure, exactly as if it were "the cause" of the accident. In this way, we were sure to avoid any further accidents due to that cause!

This philosophy did not suit the beneficiaries and their lawyers however. It was this reason that pushed

me to prohibit my investigators from accepting their appointment as legal experts by the judge. The objectives of the two types of investigation were too different for them to be carried out by the same person. What's more, information was sometimes confided to us which was useful for our technical investigation but that we wouldn't have obtained if it had automatically ended up on the judge's desk. After all, as I sometimes said to the judges themselves when they had irritated me a little too much, I considered my work more important than theirs, because it was forward-looking. My work was aimed at preventing new accidents, whereas theirs was focused on the past, since their sole aim was to punish if there was a fault and to compensate! I added that hindering my work was tantamount to failing to assist a person in danger!

And yet, how many times have I had to endure obstructions by judges? And this despite an interministerial circular specifying the essential coordination of safety and judicial investigations. I even had to remind a Tarbes judge of the existence of this circular, when he wanted to forbid my investigator from visiting the scene of an accident. He replied: There are too many circulars and they are killing us. This is what I do with them! accompanying his words with a hand gesture so vulgar, but so significant, that I still regret not having told him that in future we'd have them printed on silk paper, so as not to hurt his noble backside!

In short, because of all the difficulties the judges created for me, how do you expect me to take some of them seriously when faced with the attitude they have in so-called "cases"?"



1981. Accident to the Douglas DC-9 registered YU-ANA operated by Inex Adria Aviopromet, near Ajaccio (Corsica)

On 1 December 1981, the aeroplane, flying from Ljubjana (Slovenia) to Ajaccio, crashed into a mountain range, killing 180 people (173 passengers and 7 crew).

The investigation commission concluded that the accident was caused by the crew starting the descent below the safety altitude. Factors which contributed to putting the crew in this situation included a lack of concentration on the part of the pilots, due to the presence of the co-pilot's son in the cockpit, and misunderstandings between the crew and control. Eleven safety recommendations were issued by the investigation commission, including one aimed at improving the CVR recording and installing recorders in the towers and control rooms.

- Nearly 200 fatalities
- Led to the improvement of voice data recorders.
- Can be compared to the accident to the Airbus A310 registered F-OGQS operated by Aeroflot on 23 March 1994 en route over Siberia (75 fatalities).



This part of the Douglas DC-9 wreckage shows the difficulty of getting to the mountain site of the accident.



Perspective

Jean-Pierre Bonny An attempt at corruption

"The most serious of all the accidents I had to investigate was the one involving a Douglas DC-9 operated by the Yugoslav national airline on 1 December 1981. This aeroplane, a very recent and practically new model, crashed on one of Corsica's peaks, Mount Pinto, during approach manoeuvres to Ajaccio-Campo dell'Oro airport. The accident claimed 180 lives.

The crew, whose captain had had to be replaced at the last moment before take-off, were not acquainted with the specific approach procedure to Ajaccio and were not concentrating on piloting the aeroplane, as the analysis of the voice recorder showed. As a result of an altimeter setting error, the aeroplane struck Mount Pinto.

An "anecdote" with respect to this accident speaks volumes about American principles and business practices when their interests and the dollar are at stake. The day after the accident, a high-ranking representative from Douglas, the aeroplane's manufacturer, asked me for an appointment and tried to get me to send a telegram to his company immediately, stating that the plane itself was not to blame.

He told me that many purchase agreements had been suspended, with future buyers waiting to know the exact cause of the accident before committing themselves, and that the damage to Douglas was immense.

From the movement he made towards his wallet and the look on his face, I understood that it was now possible to

sell my honour for a very high price!

I replied that I cannot be purchased, and that right now, we don't know anything about this accident. Perhaps your plane is not implicated? If that's the case, you'll receive a telegram confirming it, as soon as we're absolutely certain. For the time being, there's no question of making the slightest assumption. And then, Sir, please, have a little decency! The dead haven't been cleared from the rubble yet!"

He left without looking back, but without slamming the door. A few months later, he received the telegram he'd been waiting for, because the plane hadn't caused the accident, and at this time, there was no longer the slightest doubt on that point. It was a case of "amateur" flying of the aircraft by an unmotivated crew unfamiliar with the procedure, who had not taken into account the safety altitude and had not even tried to understand the control messages, which were admittedly a little ambiguous.

This last point, mentioned in the final report, as it should be, was to cause some difficulties with the unions. But that was the least of my worries! On the other hand, I'd missed out on the chance to be a millionaire in dollars, but my conscience was at rest, and that's worth just as much!"



Perspective

Michel Baroin's death in Cameroon: In the absence of a report, rumours spread

based on Jean-Pierre Bonny's perspective

Of course, the publication of an investigation report, even in the *Journal Officiel*, is no guarantee that far-fetched rumours will not appear at a later date. *"The Air France Caravelle accident [11 September 1968, off the coast of Antibes] is unfortunately the most perfect illustration of this: the investigation work, the underwater searches at a depth of over two thousand meters - a feat for the time - the CVR transcript included in the report, all of this was confronted with a rumour whose starting point was what a soldier had confided one evening in a bar... Appalling!"*

The worst situation, however, is when the investigation does not end with the publication of a report. To say that aviation safety is jeopardized by the absence of a report would be wrong: when an investigation concerns a commercial air transport accident, it is international. It is extremely rare for an accident to occur where the same State of manufacture, State of the operator and State of engine manufacturer are involved.

An investigation is international, and has investigators from several countries working together, with the technical advisers from the manufacturers and the airlines. In short, all these people know exactly what the situation is. And by extension, the world of civil aviation can see if any changes are made after an accident, and can draw the appropriate conclusions.

"It's terrible, firstly for the families of the victims, and secondly it leaves the door open to a whole host of eccentrics who, under cover of theories with a more or less scientific veneer, claim to explain a disaster. They may be swindlers, emissaries of more or less crooked lawyers, pseudo-legal experts, who knows what else."

I often quote the accident to the Learjet in Cameroon in 1987, which killed nine people and received a little media coverage because it was carrying Michel Baroin, then head of GMF and FNAC, close to political circles of all colours, and whose son, Michel, would later become a minister. Even though I was already retired at the time, I know that there was good cooperation between the investigators of the Cameroonian investigation commission leading the investigation, and the BEA and the NTSB investigators as well as with the manufacturer's technical advisers.

At the end of the investigation, a fifty-page report was drawn up...

and classified as confidential by the Cameroonian authorities.

In the years following the accident, several people, often journalists, got hold of the "mystery of the Baroin accident", listened to rumours of an attack or who knows what and took them at face value by spreading them.

And the investigators who worked hard on this investigation have to keep quiet out of respect for the decision not to publish the final report."

A report which
is classified as
confidential by an
investigation authority
risks fuelling rumours
and
frustrating the
investigators
who worked
on an accident



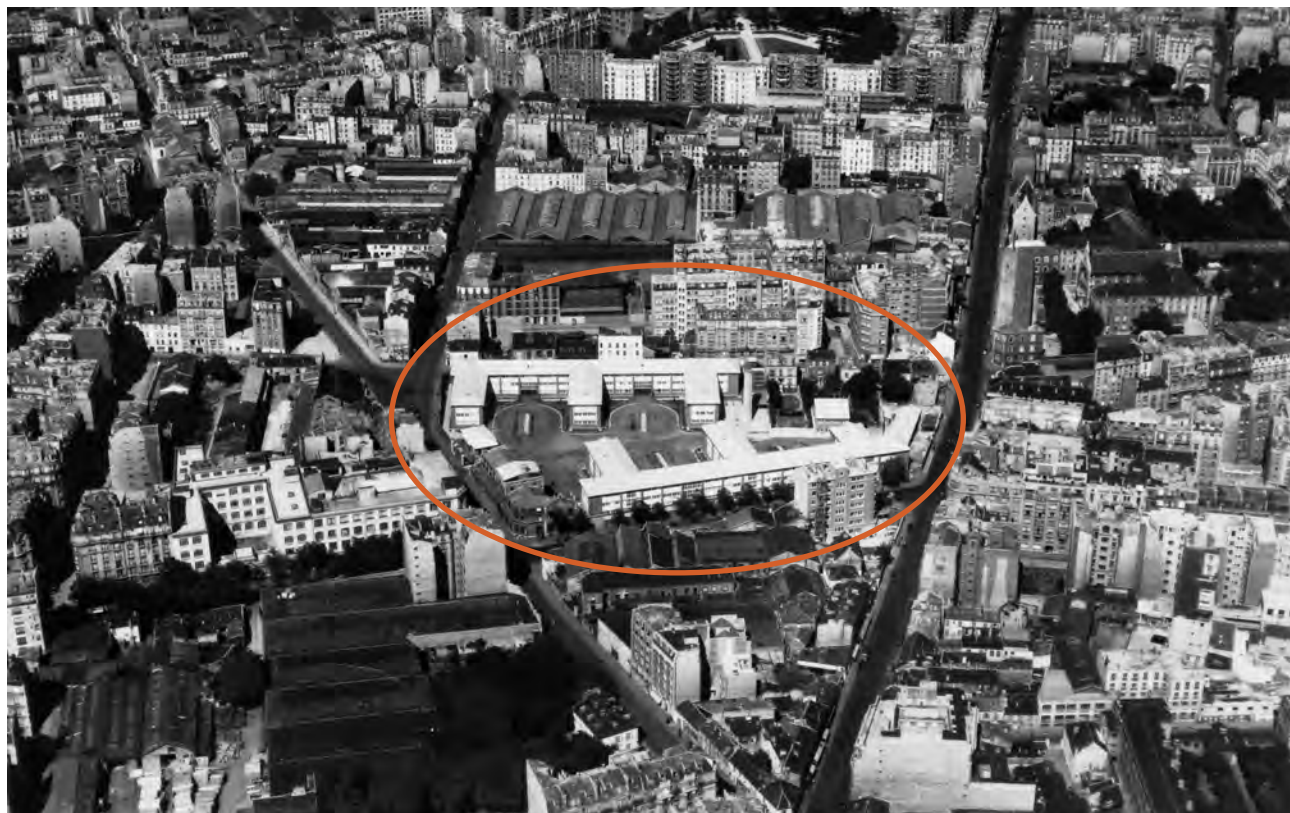
Chapter 2

Resources available to the BEA



The BEA's premises at Le Bourget, in the foreground, the Costes and Bellonte hangar and in the background, the administrative and technical Nungesser and Coli building





The “Convention” administrative centre (in ring) in the 15th arrondissement of Paris was home to the BEA until 1994 when the BEA moved to Le Bourget.

Real estate

After the Second World War, the Civil Aviation services were lodged in a newly-built administrative centre in the 15th arrondissement of Paris, originally for a duration of ten years or so. The complex covers an area of 1.5 hectares, between Rue Lecourbe, Rue de la Convention, Rue de Javel and Rue de la Croix-Nivert.

The *Bureau Enquêtes-Accidents* was housed in the same building as the Civil Aviation General Inspectorate. It's a well-known fact that what is temporary lasts... And the BEA stayed there until 1994.

It then moved to its new headquarters at 10 rue de Paris, on the site of Le Bourget airport, next

door to the Air and Space Museum. Today's headquarters house the offices and laboratories. To cope with the growing number of missions, the surface area was extended in 1999 from 1,000 m² to 3,000 m², then to 5,000 m² in 2002.

In 2018, the buildings were supplemented by a hangar, dedicated to the technical department, built on the site and used to store aircraft wreckage so that they can be analysed and certain parts and components removed during some investigations.

This hangar, named “Costes et Bellonte”, meant the BEA no longer had to rent hangars scattered around Paris.





Le Bourget at the end of the 1950s. Construction work on the A1 motorway is in progress. In the centre, the future BEA premises with, in the ring, the part that will be destroyed and provide land to accommodate the current Costes and Bellonte hangar.

15 December 2017. Rémi Jouty, Director of the BEA, laying the first brick of the hangar after having inserted a document signed by all the BEA agents present that day.

2018. Construction work in progress on the Costes and Bellonte hangar. Used for storage and analysis of wreckage parts.





BEA personnel during the inauguration of the Costes and Bellonte hangar.
In the foreground, wearing the BEA helmet: Jean-Louis Mattera and Rémi Jouty, respectively, Secretary General and Director of the BEA.

Weekly meeting for the preliminary analysis of the occurrences of the previous week.



The modern laboratories can be used for example that flight recorders can be opened before they are analysed.





The BEA's technical hangar has been one of the assets of the Le Bourget headquarters since 2018, enabling wreckage or aircraft parts to be stored before being analysed.



Financial resources

The BEA is a department which has national jurisdiction, administratively placed under the head of the General Inspectorate for the Environment and Sustainable Development (IGEDD).

The budget concerning the DGAC and the BEA is called the BACEA: *Budget annexe Contrôle et Exploitation aériens*¹. There are only two annexed budgets in France, the BACEA and the annexed budget for official publications and administrative information (DILA: *Direction de l'information légale et administrative*).

The BEA has its own program operating budget (BOP No 3 of program 614 of the *Budget annexe Contrôle et Exploitation*). To optimize the quality and effectiveness of the support it needs for its mission, the BEA has signed an agreement with the DGAC. This enables the BEA to benefit from the DGAC's financial structures, while retaining its budgetary independence. The BEA also uses a number of logistical tools shared with the DGAC.

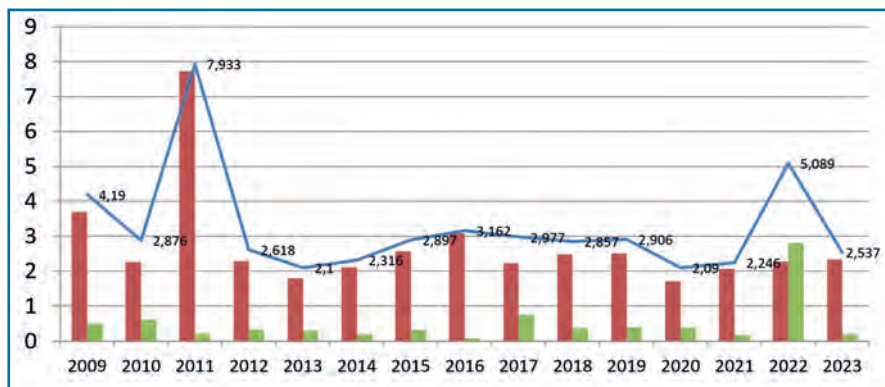
The average operating budget over the last ten years has been €2.83 million.

Commitment Authorisations (CA)

Commitment authorizations (CA) represent the upper limit of expenditure that can be committed. They are fully consumed from the moment the expenditure is incurred, i.e. when the legal act committing the State's expenditure is signed. Commitment authorizations are the means for committing to expenditure that may be spread over several years, for example in the case of capital expenditure, where completion

1. The BACEA is enshrined in article 18 of the LOLF (*Loi Organique relative aux Lois de Finances*) of 1 August 2001 No 2001-692. The LOLF is the State's financial constitution.





Evolution in the BEA's Commitment Authorisations budget from 2009 to 2023.

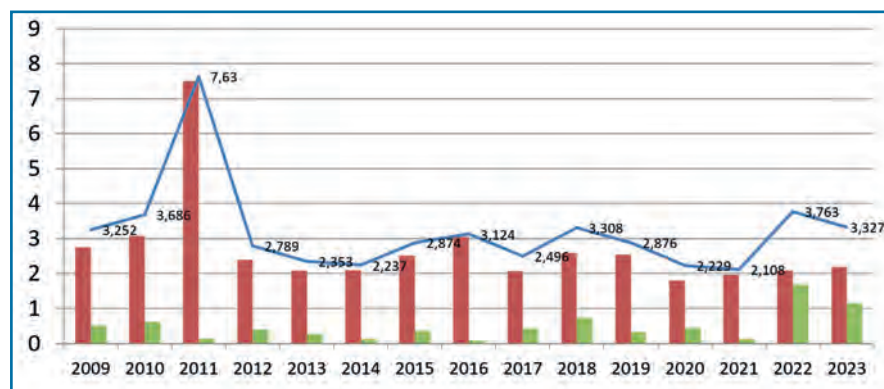
and payment may be staggered over several accounting periods.

Payment Appropriations (PA)

Payment appropriations (PA) represent the upper limit of expenditure that can be authorized or paid during the year to cover commitments entered into under commitment authorizations. They are the means for paying previously committed expenditure. In the case of a legal commitment spanning several accounting periods, the consumption of PAs is staggered over several budget years, until the total of the initial commitment authorizations is reached.

The BEA's budget enables the department to operate on a nominal basis and carry out its investigation missions. In the event of a major accident requiring exceptional resources, the BEA calls for discussions between the French government and the various parties involved.

For example, the cost of sea searches as part of the investigation into the accident to the Airbus A330-203, registered F-GZCP and operated by Air France, on 1 June 2009 over the Atlantic Ocean was €31 million¹. Of this sum, €15 million was borne by the BEA and €16 million by Airbus



Evolution in the BEA's Payment Appropriations budget from 2009 to 2023.

and Air France (€8 million each).

The cost of the investigation into the accident to the AIRBUS A380-861, registered F-HPJE and operated by Air France, which occurred on 30 September 2017 in cruise over Greenland was around €3.3 million. It was shared between the BEA, AIB-DK, Air France, Airbus, Engine Alliance, etc.

The BEA and its Danish counterpart together spent around €1.4 million.

1. See page 68 of the sea search operations report

Human resources

For the last twenty years or so, at the time of publication of this book, there have been around one hundred agents assigned to the BEA. The BEA has three departments (Investigations, Technical and Communication), a General Secretariat and a Director's Cabinet.

The investigations department directs and coordinates safety investigations, drawing on the expertise of the technical department and the laboratories of its Flight Recorders & Avionic Systems and Structures, Equipment and Engines sections.

The Communication Department defines the BEA's communication strategy, and is responsible for all internal and external communication channels (Internet, Intranet, social networks, YouTube, etc.).

It is also responsible for publishing investigation reports, ensuring that the next of kin of the victims are informed before publication, and maintaining relations with the stakeholders in the investigation.

The General Secretariat groups together all the support functions essential to the nominal operation of the BEA and more particularly those

specific to the BEA's activity, such as always having the ability to deploy agents throughout France and the world.

Finally, the Director's Cabinet is composed of the BEA's expertise in European and international relations, as well as several advisers, including a medical adviser who contributes his knowledge to certain investigations.

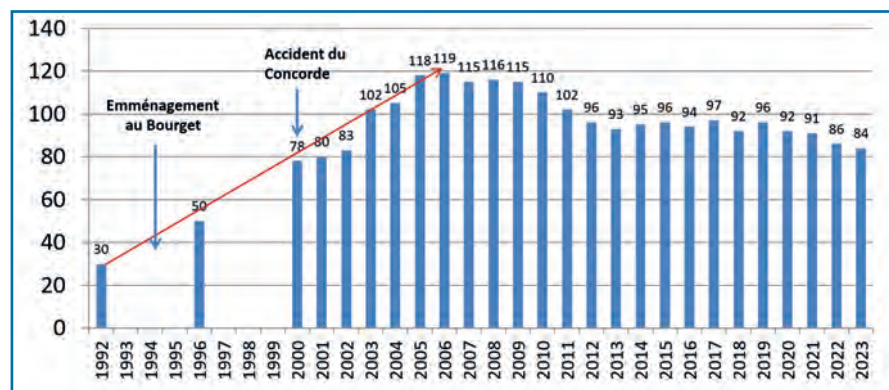
Most BEA staff are civil servants from different professional bodies (administrative staff, civil aviation advanced technicians (TSEEAC), specialised manual workers, engineers from engineering schools (Ponts, Eaux et Forêts (IPEF), etc.)). The workforce is supplemented by a number of staff who are not civil servants and who have specific skills.

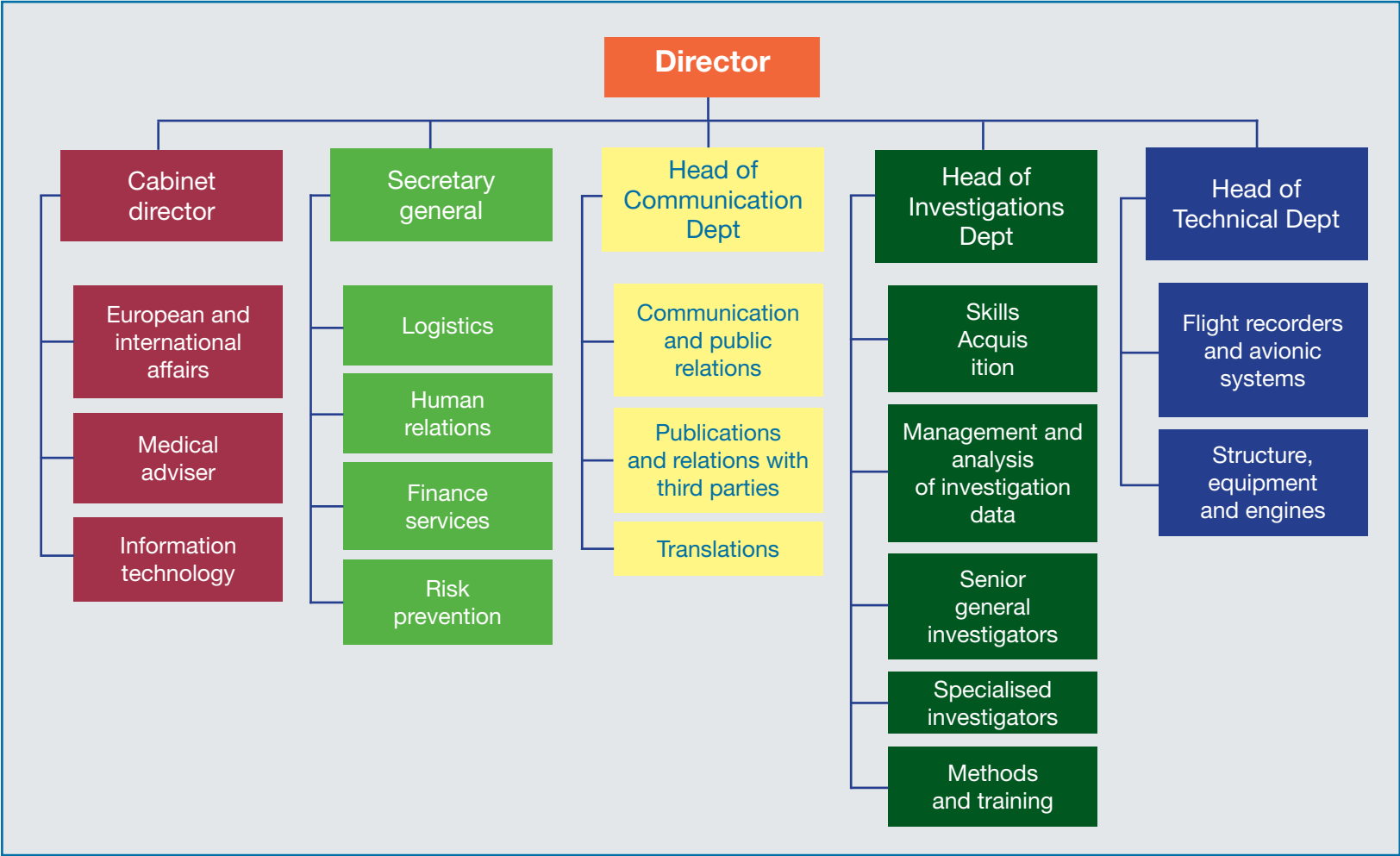
Depending on the specific needs of the BEA, staff may come from a wide variety of backgrounds, including :

- École Nationale de l'Aviation Civile (ENAC) ((National School of Civil Aviation);
- DGAC (French civil aviation authority);
- French Air and Space Force,
- Private sector (airlines, research laboratories, etc.).

Depending on the profiles recruited, the BEA can provide training for agents, notably within the Investigations department, where they can progress from the "Skills Acquisition" section to the "General Investigators" or "Specialized Investigators" sections. This is a means of ensuring recurrent training, transmitting knowledge and skills, and conserving the BEA's investigative capabilities, while at the same time welcoming new talent.

Evolution of the BEA's workforce since 1990





BEA's organisation chart in 2024



Chapter 3

Technical resources for the investigation



X-ray tomograph analysis of a part



The laboratory

At the beginning of the 1990s, the BEA laboratory in the Convention building was still in its infancy, created and run, with much merit, by Jean-Christophe Antoine. In the mid-1990s, it was still of a modest size when Jérôme Bastianelli took charge: *“As the laboratory was still recent, it often had to rely on its military counterpart, the flight test centre, the RESEDA (readback of accident recorders) located at Brétigny-sur-Orge, as well as the CEAT in Toulouse and the CEPr in Saclay.”*

The materials laboratory was run by Estelle Bancharel. Her laboratory had only limited resources, and had to act as an intermediary between the BEA and subcontracted laboratories, such as the CEPr, CEAT or a test centre in Gramat (Lot) when searches for traces of explosives, suspected of being the cause of an accident, had to be carried out.

For the read-out of CVRs, the laboratory relied on two people, Philippe Plantin de Hugues and Philippe Boyeldieu, who were always present. The decoding of the FDR was carried out by Jean-Marc Lapene and the technician Philippe Jimenez. Paul-Louis Arslanian, wishing to see the laboratory gradually become autonomous, endowed it with budgets that were, if not unlimited, at least quite generous.

At the time, experts had difficulties reading out the “F800” recorders, the first tape recorders, and had to make do with the direct play back

of undamaged recorders, with cables plugged into the recorder. A small company, “CTS”, with Dominique Lopez, who worked in collaboration with the laboratory, had developed a promising small read-out interface.

Anything that could not be read out, particularly certain tape recorder models, still required the use of the RESADA station at the CEV flight test centre at Brétigny, as was the case for the

A flight recorder is connected to a read-out bay to extract the data from it (audio recordings or flight data)



Perspective

Jérôme Bastianelli

“Ten exciting years at the BEA”

Jérôme Bastianelli
in the BEA lab in the
1990s.



“I entered the world of aviation somewhat by chance, having learned to fly small single-engine aeroplanes while studying at the École Polytechnique, thanks to the facilities the school offered us at a flying club in Saint-Cyr-l'École. I liked it right away, and I then chose to join the civil aviation engineering corps, which enabled me to perfect my skills at the ENAC for two years.

One of the jobs on offer at the end of our studies was a position with the Bureau Enquêtes-Accidents (as it was still called back then, in 1995). I contacted the director of the BEA, Paul-Louis Arslanian, for an interview, we hit it off right away, and he recruited me. For a few months, I was in charge of various air safety studies, particularly in general aviation, and of setting up a European database which, I believe, still exists, ECCAIRS (European Coordination Centre for Accident and Incident Reporting Systems).

In 1996, on returning from my “Corps techniques” pilot course, Paul-Louis Arslanian did me the honour of putting me in charge of the Technical Department - the post had been vacant for several months after the departure of my friend Jean-Christophe Antoine. I spent ten exciting years in the department where we were a small team of young engineers, with a lot to learn and a lot to develop to make the laboratory an internationally recognized player. It was truly a wonderful adventure, in the service of air safety. Then I wanted to do something else, so I went to work for the Cour des Comptes (moving, as I was jokingly told, from “boîtes noires” to “caisses noires”), then my taste for culture led me to the Quai Branly museum, where I am now Deputy Managing Director”

Habsheim accident in 1988 and the Mont Saint-Odile accident in 1992. This was a situation that Paul-Louis Arslanian no longer found acceptable, not out of mistrust for the CEV flight test centre, but in order to reinforce the BEA's credibility.

The BEA gradually acquired the tools so that it could extract and decode data from recorders itself, including those damaged in accidents.

To improve data processing, the BEA began working with a Canadian software package called RAPS, developed by the TSB (the Canadian equivalent of the BEA). However, small tensions arose with the TSB when it began charging for this tool, even though the BEA had contributed to its development.

This attitude was poorly viewed and in the 2000s, thanks to the recruitment of a young engineer, Léopold Sartorius, the BEA developed its own data processing tools based on a MATLAB software package, enabling it to do without RAPS for good.

Franck Giraud, IEEAC, had joined Jérôme Bastianelli in 1996. The Bastianelli-Giraud team began to develop the tape recorder read-out, while preparing for the arrival of digital recorders, thanks to a sizeable budget.

The equipment of the day came from L3COM for the F800 and then the F1000, and Honeywell for its UFDR, the 4100, and DFDR, the 4700.

“Data is coded at a rate of 768 bits per second, with each second beginning with a “synchronization word” that identifies the start of the sequence - a bit like DNA sequencing!”

The BEA invested between 200,000 and 250,000 F for each model of recorder, in order to have the corresponding read-out equipment. *“Each company only sold the equipment needed to read-out the recorders they manufactured. We*



had to have them all. There were negotiations with the Financial Control, which were sometimes a little difficult, as we had to explain why we were awarding contracts without making calls for tender,” explained Jérôme Bastianelli.

Paul-Louis Arslanian lent his full support to these negotiations, and in parallel with the purchase of equipment to read out the recorders, undertook the recruitment of new engineers. Computer science, aerodynamics, electronics - several fields were concerned.

In these same years, there was a recruitment rate of one member of staff per year. One of these new recruits, Yann Pihan, IEEAC L, an electronics engineer, was put in charge of dealing with recorders that were not black boxes (see opposite).

During this period, the BEA began to accept requests from abroad to help its counterparts read out recorders damaged in accidents, in which the BEA had no other reason to be involved. This phenomenon was set to increase, due to the growing recognition of the BEA's capabilities in this field and the small number - five or six - of laboratories in the world capable of reading out recorders: the Canadians, the British, the Germans, the Australians and the Americans.

The ability to repair flight recorders still requires a bit of “resourcefulness”, with modified tape recorders and the skills of the technicians who have developed this part of the tape read-out activity.

Since the Habsheim accident, the BEA had equipped a room dedicated to the opening of recorders, with a video camera that certifies the opening of them and avoids controversy over the authenticity of the recordings, as well as allowing its personnel to work in a calm environment after an air disaster. In fact, this procedure has become

Perspective

Jérôme Bastianelli

The magical garnet stone!

“To read out the most damaged tapes, we sometimes used a rather magical little device: the “garnet stone”. This is a device that optically reveals transitions on a magnetic tape. If you pass the tape slowly over the garnet, and observe it under the microscope you will see white marks appear on a black background, a kind of inverted barcode. When you measure the distance between two white marks, you know which value is encoded: zero or one.

It's obviously very tedious, because you have to take several dozen photos for a single second of recording. We did this once with Franck Giraud, as one or two seconds were missing from an accident in Indonesia in 1998. But after four days' work, we were astonished to find that what we were decoding didn't correspond at all to the accident: we'd been on the wrong track! During the night, we had to start all over again so that by Friday morning the decoding was ready. Garnet wasn't used very often, but I keep this example in mind.”

Yann Pihan

Not a “black box”

Yann Pihan took a particular interest in recording devices other than the traditional “black boxes”, such as GPS, Go Pro, tablets, smartphones or specific calculators likely to provide valuable additional information. These recording devices can be equipped with non-volatile memories that can be separated to be read out, or volatile memories, which are more difficult to read out given the silence of equipment manufacturers'. The BEA was the first to focus on these devices, convinced that it was possible to “make them talk”. Yann Pihan developed specific equipment for this purpose. Using these mass-market means of communication makes perfect sense, given their increasingly widespread use in general aviation...

the norm for investigation authorities...

This broadening of skills led to more and more requests for technical assistance from foreign countries, even in the absence of French involvement. At this time, the BEA worked with African countries, the Swiss and the Belgians, as well as more distant countries such as Iran. The latter often came to the BEA because of the embargo imposed on it by the Americans. An embargo which also posed a problem for the laboratory when the American authorities refused to release the decoding table of an Iranian Boeing which had been involved in a serious incident.



Opening a recorder under the eye of the camera in order to certify the operations.

This table was essential, however, as the position of a parameter in the 768 bits recorded each second varies from one aircraft to another.

"We tried a lot of different tables, it was quite annoying, like standing in front of a door with a huge bunch of keys and not knowing which one to use," Jérôme Bastianelli recalls.

The number of foreign requests was so high that the BEA lab found itself having to read out up to a combined total of 90 CVRs and FDRs a year.

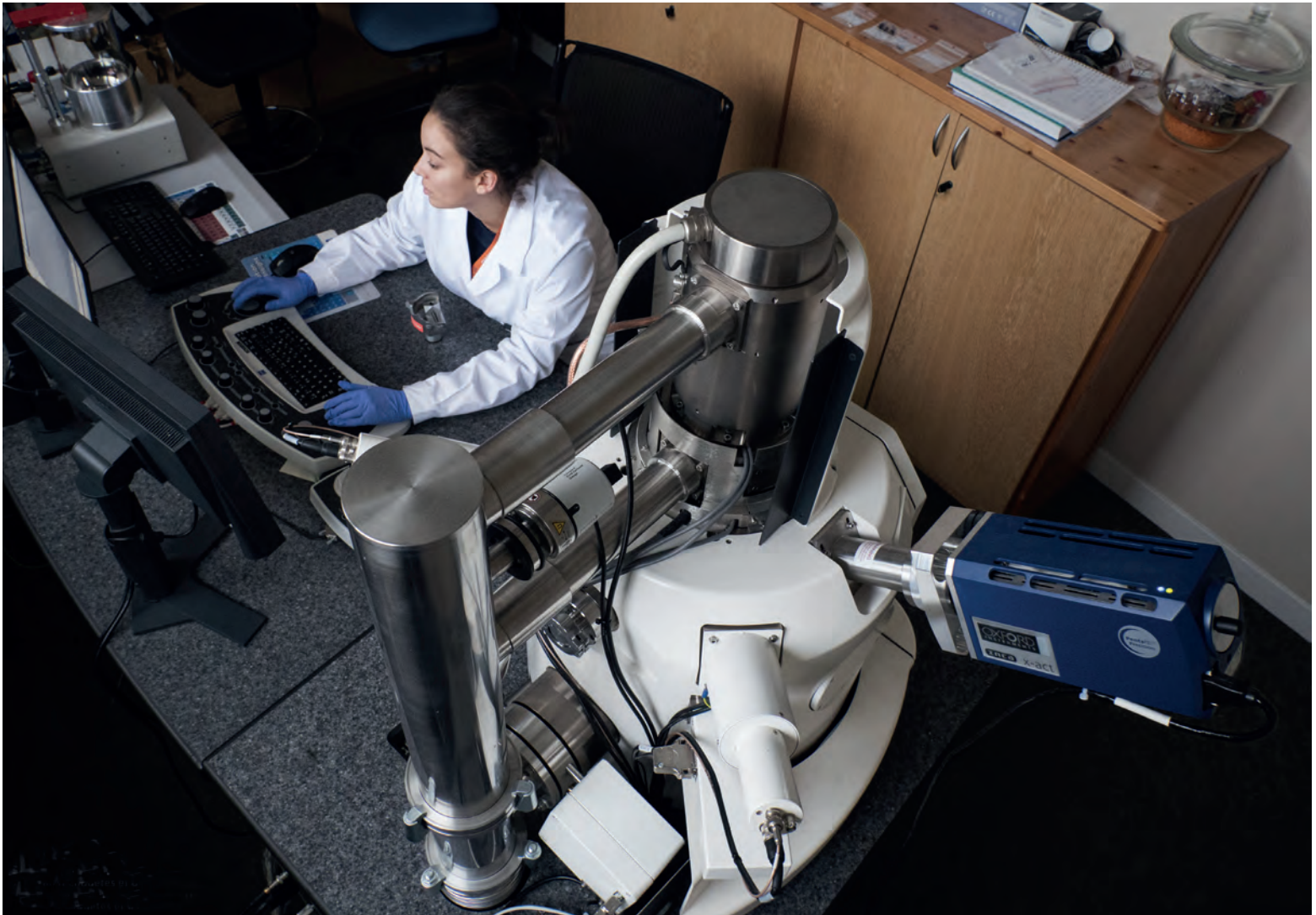
Material analysis

The BEA enhanced its materials analysis capabilities by the purchase of a scanning electron microscope in 1988.

Expertise also increased with the arrival of Achille Awade, a materials fracture specialist from Togo.

Caroline Regenet then joined the team, increasing the number of metallurgical examinations that could be carried out by the BEA.

A large x-ray system (costing €200,000) was added to the existing equipment. It could be used not only to see the materials, but also inside the recorders. When Yann Pihan left for Toulouse, he was replaced by Jérôme Progetti, whose work greatly advanced the BEA in the electronics field. As for the CVR work, it was still going strong with the two Philippe's, Plantin de Hugues and Boyeldieu. From a staff of three in the late 1990s, the laboratory grew to sixteen in the mid-2000s, a fine example of the development of one of BEA's flagship departments.



The BEA has many high-tech tools at its disposal, such as the scanning electron microscope, capable of producing high-resolution images of a part's surface, using the principle of electron-matter interactions.

2015. Accident to the Germanwings Airbus A320 registered D-AIPX at Prads-Haute-Bléone (Alpes-de-Haute-Provence)

On 24 March 2015, the Airbus A320 registered D-AIPX, crashed in the Alpes-de-Haute-Provence region in France, killing all 150 people on board (144 passengers and 6 crew).

The aeroplane was flying from Barcelona in Spain to Düsseldorf in Germany. When the captain left the cockpit to use the toilet, the co-pilot changed the autopilot settings to command a descent. The captain was unable to return to the cockpit, as the access door could no longer be opened from the outside to prevent intrusion.

The aircraft began a rapid descent and struck the mountainside at high speed. The safety investigation carried out by the BEA showed that the co-pilot had rehearsed his action on the previous flight. It also revealed that this pilot, who suffered from depression and suicidal thoughts, had concealed his illness from his employer.

The BEA issued eleven safety recommendations, aimed at the medical assessment of pilots with mental health problems; regular analysis of in-flight incapacitation; mitigating the consequences of loss of license; antidepressant medication and fitness to fly; balancing medical confidentiality and public safety; and promoting pilot support programs.

- The only suicide of an active airline pilot in Europe
- Three heads of state near the accident site.
- Pilot had attempted suicide on outbound flight.
- The pilot had previously been hospitalized.



The aeroplane struck the Southern Alps at high speed.



New (left) and old (right) generation flight recorders.

In a safety investigation, the BEA's work begins at the accident site, notably by mapping the site and drawing up an exhaustive inventory of the elements present. As far as it is practicable, a number of investigation acts are carried out on site. These may include, for example, checking the flight controls, the condition of the landing gear or the level of fuel in the tank(s). On-site work may reveal a technical malfunction that needs to be confirmed, and what caused it identified.

This is why the BEA may need to bring all or part of an aircraft back to its facilities for analysis. From the whole aircraft (in the case of a general aviation accident) to specific elements such as the landing gear or a particular avionics component, the decision is taken on a case-by-case basis according to the specificities of the occurrence.

Wreckage parts taken from the accident site are sent to the laboratory for examination. They can be very diverse in nature: structural parts or fragments, mechanical assemblies, equipment, on-board instruments, bulbs from warning lights, fluids, debris, deposits.

The purpose of the examinations carried out is to determine what caused the failures of the various components and their possible involvement in the accident: cause or consequence? They may also provide additional information on the aircraft's configuration at the time of the



accident. These examinations are carried out in the BEA's failure analysis laboratory or in external laboratories, under the supervision of the BEA.

Within the BEA failure analysis laboratory, investigators now have the following resources at their disposal:

Observation equipment

- A macroscopic bench, a binocular magnifying glass and an inverted optical microscope, equipped with digital cameras and connected to image processing software for low and medium magnification observations.
- A digital microscope with a large depth of field.
- A variable pressure scanning electron microscope (SEM) with a large chamber for high and very high magnification observations and its metallizer.
- A real-time X-ray radioscope and tomograph for non-destructive examinations.

Preparation equipment

- A workbench for disassembling small mechanical assemblies.
- A micro-cutter, a hot coating machine, a polisher and a fume hood for preparing metallographic sections.

Measurement and test equipment

- A universal hardness tester (Vickers, Rockwell, Brinell),
- A microhardness tester (Vickers and Knoop).

Material analysis equipment

- A spark optical emission spectrophotometer for quantitative chemical analyses on metallic materials,
- An energy dispersive spectrometer (EDS)

Analysis of a part using a scanning electron microscope.

The BEA laboratory's staff have wide-ranging skills: from using grinders to operations requiring surgical precision.



coupled with a scanning electron microscope for qualitative and semi-quantitative chemical analyses.

For example, a detailed examination of the on-board instruments can provide information about their readings at the moment of impact.

Another example is the observation of the filaments of warning panel bulbs, which can determine whether certain lights were off or on at the moment of impact. This information makes it possible to identify any failures indicated in the cockpit prior to impact.

X-ray of two bulbs from two warning lights.

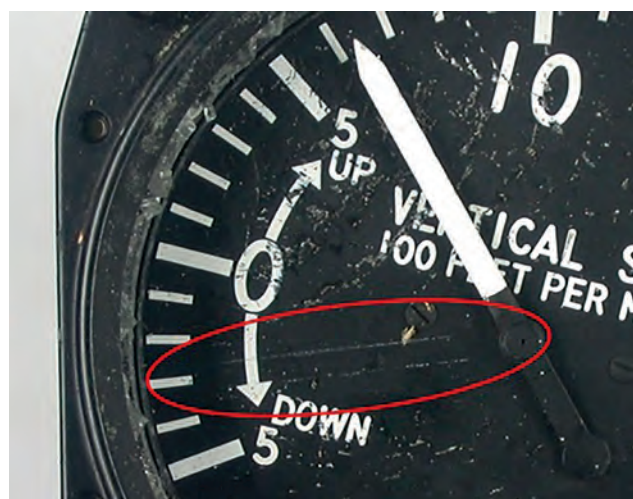
Top: broken filament, slightly deformed, coils not stretched - the filament was cold on impact, the warning light was off.

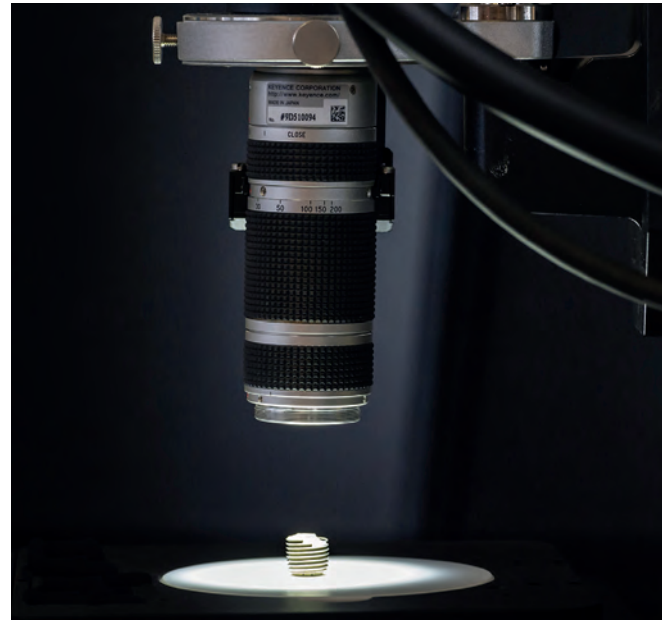


Bottom: filament not broken, general deformation, coils stretched - the filament was hot on impact, the warning light was on.



Photos of the dials of a tachometer and a variometer. Note the marks left by the needles at the moment of impact, indicating an engine speed of 2,200 RPM and a vertical speed of 300 feet per minute in a dive.





Electron microscope analyses.

The BEA wreckage specialists are on the front line when it comes to making technical observations and collecting parts.



Flight recorders Major tools in the safety investigation

Most BEA investigations into commercial aviation accidents are based not only on observation and analysis of the wreckage and its surroundings, but also on the analysis of data from flight recorders, commonly known as “black boxes”.



A short history A legacy of flight testing

Today's flight recorders represent the technological culmination of years of research and improvement, both in terms of data recording capacity and the mechanical strength of an on-board aircraft system. These recorders have evolved from photographic to analogue and finally digital technology, in step with the phenomenal development of mass data collection and processing. Flight tests prompted the first collection of on-board data.

Air Force engineer François Hussenot (1912-1954), faced with the need to collect numerous parameters during flight tests even before the Second World War, invented a system based on photography that recorded essential flight data. These cameras are said to be the origin of the term “black boxes”, which is still used today.

Quickly recognised for their value, HB flight recorders moved beyond the experimental stage and were industrialised by a company founded by François Hussenot, SFIM, in 1947. The irreplaceable contribution of HB recorders was quickly recognised in Great Britain:

- Several manufacturers used HB recorders for their tests in the early 1950s, notably (from 1952 onwards, if not earlier) de Havilland, Saunders, Folland and Rolls. Handley Page on the *Victor* (first flight on 24 December 1952 with two A13s and a photopanel); English Electric on its *Canberra* and Hawker on the P1127 (1955);
- in 1955, the British made HB recorders mandatory for official tests (A&AEE);
- Later, 70 HB recorders were ordered for the TSR2 programme, all of which were delivered before the programme was discontinued in 1965. The French flight recorder had thus made its breakthrough, and in 1954 the idea arose to use this invention to monitor the flight parameters of commercial aircraft. The aim was to increase flight safety by helping to identify the causes

A French invention, François Hussenot's black box



François Hussenot, left, with the engineer Mr Idrac.

In the wake of the Second World War, when the flight altitude and speed were about to take a new leap forward with the arrival of jet propulsion, flight tests were still the essential tool in the development of an aircraft: existing aerodynamic wind tunnels were ill-suited to exploring these new flight envelopes, and the computing and simulation resources that computers were to provide did not exist. In order to advance, it was accepted that risks would have to be taken in flight, risks that were all too often sanctioned by fatal accidents; at each funeral, the flight test family closed ranks.

Isolated in-flight measurements were gradually added to the pilot's report, but having a tool that could show the continuous and simultaneous evolution of the various flight parameters (altitude, air speed, attitudes, rotations, accelerations, control positions, etc.) remained the decisive step towards effective flight testing.

At the time, this requirement could only be met by photographic recording. For all the measurements converted into an electrical signal, the solution existed, with the signal driving the rotation of a mirror. Unfortunately, this was not the case for most flight parameters, as the corresponding measurement system in on-board instruments still involved direct "clockwork" transmission between

a sensor (barometer, capsule, gyroscope, gyrometer, accelerometer, etc.) and receiver (or dial). The only exception, with no need for a transmission system between the sensor and receiver, was the "ball". To take the decisive step, it was therefore necessary not only to develop a multiple photographic recorder, but also to adapt the on-board instrument measurement system to photographic recording, i.e. to develop specialized sensors installed in the recorder and driving mirrors.

This was the approach taken by François Hussenot who, since his arrival in flight testing in 1935, had been working with the Charles Beaudouin workshops on the industrial production of a multiple photographic recorder, as well as precision receiver sensors adapted to specific needs (altitude and speed capsules, gyros, accelerometers, etc.).

The oldest conserved recording (time, altitude, speed, "top") dates from 2 March 1940, and concerns a Potez 567 flight, a navy aircraft derived from the Potez 56. At this time, François Hussenot was at the CEPA in Saint-Raphaël.

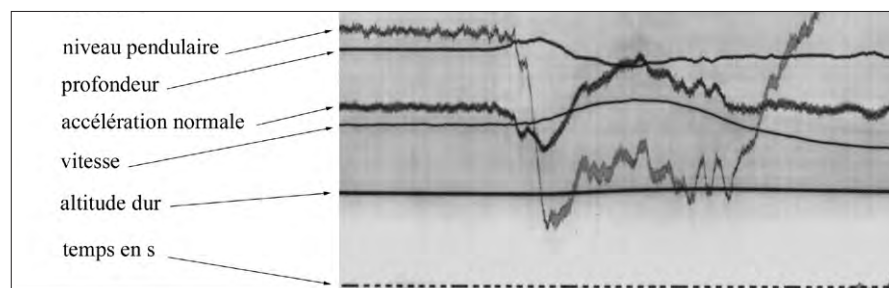
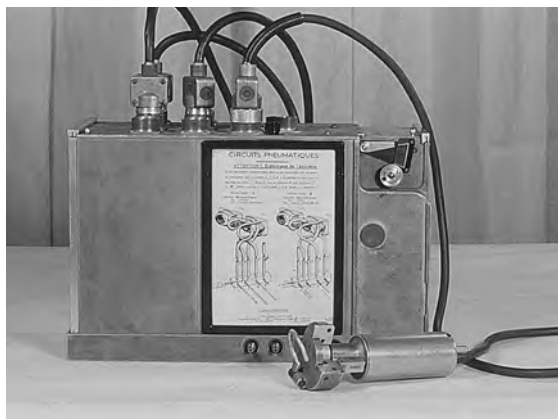
François Hussenot became one of the three members of the Commission des gros hydravions (Large Seaplane Commission) and, with the part of the Beaudouin workshops that had moved to Roanne, developed the HB for large seaplanes (SE 200 and Laté 631). By 1945, 25 HBs were available, complete with operating instructions; SNCASO's HB No 12 and its experiment researcher, Dubus, a former apprentice at the Charles Beaudouin workshops, are particularly noteworthy.

Isolated and out of touch after four years of occupation, France, although drained, had at its disposal, by 1944, the HB or Hussenographe "multiple" photographic recorder, unique in the world and well suited to the weakness of our resources and the modest size of our prototypes. When back from a flight, the HB tape was quickly developed photographically: even before it was dry, the tape provided an easy-to-read history of the flight, even if some young engineers could fall victim to optical illusions when analysing it. Folding these kilometres of tape was also a problem.

(Jean Forestier, *L'inventeur de la boîte noire, François Hussenot (1912-1951)*, in "La Jaune et la Rouge", École Polytechnique alumni magazine, No 583, March 2003.



The beginning of the “black boxes”: the A11 recorder and the measurement tape that it supplied to experiment researchers.



of accidents. To this end, an experiment called “100,000 flight hours” was set up jointly by the SGACC and the CEV flight test centre. It began in May 1954 with A20 recorders on ten aircraft (DC-6, *Constellation*, *Super-Constellation*) belonging to two French operators (Air France and TAI). Paid per hour of flight correctly recorded, SFIM was responsible for its implementation and monitoring. The planned 100,000 flight hours were reached in 1957. Convinced of the benefits of the system, the airlines very quickly requested, at their own expense, one-off recordings for specific tests or monitoring of aircraft components.

An indispensable witness

However, the handling and read-out of HB recorders remained complex and tedious. With technical advances, reliable magnetic

tape recordings appeared in the 1950s, and an Australian scientist, David Warren (1925-2010), an engineer at the Defence Science and Technology Organisation - Aeronautical Research Laboratory (Melbourne, Australia), whose father had died in a plane crash in 1934, developed a new generation of recorders. His idea was to collect flight data on magnetic tape placed in a shock-resistant case installed in the rear of the aircraft, the part least likely to be destroyed in the event of impact with the ground or water.

The Warren system became the standard in the 1960s and 1970s. However, the data collected was still very limited, and many details of the flight remained unknown to investigators when needed. The use of this tape recorder to record sounds and conversations in the cockpit followed shortly thereafter, giving rise to the CVR.

In the early 1970s, the *Bureau Enquêtes-Accidents* issued a note revealing a study conducted on investigations into accidents or serious incidents involving 37 transport aircraft (9 registered abroad, 28 in France) between 1 January 1960 and 31 December 1970.

This study covered 12 four-engine jet aircraft, 10 twin-engine jet aircraft, 2 four-engine turboprop aircraft, 10 conventional four-engine aircraft and 3 conventional twin-engine aircraft (over 5.7 tonnes).

When the recorders could be recovered and read out, the information gathered in this way was deemed:

- essential in at least three cases,
- very useful in nine cases,
- fairly useful in six cases,
- of little use in one case.

Above all, however, the BEA drew attention to the lack of information concerning several parameters: “... the study of the 37 accidents or

very serious incidents highlights that obtaining additional parameters (operation of GMP or GTR, position of controls or control surfaces, position of landing gear, longitudinal acceleration, operation of radio-electrical aids, hydraulic systems, electrical power systems, flight instrument indications, radio-altimeter, warnings, operation of autopilot) would have proved to be:

- essential in at least 7 cases
- very useful in 15 cases
- fairly useful in 13 cases
- of little use in 2 cases.

Lastly, the information that could have been provided by a cockpit voice recorder (which would certainly have provided communications with the ground that were not recorded on the ground in three cases) was considered highly desirable in almost all the accidents and likely to provide crucial information in at least eight cases.

It is interesting to note that, in 1971, investigators were aware of the need to amass a large amount of flight data, but at the same time, regulations remained relatively lax regarding the amount of data required. The 1971 ministerial decree concerning the obligation to carry flight recorders only covered:

- the flight path of the aeroplane,
 - the flight attitude of the aeroplane,
 - the forces acting on the aeroplane and their origins,
 - fortuitous circumstances and their origins,
 - conversations and aural warnings in the cockpit.
- The number of items applicable depended on the aeroplane's weight and passenger capacity.

During a meeting held on 20 February 1970, officials from the BEA and the DTA, chaired by René Lemaire, secretary general for civil and commercial aviation, attempted to review the problem.

They faced two main problems: the start of Boeing 747 operations at Air France and its equipment with recorders, and the development of a recorder with a sufficient number of parameters to provide investigators with all the information they need to determine certain causes of the accident. With regard to the recorders on Air France's Boeing 747s, this meeting ensured that they would be equipped with SFIM models, which were considered more accurate than others that could be fitted to this aircraft.

It is likely that the passenger capacity of the new Boeing 747 (nearly 500 passengers) led to greater awareness of the need to know the slightest cause of an accident or incident.

The appearance of the CVR

In the 1970s, a new type of recorder entered the in-flight data collection loop: the CVR or Cockpit Voice Recorder. Not only does this

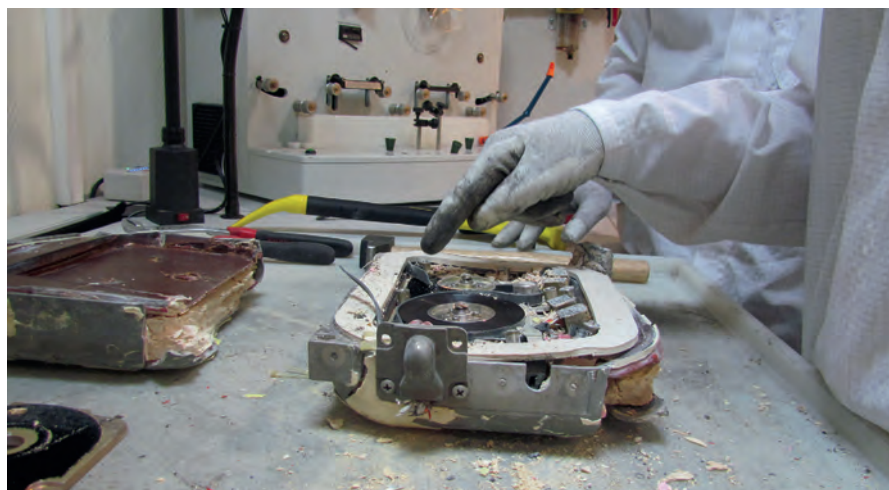
The Caravelle's SFIM recorder was considered to be better than that used on Boeing 707s of the same era...



The state of a recorder after an accident, and its contents after opening. Different levels of protection ensured the integrity of the data. Below, an old magnetic tape model, now banned.

equipment record discussions between the pilots, it also records conversations with air traffic control, various cockpit noises, aural warnings, exchanges with mechanics on the ground, etc.

This data supplements and can be compared with data from the FDR (Flight Data Recorder), now known as the FDAU (Flight Data Acquisition Unit). Today's recorders have reached their limit, illustrated by the need to know the situation -



Flight recorders in the 1990s

In a memo dated June 1989, the BEA summarized the investigative resources available. This memo provides an overview of the “state of the art” at the time. Extracts.

II. Regulatory aspects

The International Civil Aviation organisation (ICAO), a UN specialized agency, stipulates the carriage of accident recorders according to aircraft category. These international rules are supplemented by national regulations.

In practice, large public transport aircraft (Boeing, Airbus, ATR, etc.) are fitted with a data recorder and a cockpit voice recorder. Medium-sized aircraft (LearJet, Falcon, Metro, etc.) may have either recorder. Small flying club aircraft have no recorders.

III. Characteristics shared by all recorders

By virtue of their function, they are designed to protect the information they contain from the consequences of a serious accident. For example, the recorders are mechanically shielded and resistant to immersion and intense fire.

For the same reasons, they are located as far aft as possible in the aeroplane.

They automatically start and stop operating with the other on-board systems. The crew can check that they are operating correctly by means of indicator lights on the instrument panel. Flights are prohibited if a recorder is inoperative, except to reach a repair site. To ensure that they can be found quickly after an accident, they are painted bright orange, marked “Flight recorder, do not open” in English and French, and fitted with an underwater locator beacon (ULB).



IV. The various recorders

IV. 1. Flight data recorder

IV. 1.2. Old generation

The parameters were recorded by a stylus punching a metal roller, or by printing a light beam onto a photographic roller. The number of parameters recorded was small: less than a dozen (speed, altitude, heading, etc.).

As the rollers sometimes represented a hundred flight hours, the development and conversion of the curves obtained into quantities usable by investigators required a laboratory equipped with specialized optical and computer equipment.

IV.1. 3. Current generation

The recorder behaves like a computer tape recorder. Multiple parameters are recorded in binary coded form on a magnetic tape. The recording is thus an uninterrupted succession of 0's and 1's, with each second of tape recording over 700 characters. The tape runs in a continuous loop and contains 25 flight hours, the oldest information being erased and replaced by the new.

On-board computers have, of course, sorted and coded the information to be saved. Thanks to this technique, the parameters recorded in this way can be very numerous: several dozen, adding information on the status of flight controls, autopilots, etc. to the conventional parameters.

The ways in which information is stored and coded vary, of course, from one aircraft to another, but also from one operator to another.

Recorders of this type are therefore read out in a computer laboratory equipped with specialized computers and up-to-date documentation on the various coding techniques used around the world.

IV. 2. Cockpit voice recorder

As mentioned above, the voice and aural warning recorder records flight crew conversations, radio communications and, via an omnidirectional or area microphone, various noises such as engine speed, landing gear, switches, aural warnings, etc. Its operating principle is similar to that of a conventional tape recorder. It uses a ¼-inch magnetic tape. After an accident, the tape is read out in a specialized laboratory. The investigators then transcribe the conversations over time and identify the noises which undergo very detailed spectral analyses.

This equipment operates on an endless loop with a recording time of 30 minutes, running at a speed of 2 to 7 cm/sec, depending on the type.

V. Analysis of information

The initial listings may include anomalies arising from, for example, incorrect manual inputs during the read out (particularly hardware errors). The manual operations required to interpret the tape are carried out on the read-out computer and in no way affect the data recorded on the tape itself, which remains the indisputable reference, available for any subsequent interpretation.

The next step is the validation of the recovered information. It has to be checked that there have been no errors in the coding and decoding, that the physical source of the parameters is compliant (e.g. misadjusted altitude sensors), and that the tape is not running at the wrong speed. This work is carried out by making comparisons with previous flights recorded on the tape. Comparisons with test flights, recorded and kept by the manufacturer, are also possible. Lastly, the information from the data recorder is correlated with that from the voice recorder and with other reliable sources of information, such as the recordings of radiotelephone conversations and flight path recordings provided by air traffic control.

At the same time, aeronautical investigators begin the actual analysis of the accident. This work requires precise correlations between the various recordings. For example, an investigation concerning a modern aeroplane requires the moment a noise appears in relation to the variation in the corresponding parameter, to be determined with a precision of a fraction of a second, although the tapes last 30 minutes and 25 hours respectively.

In practice, all this work takes several months.





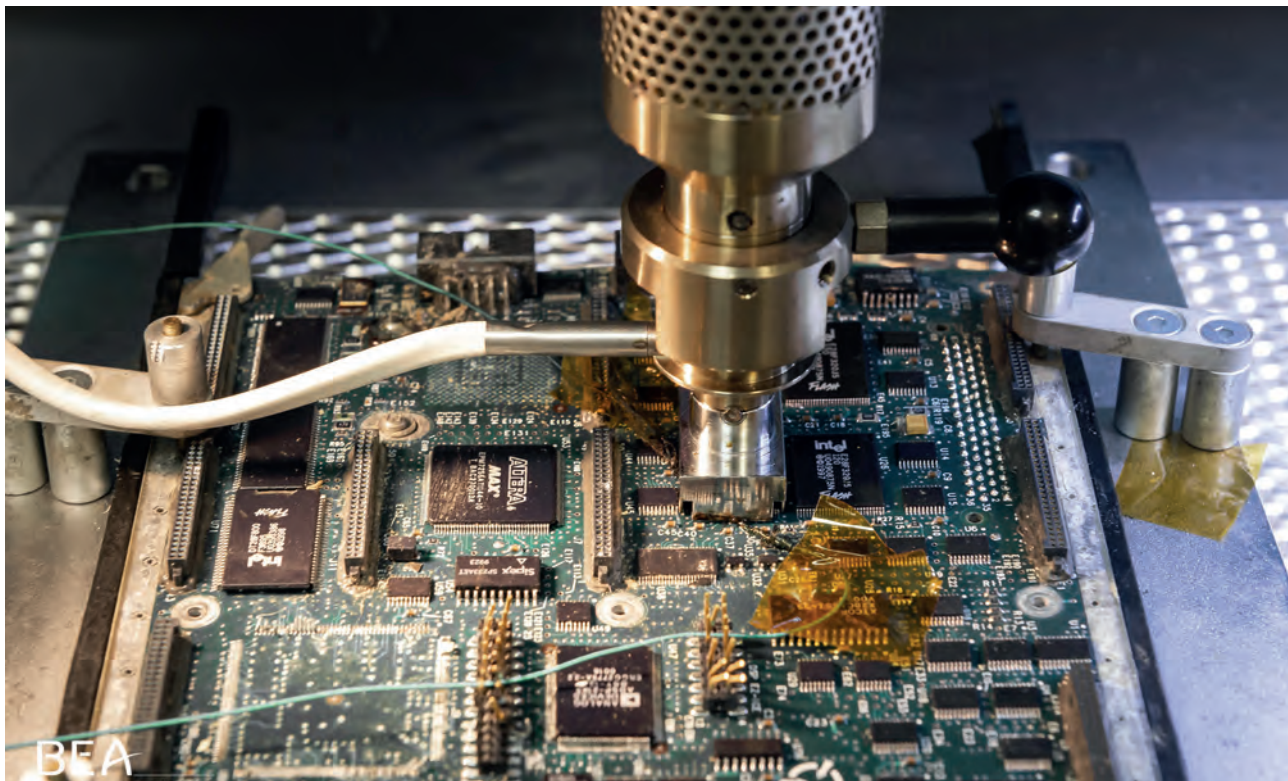
When analysing a flight recorder damaged in an accident, it may be necessary to analyse each electronic circuit, and repair them if necessary, before downloading and analysing the data.



possibly an urgent situation - and the precise geographical position of an aircraft in real time, i.e. even before an accident occurs.

The case of the Air France Rio-Paris flight AF447 prompted the aviation community to reflect on the difficulty of pinpointing the exact location of the accident site.

The search for the aeroplane's "black boxes" took two years before they were found (see Philippe Plantin de Hugues' testimony on the following pages).



The BEA laboratory is equipped to repair flight recorder circuits prior to analysis.

Perspective

When the flight recorders talk

by Philippe Plantin de Hugues



Listening to the four audio tracks of a voice recorder: cockpit area, pilot, co-pilot and conversations with the crew.

"In September 1994, we moved from rue de la Convention to Le Bourget. All the equipment for reading out the flight recorders, especially the CVRs had been disassembled at the Convention site, and nothing had yet been reassembled at the BEA in Le Bourget. It was a day when it would have been better if nothing had happened!"

Then came the in-flight loss of control of an Airbus A310 operated by the Romanian airline Tarom, which stalled, fortunately without any dramatic consequences. What was special about this occurrence, was the way we read out the recorders. And above all, that day we saw a whole host of cameras and trucks with telescopic antennas. We brought the crew to the BEA. We didn't have the car park we have today, we were at the far end of the building, which directly bordered the street. Journalists were swarming around the site. When it was time for the crew to leave, the car engine had to be running, the door had to be opened, and the pilot had to be able to run out of the building and jump into his car. Journalists were trying to open the car doors!

This augured well for the future at the BEA. Fortunately,

we've never had anything like this happen again. It must be said that the situation was really very strange, with a crew who were initially heroes because they'd saved the aeroplane, but who in fact turned out to be the cause of the accident. Thanks to my work on the audio recordings, we were able to discover that the incident began with inputs on the controls during the flight phase prior to the stall.

Let's return to the facts. An Airbus A310 operated by Tarom was on approach to Orly. Before capturing the glide and LOC, the pilot had selected the go-around altitude, which was 4,000 feet, if I remember rightly. He had disconnected the autopilot, but was in hybrid flight control i.e. he had kept the autothrottles engaged. When he extended the flaps, the ATC asked him to accelerate to land. At this point, he was in overspeed when he extended the flaps. The aeroplane, we were told, only had the autothrottles engaged. The aeroplane's system detected the go-around altitude which was above, the LOC and glide had not been captured. As the aircraft was in hybrid flight control, it had to reach the go-around altitude which was above. So both sticks moved forward and the captain, who didn't understand what was happening, tried to disconnect the autopilot.

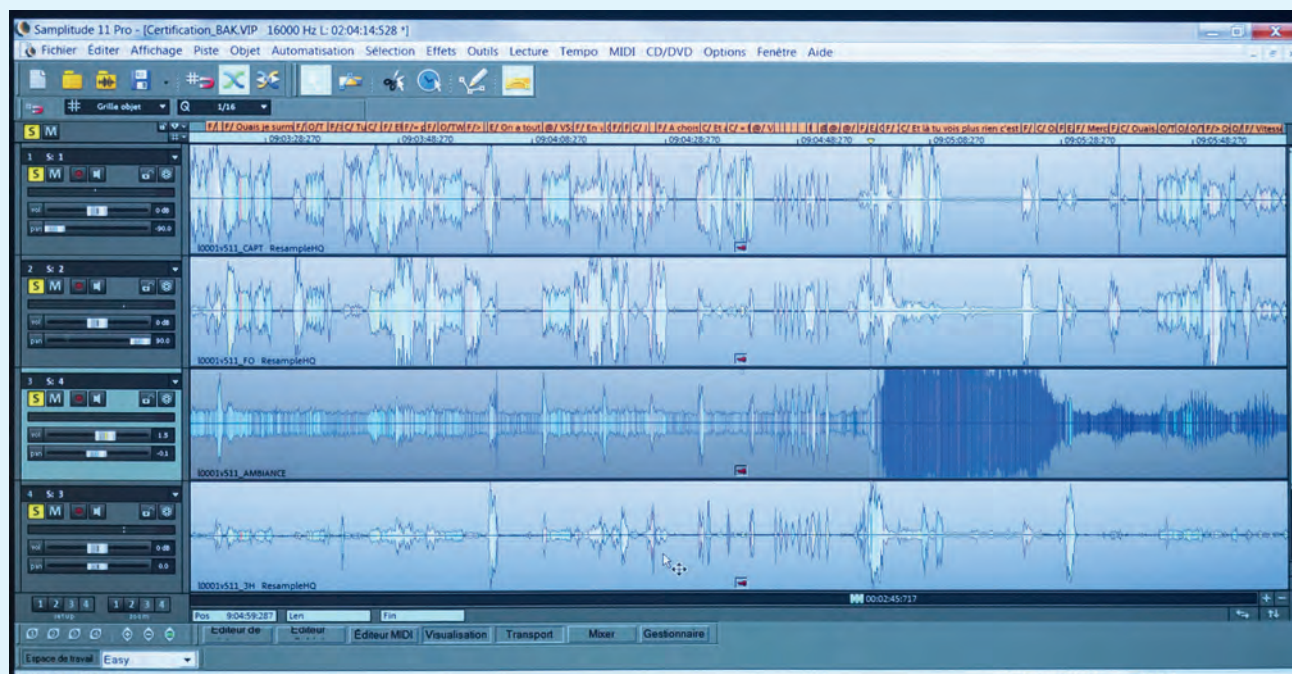
At one point, as he was not able to do this, he set the trim (acting on the horizontal airfoil at the tail of the plane) full nose-up. He pressed the button, and at the same time tried to bring the levers back.

The levers moved forward again, and he pushed the levers hard forward. He was now in a full nose-up trim condition, with the levers at full power. The aeroplane climbed vertically and stalled, but the pilot was able to recover control and land normally. This made him

look like a hero in the early days, because he had saved the aeroplane, with an autopilot that had "gone mad". That was too succinct.

I carried out an audio analysis of the recording of this occurrence. It allowed me to identify that the pilot pressed the trim button because this action makes a noise that corresponds to a small click. Half a second later, the wooler could be heard, a warning telling the pilot that the trim is in motion. After a certain lapse of time, he pressed the button





A BEA investigator is capable of visually identifying a flight phase: landing, landing gear extension, go-around, etc. before listening to the recording.

again, thus releasing the trim. This made a click noise. The wooler stopped. This analysis of noises and sounds made it possible to identify that it was undoubtedly a manual action that had brought the aeroplane into a stall. I was able to reproduce the analysis of this trim button on another occurrence, another Airbus A310 accident in Thailand, where the Thais had decided to call in the USA to read out the recorders and not the BEA, because they thought the BEA and Airbus were a little too close.

When I travelled to the United States, I went to the NTSB (the BEA's American counterpart). There, I told them that we had the same spectral analysis tools: "Let me use your spectral analysis tool and I'll identify each time the pilot pressed the trim" (the Thai authorities were saying that the trim had moved automatically and had not been controlled by the pilot). I was able to identify exactly when the pilot pressed the button, when he released it and so on. This was entirely consistent with the trim movements in this phase of the flight. I was able to prove once again that all the actions on the trim were manual, based solely on the audio recording. This is why the case of the Taron A310 at

Orly is so special.

The pilot shut down the engines

When I joined the BEA on 18 October 1993, an event occurred a few days later on an Air Inter flight from Paris to Lourdes, where both engines were shut down. It was an Airbus A320 taking off from Orly. I think it was 24 October.

There were demonstrations at the side of the runway against noise pollution. The crew didn't retract the landing gear, and at 1,000 feet, the landing gear down warning sounded. The captain shut down both engines. A first time. He then saw the engines stop. He started them back up. He saw that the engines were not regaining power. He shut them down a second time and then started them up again. He then saw that the power of both engines was increasing, and he wanted to continue. The co-pilot said, "Stop, we're going back to Orly". It was a singular occurrence. It was my first voice recorder playback, conducted with my predecessor who was still at the BEA. You can imagine the conflicts if there had been an accident. When both engines were shut down, both the voice and

data recorders stopped. So it's easy to imagine that if there had been an accident and it had been identified that the crew had shut down the engines, it would have been inconceivable for the pilot community. Fortunately, all ended well, the aeroplane landed and the CVR was removed.

We found that indeed, part of the recording was missing, and that the occurrence was not recorded for the part where both engines were shut down. I saw the captain at the BEA and everyone who knew him said that he'd aged twenty years overnight. Marks had appeared on his face. He'd aged, he'd aged with this event.

The captain said, "I shut down both engines" This was confirmed by the co-pilot.

It was very clear. Apparently, he'd had simulator sessions, where the common practice to reset (restart) the simulator was to shut down both engines. Clearly this was a reflex action for him, on hearing this warning, to shut down both engines.

Assistance to third countries in reading out and analysing CVR

During my 20 years in the BEA laboratory, from 1993 to 2012, I worked on the analysis of audio recordings from some 800 accidents and incidents that occurred in France and abroad. At the start of my career, we spent several weekends a year at the BEA reading out flight recorders from Airbus and ATR accidents and incidents which had occurred abroad and for which our expertise was required. At the time, we read between 100 and 150 flight recorders a year, most of them from accidents or incidents abroad. Our foreign colleagues used to come to the BEA. As a result, we had a very high level of international activity.

From the many recorder analyses carried out, a crucial phase in producing quality investigations, I'd like to focus on the Flash Airlines accident off Sharm el-Sheikh on 3 January 2004. The BEA was asked for help with the safety investigation and the organisation of the search at sea. The first step was to hire a boat to recover the flight recorders lying in the Red Sea. As for me, I was pre-positioned in Cairo to help our Egyptian colleagues read the recorders once they were recovered.

At the time, they had just acquired a laboratory which allowed them to read out damaged recorders. While they

had all the equipment, it had never been used. They were in the process of validating it.

The CVR, brought up from the sea bottom, arrived in the laboratory, and so I helped them with reading it, the first stage being to open the recorder and extract the audio tape. It was at this point that our Egyptian colleagues said they wanted to listen to the audio tape in-house without the presence of foreign ears. We insisted, but they wouldn't listen to our arguments, including the fact that the passengers were French.

They argued that, as the plane was not an Airbus (it was a Boeing 737), our accreditation was solely limited to representing the victims' families, even though the plane had been chartered by a French tour operator. This meant that our role would not be the same as that of representing a state of manufacture.

In the end, I believe that this accredited representative status was awarded to us in view of the worldwide prestige enjoyed by the BEA - in addition to the fact that the Egyptians were suspicious of the Americans. This was also the first time that a state representative was an ACCREP solely because its nationals were victims in the accident. However, still not able to listen to the audio recording, the Egyptian side informed me that it was of very poor quality, which I very surprised about because for this type of aeroplane, the recording quality was generally good. So I returned to France, where I insisted for weeks and months on obtaining authorization to listen to it.

Long before the Sharm el-Sheikh accident, there had been a Boeing 737 accident in Algeria (Tamanrasset), where the BEA had also been asked to read out the CVR. We provided a great deal of assistance to our Algerian colleagues, who had little expertise in the field, and in the end we carried out virtually the entire investigation with them.

As part of the investigation process, I had asked for a take-off to be carried out from the same airport, Tamanrasset, and for the CVR to be recovered so that I could use it to make spectral analysis comparisons on the audio recording. I also had to determine what had happened just after take-off, when they had experienced a problem with an engine,



which led to a crash with the landing-gear down.

So I had a sound recording on an original CVR tape of the same type as the CVR involved in the Sharm el-Sheikh accident. The idea then came to me to send this original tape to the Egyptians, saying, "You don't want me to listen, but please read this tape and send me an audio copy of the reading for comparison with the spectral analysis". They agreed to my request, and I discovered that they only had three recording tracks available, and that the recording was indeed of poor quality. I, on the other hand, had four tracks and the recording was perfect.

I informed the Egyptians that there' was a major problem with their system, and after a few months they finally asked me to come to Egypt, where I adjusted the heads of the magnetic tape reading system, which were not aligned, and their PC, which had a gain problem. The result was a four-track recording of excellent quality. This gave a new dimension to the safety investigation, and we were able to work efficiently thereafter. To finally obtain that non-Egyptians could listen to the recording, which the Americans were also demanding, I had really forced their hand. It was only by hiding behind the concept of the accident in Algeria that the Egyptians agreed to play the tapes in the presence of foreign ears."

2003. Accident to the Boeing 727 3X-GDO operated by Union des Transports Africains, at Cotonou (Benin)

On take-off from Cotonou (Benin) on 25 December 2003, the aeroplane hit a building at the end of the runway at Cotonou airport, then crashed onto the beach before finishing in the Atlantic Ocean.

Around 140 people were fatally injured and 20 injured in the accident, but some uncertainty as to the number of passengers on board subsisted ("The number of victims and survivors identified exceeded the number of people supposed to be on board, whether based on the manifests or on the number of seats available"). The national investigation commission set up by the Beninese government delegated the investigation to the BEA.

While the BEA's investigation concluded that the accident was directly caused by the aircraft taking off when it was overloaded, with an anarchic load distribution, and that the crew had been given incorrect weight and balance values, it also pointed to two structural causes: the operator's serious shortcomings in terms of competence, organisation and regulatory documentation, and the inadequacy of checks carried out by the civil aviation authorities of the aircraft's successive states of registry.

Fourteen recommendations were issued to States issuing Air Operator Certificates to ensure that they have in place a set of regulations in line with air transport safety standards and recommended practices; to ICAO, to reinforce the organisation's role as safety watchdog; and to certification authorities, so that aircraft weight and balance can be established and recorded automatically.

- Irruption of flags of convenience in commercial aviation.
- Accident originating in a company lacking in competence and rigour.
- Hasty autopsies with bodies being returned with obvious identification errors..



The aeroplane broke into several pieces on the beach at Cotonou. The accident contributed to the publication of a "blacklist" of 92 airlines by the European Union in 2006.

Perspective

Philippe Plantin de Hugues **Habsheim: a surging noise...**

"I was required to carry out audio examinations, notably for the Habsheim accident. I joined the BEA much later. Habsheim was in 1988. I joined in 1993, so that was also after Mont Sainte-Odile. There was still some controversy hanging over the BEA, according to which the BEA had tampered with the recorders. Then one day, the judge's forensic expert came to see me and said, "Mr Asseline [the captain] has an acoustics forensic expert working for him".

This expert was watching the demonstration on the aerodrome when the A320 passed over, and he saw the accident. He offered to help Mr. Asseline with his case and claimed that, on the audio recordings from the aerodrome, he could hear a surging noise which proves that there was indeed surging before the accident¹. The expert came to see me and said, "Here, I've got the audio recording. I know where this audio recording was made." I replied, "I don't want to know where this recording was taken, let me listen to it". And after listening, I looked at a map and said, "In my opinion, the person who recorded the audio and the camera were in this place." He said yes. And what we could hear was the sound of a hot-air balloon being inflated. The noise sounded like a "Prrrrrou...".

This noise also appeared after the accident. I proved to the expert that what we could hear was the sound of the hot-air balloon being inflated and that it wasn't a surging sound, because a surging sound is more repetitive, like a series of gunshots. After this event, the judge wanted to have this acoustics expert struck off.

I remember watching TV one evening when Mr. Asseline, the pilot of the aeroplane in the accident, was a guest. His expert was also on the show "They want to shut me up. I have proof that the recordings were tampered with. They want to strike me off, they want to shut me up!" All the hairs on my arms were stood on end, because you can't say anything, you can't answer. And I know it's completely false. And that his analysis was completely wrong."

1. A compressor surge or compressor stall is an aerodynamic phenomenon that can occur in the compressor of an aeroplane turbojet engine.



Parts of the Boeing 737 operated by Flash Airline being raised after the accident on 3 January 2004.

Perspective

Jérôme Bastianelli **Mistaken interpretations of CVR**

"We have sometimes been confronted with the disclosure, by the press, of recorded conversations whose content had nothing to do with the accident. The BEA's usual practice in such cases is simply to include small stars in the transcript published in the report, showing that a conversation has taken place, but not giving any details. During the investigation into the Quiberon collision between a Cessna which had taken off from Vannes and a Beech 1900 operating on the Lyon-Lorient route, private exchanges between the two Beechcraft pilots were published in certain newspapers. This gave the impression that the young pilots weren't very concentrated, whereas the cause of the accident was quite different: their reciprocal flight path, the Beechcraft, turning around the liner Norway (formerly France), meant that the crew could never have seen the Cessna."

Perspective

Philippe Plantin de Hugues
Pilot suicide

"I analysed the audio recording of the Royal Air Maroc ATR 42 flight 630 on 21 August 1994. The accident had occurred near Agadir. The Moroccan authorities had come to the BEA, and we read-out and listened to the CVR. What had happened? The crew consisted of a captain and a female co-pilot. The aeroplane took off. It carried out a circling climb in order to pass over the mountains. On arriving at 10,000 feet, the captain disconnected the autopilot and started to push on the column. The co-pilot asked him, "Captain, what are you doing?" He replied, "Dying".

This was followed by a battle over the controls, with the captain pushing the control to make the aeroplane dive, and the co-pilot pulling the control to bring it back up. I remember that these actions decoupled the elevator, as per the aircraft's design where if the control jammed, the elevator controls would declutch (decouple). The co-pilot was able to counteract the captain's pitch down input. However, she was unable to make the aeroplane pitch up. In fact, the two controls were acting independently. She was therefore able to stabilise the aircraft.

It was at this point that she sent a message to control saying, "Mayday, Mayday, the captain is..." followed by nothing. Then the captain deflected the control to one side and the aeroplane crashed. And everyone was killed. The authorities came to the BEA premises, and we read the CVR in the evening. The FDR was also read that evening. I remember arriving at the BEA in the morning, and listening to the radio: during the night, the Moroccan authorities had announced that the pilot had committed suicide.

They didn't deny it afterwards. In the report, it is stated that it was a case of "active

incapacitation". But in the morning, they had confirmed that it was a pilot suicide. I thought that was very courageous of them.

For this Royal Air Maroc case, my involvement was essentially in the analysis of the voice recorders, i.e. producing the transcript and the spectral analyses.

Another, more recent pilot suicide involved the Germanwings Airbus A320, an air accident caused by the suicide of the co-pilot, who deliberately headed his aeroplane into a mountain in the Prads-Haute-Bléone district, in the French Southern Alps, on 24 March 2015.

For this type of accident, the BEA's investigation did not focus on an anomaly in the operation, use of the aircraft or air traffic. On the other hand, the BEA report on the Germanwings A320 accident includes a number of recommendations on psychological monitoring to try to detect and/or treat a pilot with suicidal tendencies, before he or she takes action."



The Germanwings A320 CVR
when it arrived at the BEA's
premises

Perspective

Jérôme Bastianelli

Recovering Concorde's recorders from the fire

The Concorde accident happened at around 5 in the afternoon. I was away with my partner when her sister called to tell me that the Concorde had crashed. She saw it before it crashed, she saw the flames and the tragedy. I returned to the BEA. We were quite worried, because my partner lived near the site at the time. From the BEA, we could see a column of smoke, but we didn't know exactly where it was coming from. I set off for the accident site with the first go-team, we arrived at 7pm. I knew where the recorders were positioned in the structure of the aeroplane. Two of the Concorde's engines were on either side of the hotel building, which was still in flames.

I asked for access to the crash zone, despite the fact that the building was still on fire. If the recorders were close to the hotel, they had to be removed to preserve them from the fire. After negotiations with the gendarmes and the public prosecutor who were on site, I was given a team of firemen. I was equipped with a SCBA mask and oxygen cylinders. I toured the crash site with the firemen. I identified the first recorder, the CVR. And we identified the FDR which was nearby. We then called in the judicial police officers and told them where the recorders were. It wasn't a fire zone, and they were quickly removed from the site. The two recorders were recovered at around 9pm and by

11pm they were at the BEA. With a judicial police officer, I worked all night on the CVR to make an initial transcription of the last ten minutes, which corresponded to the flight phase. We worked until around 5 in the morning. I had reserved a nearby hotel so I could get an hour or two's sleep and come back to the BEA.

At the site, things went very well with the gendarmes. I remember that the gendarmes were very helpful, especially with regard to the public prosecutor. When the time came to send the CVRs and FDRs to the BEA, the latter wasn't too keen. The gendarmes helped us by saying that only the BEA had the means to read them. And that we had to be able to read them. The judicial police officer came with me and we worked together all night. I found that cooperation on the site, with the gendarmes and the fire department, was excellent."



Stored Concorde debris
pending their
analysis by the BEA.

Revealed recordings

The BEA uses CVR transcripts to shed light on the safety investigation. As we have seen, the information they contain can often help uncover the real causes of an accident, or provide elements in the chain of events leading up to the accident.

But the transcripts of the sounds and, above all, the conversations between the pilots end up filtering through to the public domain, because they are made available to the judicial authorities for the investigation to be carried out to search for possible liabilities.

The duty of confidentiality, defined by law and binding on the BEA, means, for example, that the pilots' private conversations are not published, and the pilots themselves are not identified in the transcripts.

Perspective

Jérôme Bastianelli Reading out the CVR and the neurasthenic hero

"The first time you listen to a voice recorder is of course, a moment that stands out and that you don't forget. You know that there is going to be a tragic end, but you don't know how it all started, what the warning signs will be. Sometimes, in fact, nothing happens at all, especially during "Controlled Flight Into Terrain" occurrences¹ - the conversation comes to an abrupt stop.

To cope with these tense and stressful moments, we could count on the solidarity of the team: we really were a close-knit group of young engineers and technicians.. I remember an anecdote about Olivier Py, a playwright, who wanted to make a TV film about an engineer who was an expert in aircraft accidents. He came to us for advice, but when the TV film was broadcast a few weeks later, it didn't correspond at all to what we had told him: the neurasthenic hero was taking the voice recorders home to listen to them at night, something absolutely unthinkable for us!"

1992. Accident to the Trans-Air Limited Boeing 707 registered 5N-MAS at Istres (Bouches-du-Rhône)

On 31 March 1992, the cargo plane was flying from Luxembourg to Kano (Nigeria). While over the Drôme and climbing to level 330, both right-wing engines separated from the aeroplane. The crew managed to control the aeroplane and landed with the landing gear and flaps extended and the right wing on fire, at Istres air base. All five occupants were uninjured.

The accident was caused by the failure of the No 3 engine mounting brackets when the aeroplane encountered turbulence. Engine No 3 then struck engine No 4, causing it to tear off. The rupture of the mounting brackets started from a fatigue crack in one of the brackets, which could not be detected by the visual inspection recommended by the Airworthiness Directive (AD). In other respects, the BEA issued a safety recommendation to improve air traffic control's handling of a distress situation, although the shortcomings did not contribute to worsening the consequences of the accident.

- The crew landed with two engines on the left side and none on the right.
- Aware of how close they had come to being killed, it took the Irish crew several days to recover from the event and its direct consequences before being able to give evidence to the BEA investigators.



A real scare for the crew of this Boeing 707.



Perspective



Jean-Paul Troadec, director of the BEA from 2009 to 2013

Issues concerning the publication of the CVR transcript and leaks

Although the CVR transcripts only mention “pilot” or “co-pilot”, their names may be published by the press shortly after the occurrence.

“This is the rule we apply: BEA reports contain no mention of names,” explains Jean-Paul Troadec. “I’ve even gone so far as not to publish any CVR transcripts for certain accidents. Because it’s part of the investigation. We have to trust the BEA when it says, “The CVR analysis shows this or that event”, that should be enough to understand the occurrence. The publication of the CVR transcript can give rise to a great deal of confusion in the minds of non-aeronautical professionals.

I’ll give you an anecdotal example, which was the subject of controversy over the AF447 CVR. In the BEA report, it is written that one of the pilots said, “ We weren’t given any sh.. by the cunimbs.” In another transcript published in a book, it is written, “We’re not going to let the cunimbs give

us any sh..”, suggesting a less-than-cautious attitude on the part of the crew. One little sentence, but many different interpretations...

What’s more, it’s not always easy to understand what’s being said on a CVR, especially if people are using a foreign language, such as dialectal Arabic, as in the case of the Yemenia accident. Even when they speak in French, there can be comprehension problems. So we have to be a little careful when it comes to CVR issues.

Sometimes, to lend credibility to an investigation, we may need to publish certain elements of the CVR transcript, but this is not always necessary.

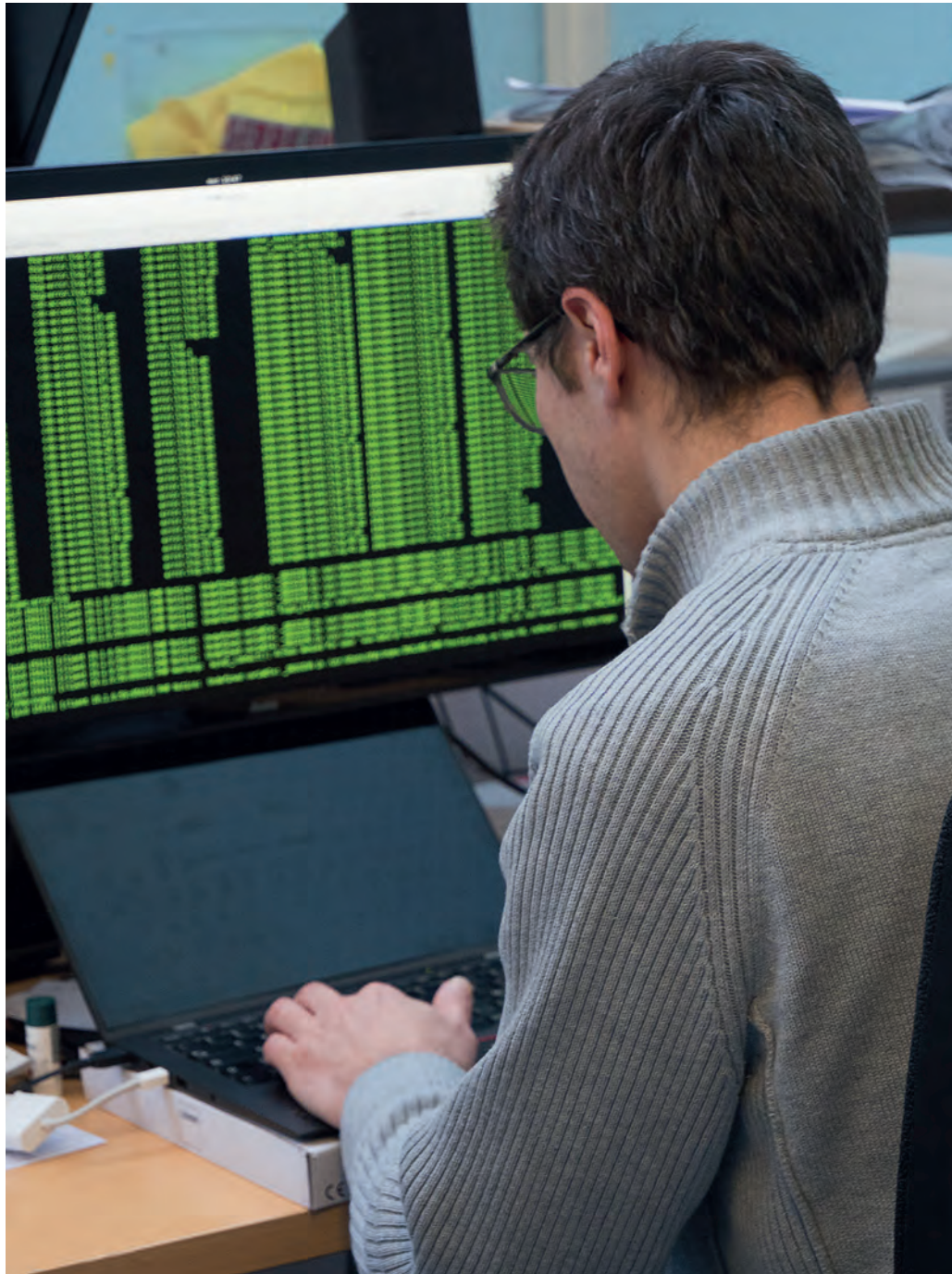
However, certain phrases that are not included in the BEA’s investigation report may come to light through the intermediary of the judicial authorities’ proceedings, which may create the feeling that the BEA has sought to hide things.

For investigations with a high media profile, we are sometimes confronted with problems of leaks. There’s no reason to believe that leaks could come from BEA staff, but there are so many players involved in an investigation that brings together representatives from the industry, manufacturers and the operator, that it’s very difficult to identify the source.

The fact remains, these leaks to the press are extremely damaging. When a leak occurs, we have to try to manage it as best we can. The BEA has been called into question on the AF447 occurrence more than once, as have my predecessors and my successor. I’m afraid we have to live with that. Once again, everything hinges on the credibility and impartiality of the BEA.”



Interpreting CVRs *“It is not always easy to understand what is said on a CVR ...”*



The analysis of flight recorder data is the work of highly qualified specialists, and leaves no room for approximate interpretations.



Chapter 4

The safety investigation



Whatever the event, whether an air disaster or a minor incident, the safety investigation follows the same process. Initiated by prior notification, it consists of three phases: gathering and validating facts, analysis, then checks. The final step is the publication of a report.



The wreckage of a damaged aeroplane is closely examined by investigators in the BEA hangar at Le Bourget.



Three investigation categories

After the notification has been received, the BEA will first determine whether the occurrence corresponds to an accident, a serious incident or an incident. The BEA is not obliged to investigate incidents, and determines on a case-by-case basis whether studying the occurrence could be beneficial for safety. To do this, it draws on its experience, and on the definitions or examples given in international, European and national texts. Once this first step has been completed, the BEA determines the category of investigation it will associate with the occurrence. The BEA adapts its investment in investigations and the type of report it produces according to the perceived level of risk and the expected safety lessons. Today, the BEA has three categories of investigation and associated reports.

Category 1 investigation

This is what is known as a “major” investigation into an accident involving an aircraft operated by an air carrier with a maximum certificated take-off weight of over 5.7 t for an aeroplane or 3.18 t for a helicopter, in which at least one person on board is fatally injured, an emergency evacuation has been carried out and the aircraft is destroyed or reported missing.

The final report is structured according to the ICAO Annex 13 model. This category of investigation is presented in the example of the investigation into a passenger commercial transport accident.

Example of category 1 investigation

Passenger commercial air transport accident. In the event of a major accident involving a passenger commercial air transport aeroplane in France, the BEA opens a category 1 investigation as soon as the notification is received and the BEA director appoints a senior safety investigator from among the senior investigators in the investigations

department.

Like a captain, the sole person in charge of his aircraft, the senior safety investigator will direct all those involved, and no investigative act can be carried out without his agreement.

The notification enables the BEA to gather initial information and take the necessary steps to initiate the investigation. When the accident site is accessible, several investigators are dispatched to begin examining the site and the wreckage.

In all cases, while it is essential for the BEA to be able to get to the accident site and gather as much information as possible as quickly as possible, the investigators only access the site once the emergency services have departed. On site, the investigators gather information and take photos, notably using drones to obtain aerial views of the site, the observation of which will make it possible to freeze the position of the various elements that may be of interest to the investigation (engines, flight controls, flight and



The documentation of the accident site makes extensive use of photographs.



maintenance recorders, etc.).

When the site is difficult to access, such as on a mountainside, the BEA investigators can be air-lifted in by helicopter. Finally, in the case of searches at sea, the BEA, with over fifty years' experience behind it, leads the operation, firstly by attempting to locate the transmitters that signal the position of the recorders, which transmit for thirty days. If the wreckage hasn't been located in this lapse of time, this doesn't mean that the BEA stops the search. In the case of the Rio-Paris accident, the wreckage was found almost two years after the accident.

Accredited representatives

Very soon after the accident or incident, the BEA sends a notification to the authorities. Under international agreements, the BEA involves in its safety investigation, the representative of the state of registry of the operator (in the case of an accident involving a foreign airline that took place on French territory), the representative of the state of manufacture of the aircraft and certain equipment, or the states whose nationals were among the victims.

These investigation authority representatives are called ACCREPs (ACCredited REPresentative). The role of an ACCREP is to provide the senior safety investigator with the benefit of his or her expertise. At the request and under the supervision of the senior safety investigator, experts from the aircraft manufacturer or airline (also known as the operator) may accompany their ACCREPs to throw light on the specific features of their company. The only people involved in the investigation are those likely to contribute to its progress.

By law, they are bound by professional secrecy, as confidential or non-validated information is exchanged.

In the event of an accident occurring abroad, it is the responsibility of the investigation authority in that country, known as the country of occurrence, to conduct the investigation.

If the aircraft is of French construction, or the operator is French, the BEA will be notified by its counterpart and will designate its accredited representative. The BEA will participate in the investigation, but will not control the timetable or communications.

During the first phase of the investigation, when it has been decided to remove a part, every

On-duty officer: An immediate response to the unforeseeable

An accident is, by its very nature, unforeseeable and a rupture in the normal activity. This is why the BEA must always be ready to intervene rapidly, anywhere in the world. It's a feat made possible by a well-oiled organisation and a wealth of experience.

Information

An investigator is on duty 24 hours a day, 7 days a week, from Monday to Sunday, ready to receive information about an accident or serious incident. This information is transmitted by telephone or e-mail to the on-duty investigator. The origin of the information may vary widely.

Notification

This is the official information, transmitted by the state on whose territory the accident occurred. Depending on the country, this notification may take more or less time.

In nominal operation, the management is notified every working day and calls a meeting of the investigation department, which distributes the workload among the investigators.

Crisis cell

In the event of a major accident, the on-duty investigator notifies the BEA director and department heads, whatever the time of day or night, so that they can convene a crisis cell. This cell is responsible for defining the investigation strategy: in the case of an accident on national territory, a team of a few investigators, the "go-team", will leave immediately.

In the case of an event abroad, the BEA's administrative department comes into play to take care of the logistics: plane tickets, passports and visas, health records, hotel and vehicle reservations, etc.

If the occurrence involves an Airbus, for example, France becomes the State of manufacture, which automatically justifies the BEA's involvement. Contact

with the manufacturer enables the coordination between the respective crisis cells, BEA investigators and Airbus experts.

The BEA-appointed ACCREP leads the French investigation team, made up of other BEA investigators and technical advisers who contribute their expertise to the working groups set up. The BEA can also take part in an investigation abroad as the representative of the State of registry or the State of the victims.

"When American Airlines flight AA 587 crashed in New York on 12 November 2001, fourteen of us left to join our American colleagues. The Airbus A300-600 crashed two months after the attacks of 11 September 2001. There was a certain amount of tension..." recalls Jean-François Berthier.



The BEA is ready to intervene
24/7.

Accident involving the Airbus AS 350 registered F-HLBT and operated by Héliberté, on 26 August 2017, in Guérande

precaution is taken to avoid any evidence useful to the investigation being tampered with. For each removed part, the investigators act in consultation with the representatives of the judicial authorities, and the aircraft components are placed under judicial seal. Under an agreement with the judicial authorities, the BEA can carry out or commission examinations on the parts, sharing the results with them. The BEA doctor can also request an autopsy or use autopsy reports.

After observing the surfaces and flight controls of the wreckage, and the preliminary examination of the engine(s), the next step is the detailed examination of the cockpit, warning panels and the positions of the selectors and controls. The investigators then gather all the factual elements relating to the event, including statements, crew and aircraft files, flight preparation data, weather conditions, and air traffic control data (radio

transcripts, radar flight path). Finally, the analysis of the Cockpit Voice Recorders (CVRs) and Flight Data Recorders (FDRs) begins.

These first days of work will enable the senior safety investigator to identify lines of inquiry and set up working groups. For example, if the engine parameters were nominal until the accident, the investigation will focus on other elements of the aircraft and the flight. On the other hand, if the parameters of one or more engines show inconsistencies, the senior safety investigator will make this one of the lines of investigation, and the working group will include the ACCREP of the state of manufacture of the engines.

As the investigation progresses and the read-out of the flight recorders continues, detailed examinations, tests and research into specific elements (engines, flight controls, on-board instruments, etc.) will be organised. Based on the results of these examinations, and in consultation with the members of the working groups, the senior safety investigator may decide to hold simulator sessions to validate hypotheses concerning what happened during certain flight sequences. The study of these elements may enable the first phase of the investigation to be completed or, on the contrary, may lead to new investigation work.

Once the first phase of the investigation has been completed, the senior safety investigator gathers all the elements resulting from this work, in order to analyse the circumstances of the accident and construct a scenario as precisely as possible, identifying any safety failures. He endeavours, in particular, to study the causes and contributing factors of the occurrence, taking into account not only mechanical and operational aspects, but also those commonly referred to as "human factors". These include physiology, communication both



inside and outside the cockpit, ergonomics, behaviour, decision-making, etc.

The senior safety investigator will then draw up a draft report following the model in Annex 13 to the Chicago Convention (Title - Synopsis - Body of report - 1. Factual information (including 19 sub-sections) - 2. Analysis - 3. Conclusions - 4. Safety recommendations - Appendices). After the various internal reviews in the BEA, the draft report is sent to the ACCREP for consultation.

They then have 60 days in which to make comments. If no comments are received, the report can be published. If there are comments, they are analysed by the senior safety investigator, who can either accept them and modify the draft report accordingly, or reject them. Rejected comments, however, are appended to the report, so that it presents the conclusions of all the participants in the investigation.

Although the publication of the final report is preceded by the BEA presenting the investigation and its conclusions to the victims and their families, the provision of information is not limited to this, but takes place throughout the safety investigation. The BEA takes part in the first intergovernmental meetings, designed to present to victims and their families, the various actions taken by the government in the wake of the accident. This participation is coupled with the setting up of a dedicated e-mail address, which will be one of the two main channels used by the BEA to provide information to all the victims and their families during the investigation. The BEA's second information channel is the regular organisation of meetings with those heading associations grouping families together. The information given to the victims and their families is also relayed by the national coordinator appointed by the government after the accident, as well as by the



ACCREP and embassies and/or consulates that have victims among their compatriots.

BEA investigators collect and locate parts of the crashed aircraft.

Category 2 investigation

These are investigations whose lines of enquiry and analysis are circumscribed so as to give rise to a “simplified” report.

The structure of these reports may deviate from the ICAO Annex 13 model, to suit the circumstances of the event and the issues involved in the investigation.

This category of investigation applies to all types of operation, whether passenger or cargo commercial air transport, general aviation or aerial work. Its primary aim is to provide operational feedback, but it can also give rise to the issuing of safety recommendations. This category of investigation is presented in the example of an investigation into a general aviation accident.

Example of category 2 investigation General aviation accident

The investigators

BEA investigators are either engineers in civil aviation operations (IEEACs) or senior technicians in civil aviation operations (TSEEACs), or specialized contractual staff (acousticians, metallurgy-fractography specialists, etc.). There are no initial prerequisites for IEEAC and TSEEAC civil servants, but they follow long in-house training (10 years in theory to train *ab initio* a senior safety investigator).

The BEA has a three-year training plan and a training manual detailing each training action (program, duration, objective and evaluation).

The investigator function (open to both general investigators and specialist investigators employed in BEA laboratories) comprises three levels:

- investigator,
- experienced investigator,
- senior safety investigator.

The salary of civil servant investigators and contractual investigators reflects these levels of experience.

The general investigator is in charge of the entire investigation process, from gathering evidence at the accident site to producing the report.

The specialized investigator (acousticians, fractography specialists, wreckage specialists) works in specialized BEA laboratories and provides the general investigator with their expertise; they may also travel to the accident site or to the premises of BEA study or research partners or service providers.

The safety investigation is a team effort. The investigator is supported by one of his or her more experienced peers, a team or section head.

The senior safety investigator supervises the investigation. He or she must be uncontested in his or her expertise, management and communication, while respecting professional secrecy and the prerogatives of the judicial authorities.



An investigation is a team effort, requiring many years of training.



General aviation encompasses a number of very different activities:

- Recreational aviation, largely carried out by non-professional pilots within structures such as flying clubs, or as aircraft owners, allows everyone to fly a light aircraft, provided they have obtained a pilot's license or certificate and hold a medical fitness certificate (except for microlights) issued by an aviation medical examiner.
- Public or private flying schools which train professional pilots who will then be employed by airline companies or aerial work companies.
- Private travel, aboard aircraft owned by companies or leased by a private person.
- Aerial work which covers a certain number of specific activities such as aerial photography, the carrying of external loads by helicopter, towing of banners, crop spraying, etc.

Case of an investigation into a fatal accident in recreational aviation

When the BEA is notified of a fatal general aviation accident, it dispatches a field investigator to the site to carry out the first investigative acts. Field investigators are DGAC agents, trained by the BEA, who intervene at its request and under its authority, immediately after the accident, exclusively on the national soil. As the DGAC has offices in every region, the BEA can mobilize the field investigator closest to the accident site to gather information as early as possible.

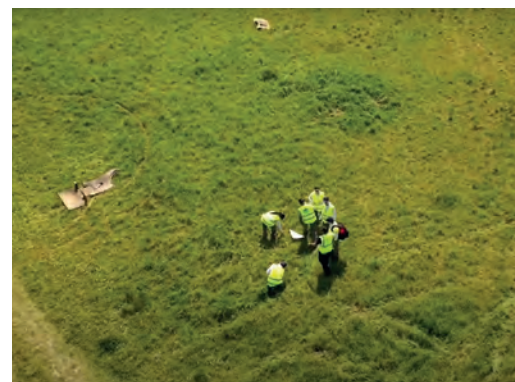
The field investigator is usually joined by a team of investigators, known as a "go-team". The go-team is made up of at least two investigators, one of whom is a wreckage specialist. On site, the investigators gather information and take photos, notably using drones to obtain aerial views of

the site. This work then freezes the position of various elements which may be of interest to the investigation (engines, flight controls, on-board and maintenance recorders, etc.).

These aerial views also often help to understand the angle of the collision and the sequence of marks in the vegetation. Investigators look for traces of fuel (visible or olfactory) to rule out fuel exhaustion. They also take the first statements. If further examinations are required on all or part of the wreckage, it is transported to the BEA hangar which is equipped with the appropriate tools.

The investigator in charge of the investigation then draws up a draft "simplified" report. The term simplified indicates that the report does not include all 19 sub-sections of the ICAO Annex 13 model, but only those relevant to understanding the occurrence or improving safety. After the internal reviews by the BEA, the report is published on-line on the page dedicated to the accident, in French and English.

The victims' next of kin are contacted by the BEA and receive a copy of the report before it goes on-line. If the report is too technical to be understood by people with no particular aeronautical knowledge, the BEA may also offer to hold a meeting to present the report to the next-of-kin.



The use of a drone allows the investigators to better understand the scene of the accident.



Perspective

Jean-François Berthier

Wreckage specialist, observer and supervisor of accident site

"I arrived at the Convention (administrative centre) where I was greeted by some strong personalities: Raymond Auffray, Michel Vigier, Michel Bourgeois and others, all of them with a will of steel, most of them experienced pilots. Despite our close physical proximity to the DGAC, we had no problem with independence. We didn't even ask ourselves the question. The only problem concerning independence arose when BEA experts were also working for the judicial authorities. The situation was a bit flawed, since they were receiving remuneration for their services as judiciary experts! Robert Davidson, the head of the BEA at the time, put an end to this practice: you can't be judge and jury..."

I arrived at the BEA as a general investigator, with colleagues who were "big names": Raymond Auffray, for example, was very close to engineer general Louis Bonte, head of the Flight Test Centre.

This was crucial at the time, because we had no resources. We had to go knocking on doors, particularly military doors, at the CEPR and at the CEV flight test centre in Brétigny, which had analysis equipment. But as everyone knew each other, there was true cooperation.

I also began my career with Vincent Favé, a very hard-working and efficient professional who was also an IFR pilot, and Bernard Mangane. My first investigation involved a microlight that crashed in Pau in February 1986.

In 1992, during the Mont Sainte-Odile accident, at the request of Paul-Louis Arslanian, I created the post of "wreckage

specialist" whose role is to supervise the wreckage at the accident site, describe the site and the wider area, document the wreckage by taking measurements, photos, orientation, etc.

There was a time when, as soon as we arrived on site, we would take away the parts that seemed most interesting to us, and do the analysis afterwards. With the creation of the wreckage specialist position, we began to make decisions concerning the conservation of the parts: precautionary storage, orienting the work, choice of laboratories and work program, then follow-up of this work and discussions with the laboratories. All of this in order to give the investigator precise information for the final report...

The wreckage specialist is the person who visually examines the state of the materials on site: what event is responsible for the deformation of such and such a part of the aircraft, why does the wood of a spar show such and such a break, how does the delamination of a composite part explain the location of a breaking point? This is where observation and experience come into their own.

The wreckage specialist is responsible for collecting electronic equipment, for example, and directing it to the specialists at PESA, the BEA's recorders and avionics systems department.

In the case of major accidents, the wreckage specialists are divided into working groups covering different systems: engines, airframe and structure, landing gear, etc.

Some accidents, particularly difficult to analyse, sometimes require spectacular measures, such as piecing together a fuselage in a hangar.

This was the case for the UTA DC-10, which exploded in flight over the Ténéré. We had to confirm with certainty that the explosion had been caused by a charge placed in the plane by terrorists.

I was also involved in the case of TWA flight 800, the in-flight explosion of a Boeing 747 in the United States. We took part as representatives of the State of origin of some of the passengers. Among them was the guitarist Marcel Dadi. With our American colleagues, we reconstructed the fuselage to find the point of origin of the explosion, which turned out to be the plane's central fuel tank..."

Jean-François Berthier at the site of the accident involving the microlight identified 974-GQ on 30 March 2020 at Tan Rouge (Reunion Island).





Ground search exercise organised by ATR and the BEA in April 2023, April 2023 in Auch (Gers).



Perspective

Olivier Ferrante : Including human factors in investigations



The training of investigators in human factors began in the late 1990s. We set up this training with the IMASSA (Aerospace Research Institute of the French Army Health Service) and, above all, the LAA (Applied Anthropology Laboratory) at René Descartes university, then headed by Professor Alex Coblentz.

It may be interesting to note that the LAA had been called the Anthropology and Human Ecology Laboratory a few years earlier. Some of our investigators had acquired university qualifications in human factors. We extended this training to all investigators. It was a bit of a turning point. For a long time, investigations were purely technical. We were very dedicated, but there was a kind of dichotomy: we got to the bottom of the technical cause, but the treatment of the human cause often stopped at pilot error. It was now a question of going beyond this by raising the level of investigator training in this field.

However, the genesis of the implication of human factors in safety investigations went back to a few years earlier, when a difference of opinion broke out between the director, Mr Arslanian, and his deputy, Mr Pariès. The latter was “pro” human factors... so was Mr. Arslanian, but he preferred to wait for the academic doxa before going any further in this field. Gradually, thanks to the training courses I mentioned, a new generation of investigators became interested in this aspect of accidentology. As cockpits became more automated, we also had no choice: when you're faced with highly evolved man-machine interfaces, you have to analyse possible errors or interpretations in a little more depth. This whole human factors culture really arrived at the BEA in the early 2000s. At the same time, safety studies were introduced and databases set up to support these studies, in an attempt to better cross-reference the factors contributing to accidents. This, combined with in-depth incident investigations, enabled us to break down the factors involved in different events into descriptive and explanatory factors. Taken together, this new approach enabled us to try and make even more useful air safety recommendations.

Better still, safety lessons were learned from ordinary events, thanks to the REC, a confidential reporting programme for general aviation, set up in 2000 by Bernard Boudou, and the ITA (air transport incidents) for commercial transport, set up in 2004 by Pierre Jouniaux.



Flight simulation training device: the human factor is analysed in order to be incorporated in the safety investigations.

By analysing and aggregating this data, we were then able to carry out safety studies and adopt a more “safety culture” approach, a Safety Management System (SMS) as we know it today, i.e. using reactive data if you want to be more proactive.”

Analysis of SupAéro student behaviour



Category 3 investigation

This is a “desktop” investigation. During this investigation, information is mainly gathered via statements from those directly involved.

This information is generally not validated by the BEA, which does not seek to develop any analysis, conclusions or safety lessons. For the BEA, this category of investigation is above all a means of rapidly sharing individual experience within the community concerned. This category of investigation is most often reserved for light aviation, for occurrences that have not resulted in serious bodily injury. However, there is always the possibility that either the category of the occurrence and that of the investigation will evolve according to the elements gathered in the course of the inquiries.

The first phase of the safety investigation is always the longest. It begins at the accident site, where information is gathered. The study of this information will guide further work. During this phase, all the technical examinations and tests required to understand the circumstances of the event are carried out.

Only at the end of this phase can the analysis begin. This is to ensure that the analysis is based on and responds to all the facts. The analysis ends with the investigator drawing up a draft report. In the next phase, a number of different

reviews are carried out by investigators, members of management and the Communication department. It is by this means that the report which is validated become a BEA report. Finally, the investigation concludes with the publication of the report and its English translation on the BEA website.

The report may be supplemented by safety recommendations which, according to the ICAO definition, are proposals formulated by the accident investigation authority of the State which carried out the investigation, on the basis of information resulting from the said investigation, with a view to preventing accidents or incidents.



Perspective

An investigation at the beginning of the 1980s

Jean-Pierre Bonny looks back

"The resources available at the time can be summed up in a few words: examination of the wreckage, expert analysis of certain parts, various statements and, above all, the read out and analysis of the recordings made on board the aeroplane and on the ground, in the control centres.

Let me give you an idea of what our work involved.

As soon as an accident was reported, a team of investigators was sent to the scene. They would meet up with the gendarmes who were usually the first to arrive. The latter would be working for the designated investigating judge, but as they were not aviation specialists, they heavily relied on us. The gendarmes would help to gather the parts of the wreckage in order to piece the aeroplane together as completely as possible. This reconstruction was the only way to ensure that the aeroplane had not lost an essential part in flight, a part which, if missing or broken, could have caused the disaster. It has to be said that, at this stage of the investigation, very little is known, and every hypothesis has to be considered.

As we shall see, the read-out and analysis of the various recorders often made it possible to avoid this long and costly reconstruction.

Certain parts would be selected for examination to determine why and how a particular break had occurred.

To protect their legal validity, the gendarmes would seal these parts, which could only be examined under their supervision, which did not speed up the process.

In general, expert examinations were carried out at the CEP, the Saclay propulsion system test centre, an official organisation under the French Ministry of Defence, staffed by highly-qualified scientists. Using state-of-the-art measuring equipment, they were unsurpassed when it came to determining the cause of a crack that had led to a rupture. In my dealings with my American colleagues, I was able to see that they had no-one better among their enormous workforce! On occasions, they even sought the advice of our scientists, in particular Mrs Pinochet (no relation to the Chilean dictator). She was a veritable "well of science" when it came to crack analysis. A fracture always begins with a crack that has propagated through the metal. As aircraft and engine structures age, these structures become the site for cracks due to the stresses they undergo during flight. If these cracks can be detected in time, a number of failures and hence accidents can be avoided. Similarly, by examining the cracks in the parts of an accident aeroplane, accidents in the making can be avoided.

A second team was mobilized to check the operation of the radio guidance systems, where a faulty indication could have been the cause of the accident. We would ask for a control flight to be carried out, under the supervision of the judicial authorities of course.

A third team would obtain information about the validity of the licenses of the controllers who may be implicated.

At the same time, BEA specialists would extract from the recorders, the information they had stored during the flight and, more particularly, in the minutes leading up to the accident. This work would also be carried out in external laboratories, under the close supervision of the judicial authorities. This did not prevent controversy, however. Some people when concerned by an accident would not hesitate, if it suited them, to accuse us of criminal intent by claiming that we were tampering with the recorders !

Accident to the
Airbus A320
registered F-GFKC
operated
by Air France on
26 June 1988, at
Habsheim
(Haut-Rhin).



Let's look at the nature of these recorders for a moment. And, to begin with, those placed in the control centres. There were the conversation recorders, which stored all voice exchanges between the controllers and the aircraft, and between the various controllers. In fact, all radio and telephone messages were recorded and kept for several weeks. Radar recordings enabled us to reconstruct the aircraft's flight path, in elevation and azimuth, with the utmost precision.

Finally, we also had recordings of the operation of the radio guidance systems, enabling us to check their performance over time.

This work took long hours, but it was nothing compared to what was in store for us with the on-board recorders: the Cockpit Voice Recorder (CVR) recording noises and conversations by means of microphones in the cockpit, and the Flight Data Recorder (FDR) although the name DFDR, D for Digital, is more correct. This was followed by a third recorder, a maintenance recorder, whose data, intended for the operator's departments, was used to cross-check the FDR.

First of all, we had to find them in the debris of the aeroplane, which was far from easy. It was also very unpleasant. Just think, we often had to rummage through human remains, in an atmosphere that was hard to bear. Sometimes young investigators just couldn't cope. The gendarmes were marvellous in this kind of particularly difficult and demoralizing work, and I pay them tribute.

Secondly, the recorder boxes had to be opened without damaging their contents, which was sometimes a real tour de force given the extent of the physical and thermal shocks

they had undergone. The boxes were made to withstand such shocks, but sometimes the reality exceeded even the most pessimistic of forecasts!

What did these various on-board recorders contain? The first, the CVR, continuously recorded everything that was said in the cockpit, as well as the various noises. In this respect, it's worth knowing that every action on a control triggers a different sound signal. Thus, by listening to the CVR recording, we can determine the precise moment when the pilot activated the landing gear or the wing flaps, for example.

The CVR makes it possible to follow the conversations that took place, which was often highly instructive for the investigation. For a few accidents, this enabled us to observe that the crew were very busy with tasks that had nothing to do with flying the aeroplane!

There were often very personal confidences on the recordings, which led me, throughout the time I was in charge, to stubbornly refuse to communicate the full CVR transcripts, despite the enormous and growing pressure I was under. I deplore the fact that today this principle has been abandoned and that, by virtue of the highly questionable "right to information", certain judges or journalists do not hesitate one moment to make the last confidences of a dead person public! Do they think about the harm they can do to their loved ones?

But let's get back to the recorders.

What did the DFDR contain ?

As the name suggests, it contained the various flight parameters. In the older systems, only a few essential parameters were recorded, such as altitude, heading and speed, which was notoriously inadequate for a valid reconstruction in the event of an accident. I know that now, in the latest generation FDRs, several thousand parameters are recorded. In addition to the above, in no particular order, there are all the control surface settings, the aircraft's roll, pitch and yaw movements, all the engine parameters such as pressures, air intake and outlet temperatures, gas ejection speed, turbine and compressor rotation speeds, thrust forces, settings for all the radionavigation and landing systems, and so on.

Accident to the Fokker 27 registered F-GCPS operated by TAT on 4 March 1988, at Machault.



In my time, based on the few dozen parameters recorded, we were able to reconstruct the flight path right up to the moment of the accident. Today, we can do even better: using the data contained in the DFDRs, the computer displays on a screen, the exact evolution of the aircraft, in all three dimensions.

But when I was head of the BEA, we were already able to reconstitute the conditions in which the aircraft was flying at the time of the accident by feeding this data into a flight simulator. This was enough for an aeronautical expert to understand, but not enough for a judge. Nowadays, judges understand, or at least believe they understand, but is it any better? I'm not convinced, especially when I see how some have reacted to recent accidents.

Despite all the information that these systems were able to give us, the solution wasn't always obvious. What's more, a number of aircraft were exempt from carrying this equipment, for a variety of reasons. In this instance, finding the solution was a case of the crystal ball technique!

This was what journalists couldn't accept. It's true that, for them, the "paper" sells better if they can hint at a scandal. Indeed, what could be more "marketable" than the hypothesis that the authorities have something to hide? I can say loud and clear that this was never the case when I was head of the BEA! And I'm convinced it's still the case. Then began the considerable task of studying the entire file, analysing it, formulating hypotheses, submitting them to the criticism of numerous experts, and trying to build a credible scenario in order to draw definitive conclusions - this last point often squaring the circle!

It was necessary to take into account not only what had been observed, examined and analysed, but also everything relating to the crew members - their state of health, their level of training, their ratings, any conversion courses they had followed, their recurrent training, etc. - not forgetting the blood-alcohol check. For the latter, an autopsy had to be carried out if, by misfortune, the crew members had been killed in the accident. In the event of a positive result, a never-ending debate would ensue, with some doctors claiming that blood alcohol levels could increase after death, and others claiming the opposite. This was part of

the reason why we always had an expert doctor on every investigation commission. This was usually a very senior military doctor. Often, a doctor general.

We also had to take into account all of the history of the aeroplane itself. Had it experienced a number of previous incidents? Were they serious incidents? If so, how had the operator dealt with them? Was the aeroplane maintained to the standards in force set out by the authorities?

To answer all these questions, we had to scrutinize the logbooks concerning the airframe and engines, and even the propellers. This was a long and tedious task, which often meant that we had to continue our investigations at repair workshops, which were sometimes located abroad. When we were unlucky, everything added up to make our investigation almost impossible, or at least to delay it as long as possible!

What's more, it was work that nobody saw, and it was easy for the eternally dissatisfied and the perpetual detractors to claim to anyone that would listen, that the authorities were "taking it easy"! Journalists, with a few exceptions, were the bearers of this "good news", which gave rise to appalling controversies, particularly with members of the various defence committees.



2009. Accident to the Airbus F-GZCP operated by Air France in the North Atlantic ocean

On 1 June 2009, the Airbus A330 operating flight AF447 Rio - Paris, with twelve crew members and two hundred and sixteen passengers of thirty-two different nationalities, disappeared while crossing the Atlantic Ocean, some 600 kilometres off the coast of Brazil. The last trace of the aeroplane was a series of maintenance messages sent by the aeroplane's ACARS system between 02:10 and 02:15 UTC.

In the days that followed, parts of the aircraft, notably the vertical stabilizer, were found on the surface of the water, leaving no doubt as to there having been an accident. In accordance with the provisions of Annex 13, the BEA opened a safety investigation.

As he had done for most of the BEA's major investigations since the late 1990s (Kosovo, *Concorde*, Moorea, etc.), Paul-Louis Arslanian appointed Alain Bouillard to lead the investigation. Drawing on the experience acquired in 2004 when coordinating the search for the wreckage of the Flash Airlines Boeing 737 in the Red Sea, Olivier Ferrante was appointed to lead the sea search for the wreckage of the plane, which disappeared in the middle of the North Atlantic Ocean. He was to be in charge of the five phases of this extraordinary search campaign.

Two initial sea search campaigns took place one after the other until August 2009, but failed to locate the recorder transmitters. The BEA then launched preparatory work for a third phase of sea searches, bringing together scientists and academics to model currents in this part of the ocean and locate the wreck from floating elements. The failure of this third phase did not discourage the investigators. The deformations on the parts which had been found made it possible to determine that the aeroplane had struck the water with a high vertical acceleration, and the investigators determined a new search area based on the study of the first three search phases and the study of previous stall accidents, calculating the distance travelled by the plane between the start of the stall and impact. In this fourth search phase, the wreckage and then the recorders were found twenty-two months after the accident.

The BEA concluded that the accident resulted from the following sequence of events: the temporary inconsistency between the measured speeds, probably due to ice crystals obstructing the Pitot probes, causing the autopilot to disconnect and the reconfiguration to alternate law; the inappropriate control inputs that destabilized the flight path; the crew's failure to link the loss of indicated airspeeds

with the appropriate procedure; the late identification by the pilot monitoring of the deviation from the flight path and the insufficient correction applied by the pilot flying; the crew not identifying the approach to stall, their lack of immediate response and the exit from the flight envelope; the crew's failure to diagnose the stall situation and consequently a lack of inputs that would have made it possible to recover from it.

Forty-one recommendations were issued by the BEA (sixteen during the investigation and twenty-five when the final report was published), notably concerning the organization of search and rescue (SAR) operations, pilot training, cockpit ergonomics, flight recorders and flight data transmission.

- Most serious accident in the history of Air France.
- Two years of sea searches to find the aeroplane.
- Record number of recommendations.



Two years of searches were required to find the wreckage of flight AF447. The recommendations issued by the BEA principally concerned the means of locating an accident.



Investigation resources

Opening a safety investigation into an aviation accident mobilizes both human and financial resources. Men and women will devote all their time and energy to the investigation which can last for varying lengths of time, depending on the difficulty involved. Sometimes during a relentless series of occurrences, investigators have to work on several sites simultaneously. For the BEA, it's a question of finding the necessary funding to carry out the investigation. These resources can sometimes be exceptional, when it's a question of searching for wreckage that has fallen into the sea or on a site that is particularly difficult to access, and in a distant country.

Today, the BEA has its own resources that can be put to immediate use, or procedures for raising substantial funds in an emergency. But in the past, it had to deal with situations where both personnel and financial resources were lacking. A time when methods that would work in the future had to be invented ...



Listening to audio tracks of a CVR



Human resources

The small BEA team of some fifteen people in the 1960s and 1970s was confronted with the growth in air traffic, the democratization of mass air transport and the opening up of vacation destinations to almost everyone.

France's deep-rooted industrial tradition in the aeronautical sector has made it the main country for the final assembly of Airbus aircraft, giving it the status of State of manufacture when an accident occurs to one of the company's aircraft. This expertise has followed the upward curve of the manufacturer which has nibbled away at the market share of its main competitor, the American Boeing, until it is now on a par with and has sometimes overtaken the latter in terms of worldwide sales.

At the same time, as aeroplanes became increasingly complex, there was a multiplication of required skills, and the BEA found itself obliged to call on increasingly specialized experts. One of the greatest concerns of successive BEA directors has been the recruitment of new investigators, both in terms of numbers and new specializations.

Paul-Louis Arslanian was one of the most prolific recruiters. His determination to build a great BEA, combined with his skills of persuasion, enabled him to increase the BEA's workforce from around 15 agents to 50, then 100, reaching a peak of close to 120 agents in the mid 2000s. The aim was to respond to the ever-increasing number of missions, the extension of these to include incidents, and general aviation, swollen by the arrival and subsequent proliferation of microlights.

However, building effective teams takes more

1988. Accident to the Airbus A320 F-GFKC operated by Air France on Mulhouse-Habsheim aerodrome

On 26 June 1988, as part of an airshow, the pilots carried out a low-level pass over a runway at Mulhouse-Habsheim aerodrome. The aeroplane touched some trees shortly after the end of the runway, and then slowly sank into the forest. The right wing broke and a fire immediately broke out. Three of the one hundred and twenty-six people on board died in the accident.

The investigation commission concluded that the accident was the result of a combination of four factors: a very low pass below the surrounding obstacles, a very slow and decreasing flight speed to reach the maximum possible flight angle, the engines in flight idle and a late go-around. It also identified a number of contributing factors, including insufficient flight preparation and the pilots' lack of air show experience and go-arounds from flight idle.

Twenty-one safety recommendations were issued by the investigation commission in the areas of flight preparation, crew training, the aircraft (e.g. seatbelts) and the organisation of rescue operations. Since the accident, flights during air shows are carried out without passengers.

Accident site at Habsheim.



than just snapping fingers. As Jean-Pierre Bonny, who was head of of the BEA in the early 1980s, points out, *candidates are not jostling each other at the door of the Bureau. The job involves constraints that are not very compatible with personal and family life, the working environment is often very hard to bear, and the pressures often stressful to manage...*

Material and financial resources

As for the resources available to investigators in the 1980s and 1990s, they were not yet up to the task: low travel allowances, unsuitable vehicles, personal protection that was no less unsuitable, an embryonic laboratory that had to draw on the

experience of other establishments. The BEA was struggling to find a momentum

due to the lack of recognition of the importance of its role within the civil aviation administration and with respect to the political authorities.

Annex 13 of the Chicago Convention, which

Perspective

Jean-Pierre Bonny

The ups and downs for an investigator abroad

A "Yemeni" anecdote.

"My representatives, called to an accident in Yemen, were handed a bill of around 5,000 francs for their brief stay at the hotel. They had to pay it even though they knew that they would only be reimbursed for about a quarter of it! After such absurdities on the part of the French Administration, how was I supposed to find volunteers for these missions, which, moreover, were no holiday? That's how it was..."

• Mission: Impossible?

"Shortly after this accident, there was another even more serious one. That Sunday, I was at home when, around 16:00, the phone rang. It was Gérard, my Airbus Industrie contact in Toulouse. When my wife heard him introduce himself on the phone, she knew that an Airbus "was in deep water!"

That day, there had been a - fortunately - non-fatal accident in Kuala Lumpur, the capital of Malaysia. As the Airbus Industrie delegation was leaving that evening, my investigators absolutely had to go with them, as we were in charge of the investigation. As for them, they were "presumed guilty!"

Before 22:00, the departure time of the Air France plane, I had to find two investigators, two foreign mission orders, two plane tickets and some local money! On a Sunday afternoon, it was the "remake" of the famous film Mission: Impossible! I phoned the Director General to inform him of the situation and ask for his assistance. He replied with the famous "démendez-vous" (sort it out yourself), so well known in the Administration, but did add: "Do as you see fit! I'll cover you if you have to put yourself in a non-regulatory situation!"

It was better than nothing! But that didn't solve the problem. I immediately telephoned those of my investigators who were most likely to leave without notice. I knew them all well enough to know that so-and-so's wife would have a fit of nerves if her husband had to travel so far away without warning!

What did she think would happen? Many were still out and about on their weekend. The only two I was able to reach were my oldest and most

loyal member of staff, who I'd called on for the Japan mission, Michel Vigier, and Bourgeois. Vigier was severely handicapped by polyarthritis, yet he was always there when I needed him. The type of old-school civil servant that no longer exists! As for Bourgeois, I readily acknowledged that in this sort of situation, he was always up for it, driven, however, by his immense pride, which led him to think that, when it came to serious matters, he was more qualified than all the others to successfully carry out the mission!

That same evening, they boarded a plane at Roissy with the Airbus Industrie delegation. Airbus had paid in advance for the tickets, and my two investigators had agreed to leave without mission orders or foreign currency. In fact, I had no authority to issue mission orders abroad, and I had been unable to obtain any foreign currency, as the Trésorerie de Paris, the only body able to provide advances on government loans, was closed, as you may imagine.

I made a commitment to Vigier and Bourgeois to send them a telegraphic money order the very next day, to be addressed to the French Embassy. What's more, I promised to get the Ministry of Finance to admit that they were entitled to use their personal credit cards in this case, since, to make matters worse, we were at a time when it was strictly forbidden to use them outside national borders due to the re-establishment of exchange controls. I made all these commitments in the belief that Daniel Tenenbaum, our Director General, would deliver. I didn't have to regret it, for he kept his word, and I pay him tribute!

However, the telegram didn't arrive in Kuala Lumpur until the day my two investigators were to fly back. They must have been very worried while waiting for it, for they had drawn on the ambassador and, as I had experienced on several occasions, no help was to be expected on that front....."



Perspective

Alain Agnesetti

"I paid for a mission to Africa out of my own pocket!"

I joined the BEA in September 1999, and worked there for 18 years, until my retirement. In that time, I noticed very clear changes in all areas of the investigator's job.

As soon as I arrived, I was put in an office with a colleague who was away on a mission and shared his computer. I was given an e-mail address, but the network had little capacity at the time. Digital technology was still in its infancy. Today, the capabilities of our PCs and the VPN enable us to work with peace of mind anywhere. As far as photography was concerned, there were one or two film cameras kept in the duty office that we had to share between us, we then had to develop the photos and transfer them to our reports.

This was also the case for cell phones: two or three for everyone and mainly used for missions abroad, at an exorbitant cost.

It was getting complicated. We were then given a code phone card, which turned out to be very difficult to use, especially from abroad. We had to wait a few years before we were assigned a business cell phone with sometimes restrictive subscriptions. This was resolved in 2004-2005. For example, during the Concorde investigation, for six months, I had to work using my personal phone.

Similarly, there were few vehicles available at the BEA. I also had to use my personal car during this period to meet all the witnesses who had been targeted. (No one offered to reimburse me for the petrol...).

Nevertheless, when the Lyon branch was set up, I was given a new, functional vehicle that enabled me to carry out my mission.

For all our trips, especially abroad, and as was the case elsewhere, a request specifying dates, times and destination had to be submitted. When coming back, a document specifying the flight numbers and dates was sufficient. The problem lay in obtaining the indemnities for hotel stays and other incidental expenses. Our reimbursements were based on the daily rate specific to each country and even to certain states (USA in particular). However, our actual expenses (hotels, meals, local travel, etc.) were very rarely fully covered by the daily rate. For example, a two-week stay in Africa cost me around €300 out of my own pocket. How could I cover a stay in a decent hotel with a daily rate of €70? In response to this problem, a colleague decided to change his return date to make up for the loss. This caused quite a stir... and since then, boarding passes have to be provided to show the dates. This also explains why many investigators prefer missions in Europe or North

America to Africa.

At one time, we were given an advance equivalent to 5,000 francs to limit our personal advance. Before that, I had to return from a mission in the Far East, as I no longer had the financial means to pay for the stay, which was to be extended. I left seven days later to finish the mission with a cash advance... All this was improved when the travel staff were able to make hotel reservations at destination (even though the daily rate would be cut by 50%, this was still acceptable and sufficient). Weekend departures were always problematic: on one occasion, the head of the investigations department travelled to Roissy to pay out of his own pocket for the plane tickets of the investigators leaving for the West Indies. He was reimbursed within a week. Today, a procedure is in place enabling the 24/7 on-duty investigator to prepare electronic tickets."



Today, specially adapted vehicles means that investigators have easier access to accident sites.



Perspective

Always ready !

The BEA investigator can be called upon to go to an accident site at any time, and must therefore always be “operational”. This availability, which used to be the hallmark of the BEA adventure, is somewhat contested by the new generation of investigators who have contributed to introducing less restrictive rules than in the past, thanks in part to recent technologies that enable greater reactivity in the organization of departures. But every year, BEA investigators must also confirm their physical fitness by undergoing a medical examination.

“We now have a logistics department responsible not only for providing the necessary equipment on site, but also for organizing the trip (air tickets, accommodation, vehicles, expenses, etc.). This wasn't always the case,” recalls Jean-François Berthier. There was a time when we had to fend for ourselves and, above all, when we only had limited means to cover our expenses...”

“Jeff” Berthier remembers the investigator who, “in the rush to leave, left with two left shoes in his suitcase”. Not exactly practical for working without distractions...

“Up until the 1990s, in other words before the logistics department was set up, we had fixed expenses that never corresponded to reality!

This is how both I and other colleagues ended up in the only affordable hotel for us which was a rather shabby one, with a vocation that morality would not recommend... I also remember in Hong-Kong, three of us having to share a room so as not to lose too much personal money. Another time, in Korea, we were put up in a “hotel for couples”.

It's a local peculiarity to offer couples who haven't yet

settled down in a home, an establishment where they can meet in private... That night, we were surrounded by pink and mirrors...”

Well equipped...
by the “Au Vieux Campeur”!

“It was a good while before we were properly equipped to intervene safely at accident sites,” explained Jeff Berthier. For a long time, we didn't have any special clothing”.

Other times, other ways of doing things ...

“We've seen investigators working on wreckages in summer clothes, shorts and flip-flops! Unthinkable today...” points out Sébastien Barthe, Head of the BEA's Communication Division, as he looks through some old photos. As society evolved, so did the employer's responsibility to protect its employees' health, the physical risks taken by the investigators had to be taken into account and protection provided.

Personally, I've always worn a helmet when working,” explains Jeff Berthier. For years, we used to buy hunting gear - boots, trousers, hiking boots, etc. from the shop, ‘Au vieux campeur’.

One day, I blew my top when a rusty nail went through my shoe in the Melun hangar. Then we received more reliable personal protective equipment, safety shoes, breathing masks - and even then we only had three masks for the whole team! Then I asked for pressurized masks to protect me from particles, but I'm still waiting...”



A BEA investigator on site after being lowered down from a helicopter

Alain Agnesetti:

“Equipment-wise, it was very modest at the time. Not much equipment, often not the right size. For more than 15 years now, we've all had our own personal equipment, in our size and regularly renewed. In our Rhône Alpes Auvergne region, as in all mountain regions, investigators have long had almost complete mountain equipment.”

affirms the importance of the safety investigation, lacked the “political” dimension that would only come with the European Union and its 2010 ruling. By “setting in stone” the institutional, financial and moral independence of investigation bodies, it enabled the new BEA to reach its true position. The description by investigators, of how things

were makes it possible to appreciate the evolution of the resources of a “small company” towards those of the Bureau d'Enquêtes et d'Analyses equipped with all this is needed for both “national” and international investigations.

1992. Accident to the Airbus A320 F-GGED operated by Air Inter close to Mont Sainte-Odile

On 20 January 1992, an Airbus A320 carrying out the Lyon-Strasbourg air link, collided at night with Mont La Bloss, near Mont Sainte-Odile in Alsace. The flight had proceeded normally, but on arrival the flight crew had to modify their approach strategy and carry out a VOR-DME approach for a landing on runway 05. They were guided towards the approach axis by the controller. They began the descent when the aircraft was ten degrees to the left of the axis, with a rate of descent four times higher than the specified value, of which they seemed unaware. The wreckage was found more than four hours after the accident. Eighty-seven people died in the accident or while awaiting rescue. There were nine survivors, five of whom were seriously injured.

In its conclusions and recommendations, the investigation commission did not establish a hierarchy between the elements that contributed or may have contributed to the accident and its consequences. It determined that the pivotal event was the aeroplane's descent at an abnormally high rate, the most likely hypotheses being confusion in the selection of the descent mode or in displaying the setpoint value, and that the accident had been made possible by the crew's failure to perceive the resulting incorrect vertical flight path. It identified various contributing factors, including the lack of experience of both pilots on this type of aeroplane, ambiguities in communication between the crew and control leading to late modification of the approach strategy, and below-average crew performance, the ergonomic presentation of the parameters to monitor the vertical flight path not being sufficiently salient to alert a crew who had an erroneous representation of the situation, and the absence of a ground proximity warning system (GPWS) which deprived the crew of a last alert with respect to the serious anomaly of the situation.

Safety recommendations were issued in the following areas: crew, GPWS warnings, recorders, aircraft-crew interface ergonomics and autopilot system certification, survival, air traffic procedures, exercise of State supervision and feedback.



Accident to the A320 F-GGED,
close to Mont Sainte-Odile.



Perspective

Financing sea searches

Example of AF447 Rio-Paris in 2009

Launching a search operation as extensive as that for the wreckage of the Airbus A330 AF447 generates staggering costs that exceed the usual resources of the BEA. The logistical, financial and administrative aspects were so substantial that this search turned out to be the most expensive in the history of the BEA. They were carried out by a team made up of Olivier Ferrante, head of the AF447 sea search group for the technical aspects, and Jean-Luc Benesse, BEA Secretary General and financial expert. They played an essential role.

The more “routine” investigations are carried out primarily using the BEA’s own funds, supplemented by those of the DGAC, which, functioning with an annexed budget¹, ensures a degree of flexibility for responding urgently to a call from the BEA. Then there’s the State – through the various ministries concerned – when the sums to be committed exceed the capacities of the above.

Jean-Luc Bénésse, who knows the financial workings of this type of investigation inside out, explains:

“In a context where ministries are always short of funds, turn their eyes away and hope that their finances won’t be called upon for an extraordinary operation, it is the Prime Minister who has to be appealed to. It is the PM who arbitrates every day in interministerial meetings on important shared issues. He is represented by an advisor from his cabinet. A representative of the Secretariat General of the Government, who is present, drafts the content of the arbitration on a blue sheet of paper, the “Bleu de Matignon”, a decision which is then binding on all.

The BEA had to have its needs expressed in the interministerial meeting. To do this, it needed an ally who understood its objective and its needs. For sea searches, this will be the General Secretariat for the Sea which is under the Prime Minister. This search for funds proved necessary when the civil aviation annexed budget, managed by the DGAC, was unable to meet all the needs.

It should be noted that, in all the BEA investigations in which

I have participated, the DGAC has always done its utmost to provide the BEA with the funds it needed. But for the Rio-Paris, the financial requirements were greater than anything we’d seen before.”

Jean-Luc Bénésse at the controls to raise the necessary funds. *“Initially, the French government did not wish to finance the search.*

When the search was over and the wreckage had been found, however, the government had to do its part, particularly the recovery of the victims’ remains, which could not be left to private funding. But at the start of the investigation, the government left the BEA to work out the financial arrangements. Fortunately, Airbus insisted on financing the searches. Air France then followed suit, urged on by the families of the victims and the BEA. This led to the creation of a fund managed by the BEA.”

The allocated funds were placed in the BEA account via the DGAC. The BEA did its utmost to keep extremely precise accounts, which enabled the unused funds to be returned. *“However, stage 4, if I remember correctly, during which the wreckage was discovered, was financed directly by Airbus and Air France. The BEA supervised, but did not intervene. Then stage 5, entirely by the BEA. So there was a certain amount of financial creativity involved in getting to the end.”*

It’s interesting to note that circumstances such as these take some of those involved to the limits of their knowledge. In this case, the French Navy relied on the BEA’s administrative expertise, as did other players such as this organization, which requested the specifications developed by the BEA for sea searches, in order to refer to them from an administrative point of view.

“The financial controller had asked us some very specific legal questions about the choice of certain service providers over others. We had the right legal arguments to answer him.

For the Rio-Paris accident, five legal structures were used, corresponding to the five phases of the operation. The

1. Annexed budget Under French budget law, an annexed budget records the operations of unincorporated government departments that supply goods or services for which fees are charged. It is therefore civil aviation users who provide the DGAC’s resources (and therefore those of the BEA), and not taxpayers.



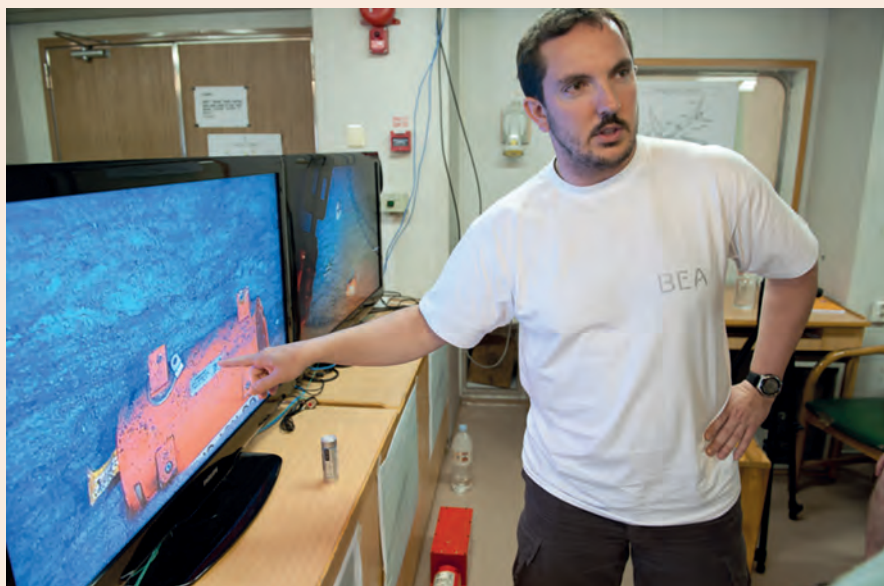
final phase, raising the wreckage from a depth of almost 4,000 m and transporting it to France, was carried out via a framework agreement ¹ to select a small number of marine operators offering a crane ship and the appropriate technical equipment, as well as the experience required for this type of work. The final choice of operator was made under a subsequent contract², based on the criteria of speed of intervention on the wreckage site and the price.”

In this context, the BEA's administrative services have to remain vigilant with regard to the legislation, in order to remain within the frameworks it defines, but also those... which lie outside its scope. For example, it is sometimes possible to act outside the Public Procurement Code, which does not apply to services provided on the high seas by an international organisation.

“We used this for certain services and negotiated directly. On the creative side, there’ was also the agreement with the US Navy: we wanted to rent equipment from the US Navy, but they don’t provide services. We had to fall back on the Franco-American intergovernmental agreement on national defence, which allows us to purchase equipment and services from the American military under the Foreign Military Sales (FMS) agreement. It was quite dense as you can imagine because the BEA is a very small organisation compared with the US Navy, but it was highly reactive and made its voice heard. Various stages of the search were thus able to take place.”

1. Framework agreement. A public procurement planning instrument, a framework agreement is a contract by which the public purchaser undertakes to award contracts or purchase orders to the holder(s) of the agreement, for a given period and for specified services.

2. Subsequent contracts are contracts awarded on the basis of a framework agreement, specifying the characteristics and terms of performance of services not contractually agreed in the framework agreement.



Considerable resources, such as the use of the cable-laying vessel *Ile de Sein*, had to be financed in order to locate the plane and recover the flight recorders...



Field investigators

The field investigator is an agent of the DGAC or the aeronautical regional service where they work. They intervene within minutes of an aeronautical occurrence, and are responsible for carrying out an initial investigation, under the dual authority of the administration to which they report and the BEA, before one of the BEA investigators arrives on site. To this end, the field investigator is equipped with basic technical equipment, and an on-call rota is organized to ensure that a field investigator is always available. They must also be competent in a wide range of subjects, and to this end receive training within the BEA.

A field investigator training course where the engine parts of a light aeroplane involved in an accident are examined.



Perspective

Jacques Pageix
Field investigator: "A hard job"

In my second year at the national school of civil aviation (ENAC) in Toulouse (1968), a theoretical course on air accidents was given by Mr. Michel Vigier, an engineer from the *Bureau Enquêtes-Accidents*.

Five years later, in 1973, the memory of this course had faded from my mind after two years spent in Africa with ASECNA (Agency for air navigation safety in Africa and Madagascar), followed by my first posting to Paris with STNA (Air navigation technical service). However, in 1973, my new duties with the Auvergne aeronautical regional service required me to carry out accident investigations, an activity which was not the least of the missions assigned to this service based in Aulnat, and which then continued at Toussus, in the Paris airport general aviation service until 1997...

Needless to say, accident investigations were one of the high points of my career, and one that I will never forget...

It's a delicate subject that I can't broach without expressing a dual concern for discernment and discretion. The investigator was sometimes confronted with real human tragedies, and the ever-present possibility that relatives or heirs of families affected by such disasters are still with us, prompts me to show a certain reserve...

Forgetting my initial misgivings, I nevertheless set about writing "as I went along", interspersing a few cautious accounts¹ with an account of current practices and how they evolved over the years that saw me tackling this hard² job (1973-1997).

1. Refer to the site <http://aeriastory.fr/themas/memoires-de-jacques-pageix/>

2. Hard... I'm not afraid to use the word!

I wasn't at all surprised when, on the job advert for the *Bureau Enquêtes-Accidents*, I read that one of the qualities required was "ability to work in a hostile environment": I had considered joining this service, where the investigator activities, notwithstanding their morbid aspects, fascinated me.... (the Sherlock-Holmes side of me...). As my friend Jean-François Berthier from the BEA, said when he met me at the scene of a fatal accident where the wreckage offered no tangible clues: "Jacques, it's not telling us much..." We are just going to have to make the debris talk.



Where field investigators learn how to “make a damaged propeller talk”...



Jacques Pageix, field investigator at a glider accident in the Auvergne region.



A group of field investigators, during a training course led by Stéphane Otin, in March 2018, on the BEA premises.



Perspective

Jacques Pageix
Directive No 300 of June 1957

Jacques Pageix, IENAC 1967, presents what was the reference text for French investigators from 1957 onwards, directive No 300 IGAC-SA of 3 June 1957, designed to clarify the steps to be taken in the event of an aviation irregularity, incident or accident. He drew on this document himself during the many field investigations he carried out in the course of his career, and comments on how he would proceed.

"It's important to remember that, while the BEA's role was to investigate the causes of the accident and to word the recommendations, it was up to the field investigators, within their allocated service, to carry out all the tasks assigned to them.

In addition to the technical investigation itself, we had to identify any faults and infringements, and take appropriate corrective action (individual or collective measures with respect to pilots, companies or flying clubs, for example). In this respect, the inspector pilots of the aeronautical training service made an effective input, contributing to flight safety in the clubs through their checks and advice.

Field investigator

Let's start by recalling what was involved in what was colloquially known as "field investigations".

There were several aspects to a field investigation:

a)- Dissemination of information:

The first step was to notify the authorities specified by the legislation in force (BEA, DGAC hierarchy, Gendarmerie, Prefecture, etc.) by means of an "AFTN" message with "DD" priority. It was drawn up according to a standardized model, with items added as and when they were known (see example below).

b)- Search for wreckage

This may come as a surprise nowadays, but I was sometimes confronted with this problem (emergency locator transmitters will come later)...

c)- Preserving evidence (documents, radio and radar recordings, etc.). The investigator had to get to the wreckage site as quickly as possible to preserve it and collect evidence and statements: photos of

the wreckage classed with notes and sketches; statements taken (usually by the Gendarmerie); radio and radar recordings obtained from air traffic control services and weather reports from a departmental weather station.

d)- Samples

The investigator could take samples of lubricants and fuels, or even seize the engine(s) or various parts (for crack detection, for example) for analysis by the Saclay powerplant test centre (CEPR).

e)- Other data

In most cases, a transcription of the radio recordings had to be made and radar readings obtained where necessary. Meteorological measurements obtained from a nearby weather station (there was at least one in each department) were also crucial in reconstructing the preparation and progress of the crew's flight.

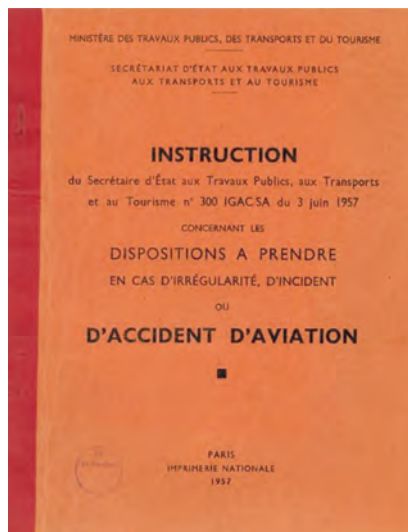
f)- On-site investigation

The field investigation was carried out in conjunction with the air transport police (GTA)¹ and, sometime, with the border police, being responsible for the judicial investigation. The investigation was conducted under the aegis of the BEA, which could travel to the site or give free rein to the local investigator. In most cases, the prefectural authorities were notified.

g)- Data collection, compilation and analysis in the quiet of the office, and drafting of the field report as described below.

The service which the investigators were assigned to organized their duty period by means of a duty rota, and drew up appropriate instructions: for my part, I drew up the accident

1: The GTA provided invaluable assistance to the investigator, in particular by collecting statements from witnesses to the accident, which could be consulted in their audition notebooks. I would like to emphasize this all the more, as on two or three occasions I was obliged to do this work myself, which is no mean feat... The gendarmerie and police services could act under a rogatory commission from an investigating judge.

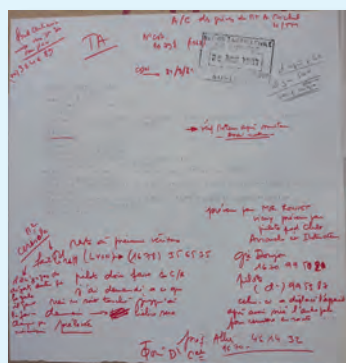


investigation instructions in Auvergne (in 1974)."

Example of an accident notification message on the AFTN (aeronautical fixed telecommunication network)

It concerns the accident to the MS 893 F-BPHI, on 26 August 1981 at Le Donjon (south-east of Moulins, Allier), message broadcast by Vichy-Charmeil aerodrome, with my annotations in red...

261609 LFLV
aviation
accident advice
 a) 261500TU
 b) landing in
 open country
 3 kilometres
 from Le Donjon
 south-east of
 Poupetière
 c) F-BPHI
 d) MS 893
 e) Avranches
 flying club
 f) Lycoming
 g) Pilot-in-command M. L.;
 Passenger, Mrs L.
 h) propeller blade tip
 i) Mâcon-Avranches
 j) lost propeller blade tip in flight -
 decided by land in open country
 k) information received at LFLV at 1539
 TU following telephone call from pilot
 Stop and end.



Perspective

Jacques Pageix Aeroplanes without a pilot, but a report nonetheless...

"Accident reports had to be written for the BEA, for the IGAC (the General Inspectorate), and for our regional office in Aix-en-Provence. From a regulatory point of view, these reports only concerned aircraft involved in accidents with a pilot at the controls. However, in Auvergne and Toussus, there were occasions when I had to intervene in occurrences where no pilot was on board.

I remember at Aulnat the case of a plane, whose pilot had started the engine by turning the propeller, which ran off in a straight line, only to stop several hundred meters further on, engine running, when it smashed into an obstacle.

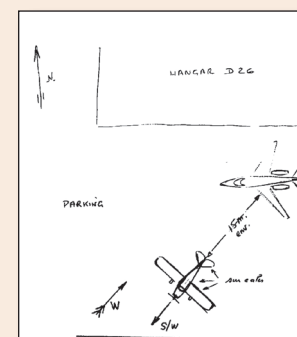
At Toussus, I dealt with the case of a plane equipped with manual controls for the disabled, with the student inadvertently left on board alone by the instructor, who did not know how to brake when the aeroplane started moving forward; it ended up against a Bell 47 helicopter, which was almost destroyed.

At Meaux, during violent 140 km/h wind gusts, a Jodel parked near the petrol pumps took off vertically, rose several dozen meters and fell back on its side.

The next case, involving a company LearJet, occurred on the apron of Clermont-Aulnat airport on 16 November 1974. A Piper was parked in front of Air Centre hangar D 26, on its chocks and facing into the wind (S/W). A strong gust made the aeroplane oscillate and pass over the three wheel chocks (front wheels and tailwheel). After rolling backwards, the aircraft struck the parked Air Massif Central LearJet, damaging its rudder and elevator. The two aircraft were parked 15 metres apart.

The airport weather station gave average wind values of 25 kts (47 km/h), gusting to 50 kts (93 km/h). Damage to the PA 18: rudder (skin torn off), right elevator (skins torn off). The LearJet 23 escaped with two antennae torn off: the radio compass antenna and the transponder antenna, and scratches on the left fuselage side and on the leading edge of the left wing."

Freehand diagram of the accident
 drawn by field investigator



Over Greenland the Airbus A380 on the Paris-Los Angeles flight AF66 lost part of an engine

The investigation that followed the accident to an Air France Airbus over Greenland in September 2017 showed the difficulties of recovering aircraft parts in extreme and isolated conditions. Although fortunately there were no casualties, the event was classified as an accident due to its exceptional nature. The conclusions of the analysis threw light on a poorly mastered phenomenon in metallurgy.



On Saturday 30 September 2017, the Airbus A380-861, registered F-HPJE, operated by Air France, took off from Paris bound for Los Angeles, with 497 passengers and 24 crew. While the aeroplane was in cruise at 37,000 ft over Greenland, an explosion was heard. The

front part of engine 4 (outer engine on right wing) had separated in flight. The crew diverted and landed at Goose Bay airport, in east Canada. In the days that followed, an Air Greenland helicopter on a scientific mission in the region managed to find several parts of the engine.

The Airbus A380 after landing at Goose Bay.
In the foreground, engine 4, whose fan was torn off in mid-flight.



The initial visual examinations by investigators suggested a failure of the shaft supporting the forward section of the damaged engine.





Satellite, helicopter, radar, electro-magnetic detectors... Exceptional technical resources were deployed to find the engine part buried in the snow.

But snowfall interrupted flights over the area and a thick layer of snow eventually covered the ground, making further visual detection impossible.

The examination of the parts that were found - fan blades and parts from the nacelle - was insufficient to explain the cause of the failure. It became imperative to find the hub - a titanium part one metre in diameter - buried under the snow somewhere in a 10 km² zone!

In April 2018, over a three-week period, ONERA (the French Aerospace Lab) searched the area in order to locate the missing parts under the snow using synthetic aperture radars installed on a Falcon 20 operated by AVDEF (Aviation Defense Service).

In May, scientists from GEUS (Geological Survey of Denmark and Greenland) travelled to the zone to recover the parts that had been located.

For nearly a month, they criss-crossed an isolated barren area in hostile meteorological conditions, exploring the sites indicated by ONERA without finding any debris.

The ground, composed of heterogeneous layers of ice and snow, complicated the analysis of the radar images and created numerous "false positives".

GEUS then carried out a systematic ground search using ground penetrating radars. However, at the end of June 2018, after nine months of searching and despite the substantial resources deployed, the fragments of the fan hub had still



Located with great precision,
the lost part was to be found under
four meters of snow...

Tons of snow had to be cleared away
for this very special treasure hunt...



not been found.

Once back in France, ONERA continued to analyse the radar images acquired while flying over the search zone. The investigation team, for its part, worked to develop more suitable detection means.

After one year spent looking for engine parts which had fallen from an Air France A380 onto the Greenland ice cap (phases I and II), preparations were made for a new campaign in 2019. New detection techniques were used to search for the fan hub, its examination being considered decisive for the investigation.

At the end of 2018, the Hydrogeophysics Group of Aarhus University, Denmark (HGG) proposed an improvement to its towed electromagnetic detector making it capable of identifying a titanium part buried under the snow and ice. Tests were carried out in January 2019 on a glacier at Zermatt in Switzerland.

ONERA, for its part, continued analysing the radar data acquired during flights over the zone in April 2018. The specifically developed algorithms showed three potential sites for the fan hub, one of which situated in the zone where the part was thought to have fallen.

The searches resumed in May 2019. A team composed of members from GEUS, HGG and PRE (a Dartmouth university laboratory using a Frostyboy robot equipped with a ground-

penetrating radar) travelled to the site to sound the positions given by ONERA.

The adverse weather conditions and technical problems interfered with the searches.

Nevertheless, at the end of the mission, the examination of the zone considered the most promising by ONERA confirmed the presence of a metal part, probably a fragment of the part sought. The access to the part was perilous as it was situated one metre from a crevasse. Glacier rescue specialists from Iceland had to be called in

After working for 30 hours and evacuating 20 tonnes of snow, they managed to extract the part buried under four metres of snow and ice in July 2019. It was indeed a fragment of the fan hub from the A380 engine which would be sent to the manufacturer, Pratt and Whitney, for detailed examination.

After thirteen weeks of search operations, spread over two years, it was airlifted to the nearest airport, where a member of the BEA prepared it for shipment to Pratt & Whitney in Hartford (USA). The electron microscopic examination invalidated the initial hypothesis of a blow sustained during maintenance. The fracture was due to poor casting of the titanium part, giving rise to a phenomenon known as “dwell fatigue”, little known despite 40 years of metallurgical research.

The investigation came to an end in June 2020.



Perspective



Marc Lever:
**“We had to call
 on polar specialists”**

The investigation into the Paris-Los Angeles occurrence changed nationality four times in the first few hours. It was first a serious incident requalified as an accident in view of the potential consequences, although there were no casualties. The investigation was complex because it took several years to find the parts. It was an uncontained failure of the front end of an engine (loss of the fan disc and its blades, as well as the air intake). The investigator Marc Lever, tells us about his experience.

“I was spending a quiet Saturday evening with my wife, when I received a phone call from the BEA informing me of an occurrence to an Air France A380 bound for Los Angeles. At first, we weren't too concerned, as it seemed to be a case of an engine failure on a plane with four engines. It was going to divert or even continue the flight to destination, it was not supposed to be a problem. They just asked me if I was available if they needed me, I said yes and they told me they'd keep me informed.

I quickly found photos taken by passengers, on social networks. The BEA informed me that they would probably be sending a team. And so we set off for Goose Bay without knowing exactly where the occurrence had taken place on the Paris to Los Angeles route.

The crew of AF66 made the decision to land between Greenland and Canada, choosing Goose-Bay, an airport with a runway which could be used by heavy aircraft. A colleague who specializes in flight recorders travelled to Ottawa, to the Canadian investigation authority's

premises. As the aeroplane had landed on Canadian soil, they were responsible for leading the investigation. It was then discovered that the event took place over Greenland, making Denmark the country of occurrence. Discussions were started. The Danes, acknowledging that they did not have sufficient investigation resources, wished to delegate the investigation to the BEA, as the aeroplane and the operator were French. The BEA accepted this delegation.

This posed a few problems, however, as the investigation had already been underway in Goose Bay for 48 hours, with a Canadian investigator in charge of leading the investigation, and American and Canadian group leaders (because of the Engine Alliance engines: GE and Pratt & Whitney, the damaged fan having being made by Pratt & Whitney).

We soon realized that the parts at the origin of the failure were missing. I travelled to Goose Bay a second time to help remove the engine. Going there was no routine mission. Bear in mind that heavy equipment had to be brought in by road to remove an engine of this size. The lorry sometimes had to make detours of several hundred kilometres to reach the airport, notably to cross a flooded river.

It was also at this time that with the financial support from the manufacturers and the operator, the BEA decided to launch a search for the parts that had fallen in Greenland. We knew that the site was inaccessible for part of the year, due to the very difficult weather conditions and the perpetual movement of the ice cap. We called on specialist



organisations, such as ONERA, to provide us with suitable radar sensors. Once on site, we discovered that these sensors were affected by pockets of water in the ice, which meant that we had to use ground-based resources to confirm the detection. Only specialists of this inhospitable region, holding an ice-climbing license and a permit to carry firearms (given the possible presence of bears) were allowed on site.

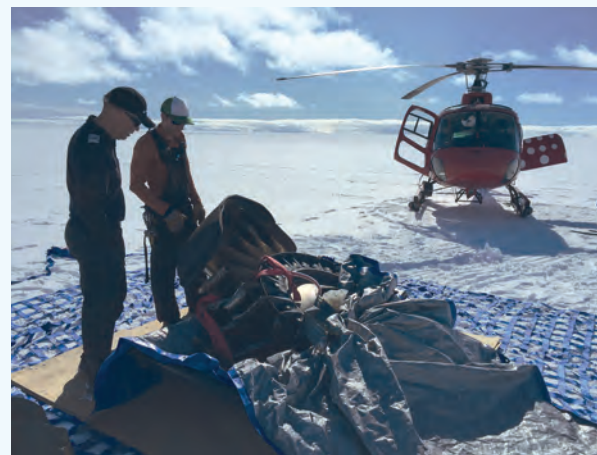
The parts were found shortly before the fixed deadline. We were thus able to confirm, among other hypotheses (notably maintenance errors), a high probability of fatigue failure in the core of the metal alloy, a rare and difficult-to-detect phenomenon, known as dwell. Before these parts were found, the decision was taken to recover the engine. It was sent to a workshop in Cardiff, Wales, with the difficulty of finding an aeroplane to transport it. This aircraft was the Ukrainian cargo plane, the Antonov An-124.

Then the A380 had to be brought back to France. It was not an A380 engine from the Musée de l'Air et de l'Espace that was fitted to the aircraft, contrary to what may have been heard following a miscommunication, but a spare engine specially shipped and installed for use for the return flight of the aircraft which is no longer used by Air France.

Six of us from the BEA took part in this investigation."



After thirteen weeks of searching spread over two year, the turbine appeared at last ...



Chapter 5

After the safety investigation



As we have seen, the aim of the safety investigation is to determine the causes of an air accident, in order to prevent them from reoccurring. It culminates in a report and recommendations addressed to all those involved in the aeronautics industry: aircraft manufacturers, equipment manufacturers, navigation services, airport infrastructures, etc. These recommendations, issued by the BEA, often in consultation with other aviation safety organizations, sometimes have worldwide repercussions on the technical organization of civil aviation.

Following their investigations, aviation safety organizations issue recommendations to the aviation industry, to ensure that the accident or incident does not happen again.

However, these recommendations are not mandatory, as long as the certification authorities do not impose an airworthiness directive on manufacturers, for example.

"But they are generally complied with, and even expected, by manufacturers," indicates the BEA. "Nobody wants to see their reputation tarnished, manufacturers or operators alike, and guaranteeing the highest level of safety requires careful compliance with the recommendations we issue..."

Sometimes these recommendations are extreme. *"After the Concorde accident, we recommended that the aircraft be grounded... It's easy to imagine that this was not unanimously supported (see*

above). Fortunately, the airworthiness authorities put their trust in the BEA..."

When it comes to convincing European or international authorities to revise texts or impose new equipment on aircraft, the procedure can be lengthy, due to the number of parties involved and the potential cost of the modifications required.

Numerous working meetings are required, and recommendations can take a long time before being implemented.

The example of retrieving flight data every minute to pinpoint the aircraft's position at any time during its flight shows the determination and perseverance of BEA engineers and their foreign colleagues to bring their projects for improving air safety to fruition.



An explanation that came late Loss of rudder on an Airbus A310

The investigation following an incident or serious incident does not always provide the definitive, rational explanation that might be expected. Doubts sometimes persist about the reasons for an incident, or even an accident, for months or even years before an explanation is found.

On 6 March 2005, Air Transat flight 961, cruising at 11,000 m (35,000 ft) from Varadero (Cuba) to Quebec City (Canada), was forced to return to its departure airport due to the loss of the rudder on the Airbus A310-308 registered C-GPAT. Following a structural problem, a large part of the rudder had separated from the vertical stabilizer, causing a Dutch roll. However, the crew managed to maintain control of the aircraft, and landed safely at Valaredo.

The investigation was carried out by the TSB (Transportation Safety Board of Canada) in its capacity as the investigating authority for the State of the operator, and by the BEA in its capacity as the investigating authority for the State of manufacture. The report did not formally identify the reason for the loss of a structural component.

The most likely explanation for this incident came a few months later. On 27 November 2005, during repairs to the rudder of a US-registered Airbus A300-600, disbonds on a rudder composite panel were discovered. The disbonds appeared to be linked to the infiltration of hydraulic fluid, weakening the bonding strength.

Following these events, EASA and the FAA, in consultation with the manufacturer and based on the information provided by the three investigating authorities - Canadian, American and French - jointly defined measures to guarantee the safety of the Airbus fleets concerned. On 10 March 2006, the BEA issued the recommendation that EASA should impose as soon as possible, a program of appropriate inspections of the control surfaces concerned. This was followed by the inspection of 408 Airbus aeroplanes. The various inspections revealed disbonds,

damage around the rudder's hoist points and rear edge attachments, hinges showing corrosion and wear, seized hinges, as well as hinges with too much play and water ingress.



Removal of vertical stabilizer
and view of position of main attach
fittings



View of vertical stabilizer
and remains of rudder, RH
side

After the accident to flight AF447

An international working group for the triggered transmission and recovery of flight data

The rapid recovery of flight data to locate a wreckage at sea is of paramount importance to investigators. Technically, it is now possible to obtain information about a critical situation even before an accident occurs. Even so, international regulations needed to be amended so that hardware solutions could be installed on board aircraft.

As early as October 2009, the BEA, represented by Philippe Plantin de Hugues, international affairs adviser and senior investigator, set up an international working group to propose solutions and change the regulations. It took eight years and two tragic disappearances - Air France flight AF447 and, five years later, Malaysia Airlines flight MH370 - to convince and have their conclusions endorsed.

"On 1 June 2009, Air France flight AF447 performed by the Airbus A330-200 registered F-GZCP, disappeared over the ocean en route from Rio de Janeiro (Brazil) to Paris-Charles de Gaulle (France). By September 2009, two underwater search campaigns had already been undertaken to locate the wreckage over a vast area of the Atlantic Ocean. Floating debris was recovered and identified on 6 June 2009. Between 10 June and 10 July 2009, a variety of acoustic detection equipment was deployed in an attempt to detect the aeroplane's Underwater Locator Beacons (ULB).

From 27 July to 17 August 2009, another search team attempted to locate the wreckage using a side-scan sonar and a Remotely Operated underwater Vehicle (ROV).

Despite these efforts, in September 2009, the

wreckage and flight recorders had still not been found.

On 30 June 2009, an Airbus A310 registered 7O-ADJ operated by Yemenia Airways, on a flight from Sanaa (Yemen) to Moroni (Comoros), crashed into the sea near Moroni airport. The two ULBs were detected and located, but were found separated from the protected memory modules of the flight recorders. It took eight days for the ROV to recover the protected memory modules, at an approximate depth of 1,200 meters. There are other examples of lengthy and extremely costly searches for the wreckage and recorders, such as the accident to the Boeing 747 operated by South African Airways on 28 November 1987.

The difficulties encountered raised questions about the suitability of existing flight data recovery technology for accidents over oceanic or remote regions.

The search for the wreckage and understanding the factors which had contributed to the accident represented an exceptional challenge for the BEA and the international aviation community.

In October 2009, I proposed to Mr Troadec, who had just been appointed Director of the BEA, to set up an international working group called "Flight Data Recovery" to examine new technologies



for safeguarding flight data and/or facilitating the location and recovery of flight recorders.

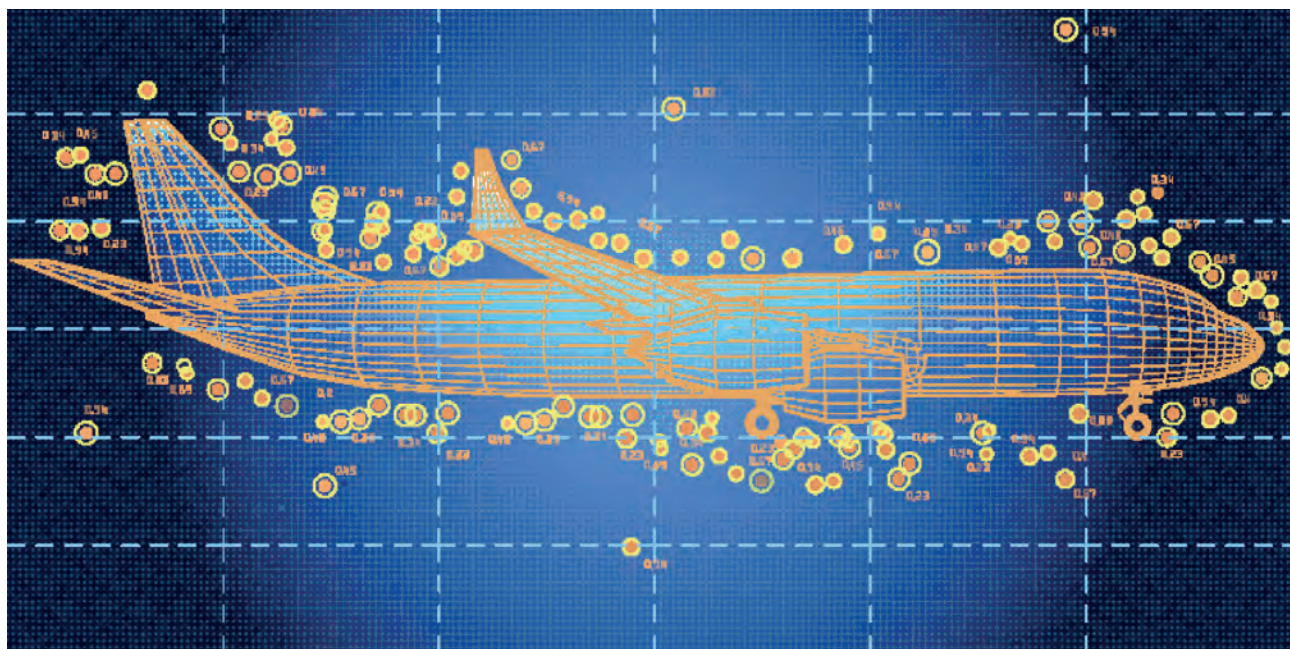
Areas such as flight data transmission via satellite as well as new flight recorder or ULB technology were to be considered. An innovative aspect of this group's work lay in the analysis of the costs and benefits of possible solutions before drawing up safety recommendations.

To accomplish this work, another BEA investigator, Arnaud Desjardin, led the group with me. The investigator, Aude Le Berre, was also appointed to help us.

Of course, at the same time, the investigators from the Investigation and Technical departments were consulted during the drafting of the report and the analysis of the results. This work is therefore a collegial undertaking within the BEA, but also in partnership with all the front-line actors in the aeronautical sector.

I wanted a small, international group so that I could easily manage it. I had already led international working groups to draw up specifications for flight recorders, the famous “black boxes”, with over 70 members.

The disappearance of AF447 had been so traumatic for the aviation industry that all our contacts wanted to contribute to the work of this group. The group was therefore made up of over 120 members from many countries, representing a wide range of actors: investigation authorities (BEA, NTSB, AAIB, BST, BFU, etc.), regulatory authorities (ICAO, EASA, FAA, etc.), aircraft manufacturers (Airbus, Boeing), flight recorder manufacturers (L3Com, Honeywell, GE, DRS, EADS, etc.), ULB manufacturers (Dukane, Benthos), air operators (Air France, Fedex), satellite manufacturers and access providers



The “flight data recovery” working group had to study available and future technologies for transmitting and saving this data.





ACARS (Aircraft Communications, Addressing and Reporting System) is a digital communications system used on aircraft to send and receive messages in text format between aircraft and ground stations.

(Astrium, Inmarsat, Iridium, SITA, etc.) as well as international associations (IATA, IFALPA). These different backgrounds enabled us to carry out comprehensive studies in all fields.

Within three months, we had organized two meetings. The first meeting (at the BEA's premises on 14 and 15 October 2009) proposed to explore solutions in three different areas: flight data transmission, new flight recorder technology and wreckage location technology. For each area, a list of possible solutions with technical feasibility studies was drawn up.

I wanted the second meeting to be held at the ICAO's premises (16, 17 and 18 November 2009), so that the results and how to achieve them would be fully understood by the members of the ICAO Air Navigation Commission.

The solutions that emerged from this assessment were:

- Extension of the ULB transmission time for flight

recorders (90 days instead of 30 days), resulting in the 2012 amendment of ICAO Annex 6 and European Regulation 965/2012.

- Installation of low-frequency ULBs (between 8.5 and 9.5 kHz) attached to the aircraft, resulting in the 2012 amendment to ICAO Annex 6 and European Regulation 965/2012.
- Regular transmission of basic aircraft parameters (via ACARS, for example), resulting in the 2016 amendment of ICAO Annex 6 and European Regulation 965/2012.
- Triggered transmission of flight data. On this point, further work was considered necessary, and the BEA again consulted members of the group to carry out a study. And finally
- Installation of deployable recorders.

The first two points regarding ULBs were seen as short-term solutions to cover the case of aircraft already in service, the transmission of triggered data is a medium-term solution for aircraft to be built from existing designs, and finally the installation of deployable recorders is a long-term solution for new aircraft designs. All these solutions complement each other to establish a robust means for locating an accident site at sea and rapidly recovering flight recorder data.

The BEA published safety recommendations based on the working group's findings in the second AF447 interim report dated 17 December 2009. In other words, in the three months from October to December 2009, Arnaud, Aude and I worked weekends and evenings as this work was in addition to the normal investigation work.

When drafting standards or regulations, the regulatory authorities analyse the cost aspects before proposing any amendments. The cost/benefit analysis consisted in evaluating the benefits that each solution might have had in past events, identified on a list provided by the

BEA. The idea behind our cost/benefit analysis was to do this work in advance, in order to reduce the time required to modify ICAO standards. By way of example, the diagram on the following page shows the process for developing ICAO standards for the carriage of low-frequency ULBs.

Following the work of this group, in December 2009 the BEA addressed a safety recommendation to ICAO for the carriage of 8.8 kHz beacons. The ICAO flight recorder panel (FLIRECP), which I headed, was tasked with analysing this recommendation and making a proposal to amend Annex 6. This was done in October 2010.

The ICAO Air Navigation Commission then analysed the proposal and consulted the States. In view of their positive comments, the new version of Annex 6 was published in November 2012, incorporating the amendment proposed by FLIRECP. This three-year period is incompressible in the ICAO process.

We will see a little further on that despite all the work carried out, not all the safety recommendations made by the working group were followed in the same way.

Commercial air transport aeroplanes are equipped with flight recorders on which high-frequency (37.5 kHz) ULBs are mounted.

The acoustic signals of these ULBs attached to the recorders can only be heard by hydrophones at a distance of up to 3 km according to the conditions. These beacons were not therefore detectable using hydrophones on the surface. The larger low-frequency (8.8 kHz) beacons provide the undeniable advantage of being detectable over large distances underwater, up to 20 to 30 km according to their power.

Determine a concept

The “Flight Data Recovery” working group identified the transmission of flight data when precursory indications of a catastrophic event have been detected, as a very promising solution. However, it was not recommended in the second AF447 interim report as it was considered that additional work to assess the operational suitability of this solution was necessary.

The cost of communications and the installation of the systems on board the aircraft are very important factors in determining whether our safety recommendations are taken into account by the authorities. This is why the BEA decided to consult the members of the group again and set up the

“Triggered Transmission of Flight Data” working group.

Once again, this group, chaired by Arnaud Desjardin with Aude Leberre and myself, took a very active part in the work.

The concept of triggered transmission of flight data consists of initially detecting whether an urgent situation is emerging based on the flight parameters. If this is the case, the second step is to automatically transmit data from the aircraft until the urgent situation ends or the aeroplane

Underwater Locator Beacon (ULB) attached to flight recorders.



crashes. Flight parameters can be analysed in real-time by on-board equipment and the use of triggered data transmission by means of a logic equation was a mechanism that was already well mastered in 2009. However, the BEA had no criteria for detecting an urgent situation on the basis of flight parameters.

At the time, I heard engineers outside the BEA say, "You won't be able to detect a distress situation" or "You won't have enough time to transmit data to the ground". This demonstration thus proved to be a real challenge.

The aim was to determine whether the concept of triggered transmission could be implemented to locate fixed-wing aircraft debris in the event of accidents over maritime or remote areas. With this in mind, the BEA, Airbus and Cranfield University developed criteria for detecting a distress situation. To test these criteria, a database of normal flights and flights that had experienced an accident or serious incident was created. This database was also used to assess the continuity of communication with satellites when aircraft are in unusual positions. The accident files were provided by the United Kingdom, Taiwan, Australian, French, Russian, United States and Canadian official investigation authorities. The "normal" flight files were provided by Air France. These "normal" flights included scheduled commercial flights that had not experienced any incidents, as well as flights that had experienced minor incidents (e.g. turbulence, slight overspeed, etc.). The files were rendered anonymous, with no dates or latitude/longitude parameters being provided.

Once again, despite our wish to limit the number of participants, the group was made up of over 150 members from many countries, representing a wide range of actors: investigation authorities (BEA,

NTSB, AAIB, TSBC, ATSB, ASC, etc.), regulatory authorities (ICAO, EASA, FAA, DGAC, etc.), aircraft manufacturers (Airbus, Boeing), access providers, equipment and satellite manufacturers (Astrium/Star Navigation, Inmarsat, Iridium, FLYHT, DRS, etc.) and international associations (IATA, COSPAS-SARSAT, etc.).

The conclusion of the work carried out over a one-year period between March 2010 and March 2011 demonstrated that the transmission of position data at a regular rate (every minute) could be an alternative to triggered transmission based on the detection of an urgent situation making it possible to achieve the objective of a search zone with a radius of 4 NM¹.

This conclusion, based on real accident/incident cases and real normal flights, proved that criteria based on a limited set of recorded flight parameters can detect 100% of these accidents and incidents. The study also showed that these same criteria can be adjusted so that nearly no untimely transmission is generated. This robustness of the system would ensure that companies would not have to pay insurmountable communication costs.

The study also proved that it is possible to develop reliable criteria for detecting urgent situations.

The robustness of the detection could be further improved with more elaborate criteria and additional parameters on modern aircraft data buses, that were not available for this study.

Reducing the search radius

The alert times, or times between detection and impact, are at least 5 s for 95% of the accidents, at least 15 s for 80% of them and at least 30 s

1. NM = Nautic Mille i.e. 1,852 m, the international distance unit used by the navy and aviation.



for 57% of them. When only taking into account accidents that occurred during the cruise phase, the alert times increase significantly: all have an alert time greater than 10 s and 91% of them an alert time greater than 30 s.

A simulation run for all the accidents in the study and all around the world compared these alert times and the transmission capability using the Inmarsat constellation. The results showed that for 85% of the cases, a data transmission would be possible before impact with the surface. Furthermore, in 95% of cases, the search area for the wreckage would be confined to a radius of less than 6 NM.

On the basis of all these results, the working group concluded that it is technically possible to significantly reduce the search area for the wreckage by triggering data transmission before impact, and/or automatically activating new-generation emergency locator transmitters (ELTs) before impact, and/or increasing the frequency of position transmissions every minute. At the final meeting, I insisted that the group should determine characteristic values: 4 NM travelled between the last position reported in the majority of accidents in the database and the point of impact, then regular transmission every minute to be within the 4 NM circle.

The BEA published safety recommendations on this basis in the scope of the flight AF447 accident.

I wanted the last meeting of this working group to be held once more at the ICAO's premises so that the results and how to achieve them would again be fully understood by the members of the ICAO Air Navigation Commission. However, it was not as easy to modify Annex 6 as it had been for the ULBs.

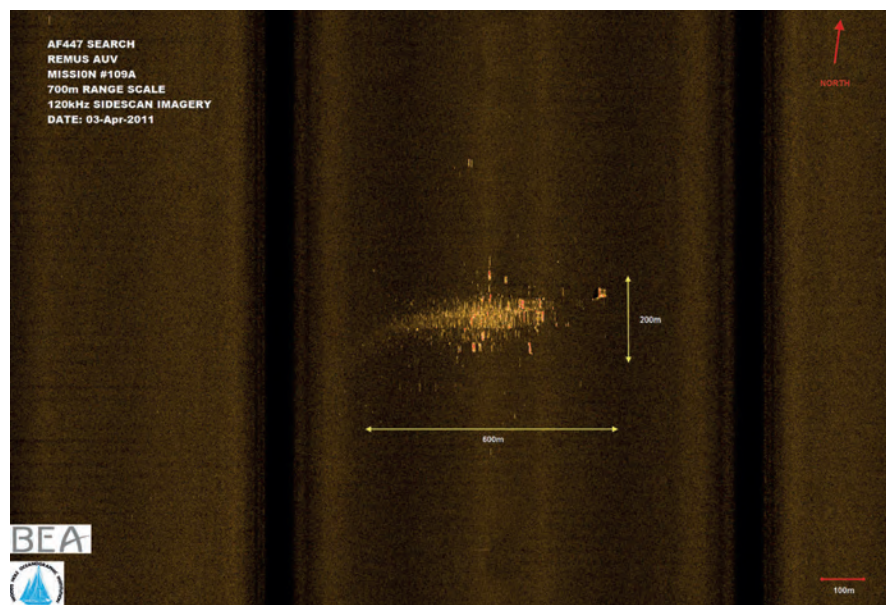
In fact, although the ICAO flight recorder panel

(FLIRECP), which I headed, was given the mandate to analyse the recommendations and make a proposal to amend Annex 6, this amendment had to wait until the disappearance of MH370 before it was accepted.

The FLIRECP made two proposals, a year apart, for the amendment with simple values, the location of an accident site with an accuracy of 6 NM and transmission every minute to achieve this. The Air Navigation Commission then subsequently analysed the proposal but did not consult the States. The Air Navigation Commission twice considered that it was too complex, despite the work carried out by the BEA group, to define the probability of positioning the site of a wreckage to within 6 NM. The graph on the **next page** shows the difficulty of amending Annex 6 on this subject... that is, until MH370 disappeared.

ICAO convened a multi-disciplinary meeting within two months of the disappearance of MH370 to address the issue. The FLIRECP

Photo of the location of the wreckage of AF447 in April 2011 after two years of searching.



was mandated to again make proposals for amendments to locate an aircraft in distress. The same proposals were suggested by FLIRECP. This time the ANC consulted the States and Annex 6 was amended in 2016 so that aeroplanes

must autonomously transmit information from which the operator can determine a position at least once a minute, in the event of a distress, the purpose being to determine, to a reasonable extent, the location of an accident within a radius of 6 NM. Finally the 1 minute and 6 NM values from the work of the BEA working group on the triggered transmission of flight data were adopted.

”

1968. Accident to the Air France *Caravelle* SE 210 registered F-BOHB in the Mediterranean Sea off the coast of Cap d'Antibes

On 11 September 1968, the *Caravelle* registered F-BOHB performing Air France flight 1611 from Ajaccio to Nice crashed off the coast of Cap d'Antibes. The accident claimed 95 lives.

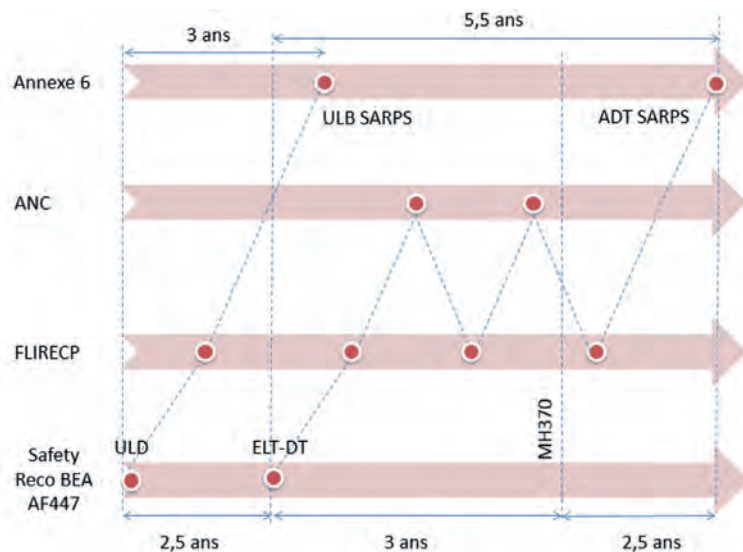
Although the wreckage lay at a depth of between 2,000 and 2,600 metres, four sea searches enabled almost all of it to be recovered for examination. This made it possible to rule out any likelihood of there having been an external explosive device (missile) or on-board explosive device (bomb).

The investigation commission concluded that the accident was caused by a fire at the rear of the cabin in the area of the right-hand toilet and the galley. Although it was not possible to determine what caused the fire, the three most probable causes were an incendiary object on board the aircraft, a malfunction in the water heater or a poorly extinguished cigarette thrown into the used towel waste bin. After reporting the on-board fire, the pilots lost control of the aircraft. The cause of this loss of control could not be established, but the commission considered that it could have been a physical incapacitation of the pilots due to toxic gas fumes or the invasion of the cockpit by passengers fleeing the fire.



Air France Caravelle, the same type as the plane that crashed in the Mediterranean on 11 September 1968.





Preparation of the regulatory changes by ICAO following the BEA's recommendations

2000. Accident to the Air France *Concorde* F-BTSC at Gonesse (Val d'Oise)

On 25 July 2000, the *Concorde* began its take-off for New York with one hundred passengers and nine crew members on board. During the take-off run a few seconds after V1, a major fire broke out and engines 1 and 2 suffered a loss of thrust, initially a slight loss for one, a severe loss for the other, and then a total loss. The crew tried unsuccessfully to reach Le Bourget airport. The aeroplane crashed onto a hotel, killing one hundred and thirteen people.

The investigation found that the accident was caused by the destruction of a tyre on the left main landing gear after it ran over a strip of titanium that had fallen from an aeroplane that had taken off five minutes earlier. Large pieces of rubber, thrown against the lower surface of the left-hand wing, deformed the fuel tank, which was full at that point in the flight. This led to the ripping away, from the inside towards the outside, of a large part of the fuel tank at a distance from the main point of impact. The leaking fuel ignited on contact with the hot parts of the engine, and then the flame stabilised. An initial engine malfunction due to the ingestion of hot gases was recorded, the aeroplane took off and flew for about a minute without the crew being able to retract the landing gear or gain speed or altitude. The fire caused a new engine malfunction which led to the loss of control of the aircraft. Even with the engines operating normally, the extensive structural damage caused by the fire would have quickly led to the loss of the aircraft.

On 16 August 2000, the BEA and its British counterpart, the AAIB, who participated in the investigation as co-state of manufacture, recommended that the *Concorde's* certificates of airworthiness be suspended until flight safety could again be assured. This recommendation was immediately accepted by the French and UK airworthiness authorities. Thirteen other recommendations were issued by the BEA at the end of the investigation. They relate to the operation of the *Concorde*, its tyres and its fuel tanks, the detection of unwanted objects on runways, the maintenance at Continental, the company operating the aircraft from which the metal part fell, the possibility of the crew to visualise parts of the structure hidden from their view, flight simulators and, finally, the protection of people working on an accident site.



On the site of the accident, in Gonesse.



Chapter 6

General aviation



General aviation accidents and incidents account in number, for a large proportion of the BEA's work. The causes of these occurrences are often duplicated and have led to the introduction of feedback systems to raise awareness among pilots. Unfortunately, the number of accidents remains constant. The occurrences recorded by the BEA reveal few original factors likely to improve the level of safety in general aviation. This explains why investigations often result in repeated recommendations.

Accident to the Embraer EMB500, registered 9H-FAM, operated by Luxwing on 8 February 2021 at Paris-Le Bourget (Seine-Saint-Denis).



General aviation has three components: on-demand transportation, aerial work and leisure.

On-demand transportation

This concerns the transportation of company executives and their customers, with variable, unscheduled timetables, but it is public passenger transport. The aircraft can be sophisticated, the operational requirements can be high if the aircraft has to be used in any weather and on any runway where the lighting and approach aids can be reduced to their simplest form.

Aerial work

The range of uses for the aircraft can be quite broad: agricultural spraying, sling operations (heli-transport of slung loads, saving human lives in the mountains or at sea, basic vocational training).

Leisure

This essentially concerns light aircraft used for basic training for leisure activities such as cross-country navigation, mountain flying, aerobatics including competitions, night flight or additional training to become a professional pilot. This activity is highly developed in our country, which has a fleet of over a thousand aircraft and more than 600 flying clubs.

The specificities of general aviation

France, like the United States, has a strong general aviation culture. Many of our aeronautical professionals, engineers, pilots, mechanics and air traffic controllers found their vocation in flying clubs.



Military aviation is a separate field, while civil aviation is divided between commercial aviation - or public transport - and general aviation. Flying for sport and leisure alone encompasses many disciplines: tourism, aerobatics, sport skydiving, gliders, motorised and non-motorised microlights, hot-air balloons, etc.

The causes of incidents and accidents in general aviation can therefore vary widely, but they all have one thing in common: the strong implication of human factors.

In his university paper¹, Bernard Boudou, BEA investigator and DGAC instructor pilot, analysed the practices in general aviation by comparing them with those of commercial aviation. He identified the specific features of general aviation and proposed a feedback system, initially known as REC (confidential reporting programme), with the aim of enlightening pilots about incidents and accidents, in order to improve the safety of general aviation.

Poorly controlled activities

According to Bernard Boudou, former BEA

Accident to the
Cessna 401
registered N517HC
on 30 October 2020,
near
Toussus-le-Noble.

1. *Création d'un système de retour d'expérience basé sur les facteurs humains pour la prévention des accidents en aviation générale*, Université René Descartes, UFR Biomédicale, 2000-2001.





Accident to the Piper
PA30 registered
N7977Y
on 2 March 2021
at Courcelles-sur-
Viosnes.

investigator and lecturer at ENAC, "Public transport is an activity with precise limits, perfectly defined by instructions, procedures, numerous regulations and close oversight by the authorities. Commercial and financial commitments, the accountability of companies towards their customers, legal constraints and the construction of a safe image, all go to explain the deployment of substantial material and human resources to prevent accidents.

General aviation includes training schools, aerial work and leisure aviation.

Training schools: administrative approvals attest to satisfactory technical skills.

Even if competition between private schools imposes a minimum cost for training, safety seems to be maintained at a good level, thanks in particular to highly experienced staff.

Aerial work companies: a specific activity manual filed with the authorities specifies the

methods and procedures employed by the company to carry out its activity. Competition is fierce between companies of different sizes and operating different types of equipment (microlights, aeroplanes, helicopters, etc.). For the managers, the company's survival in the very short term essentially depends on commercial and financial parameters.

Leisure aviation: above all, users seek to carry out a leisure activity at the best price. They are often grouped together in non-profit associations, operating on a voluntary basis. Management within the association, and supervision by the administration, are sometimes fairly invisible. While training generally meets the criteria for carrying out a private activity, there are few regulations governing recurrent training¹.

The latter two activities are often characterized by :

- non-stringent, imprecise regulations,
- largely absent local management,
- a poorly controlled infrastructure and aeronautic environment,
- priority on keeping costs down,
- a certain distance from the authorities.

Few resources are allocated to accident prevention in general aviation, particularly in the case of aerial work and leisure aviation."

As a result, safety levels between public transport and general aviation are very different.

Bernard Boudou's analysis reveals that, for public transport, the average annual activity in France [figures for 2000-2001, editor's note] can be estimated using the following figures: around 2 million departures for 100 million passengers and

1. While the general spirit of Bernard Boudou's study remains valid, it is nevertheless important to take into account changes in regulations. The new regulations concerning licenses, introduced by EASA, have created the status of Approved Training Organisation (ATO), and introduced annual private pilot proficiency checks, enabling pilots to better maintain their competency.

Perspective



Thierry Loo:

It's rare that a safety investigation doesn't address different aspects of aviation safety. Looking at them as a whole, rather than on a case-by-case basis, is essential in our job. This enables us to know, and let others know, whether themes are recurring from year to year, or whether there is an increase in the same type of event. Every year since 2020, the BEA has produced a thematic review of the general aviation and aerial work reports it published during the previous year. At the end of the review for each of these aircraft categories (helicopters, light aircraft, gliders, balloons and microlights), the BEA recalls the themes it chose to highlight in previous years.

10 million flight hours. Accidents cause an average of around ten deaths a year. The accepted safety coefficient for public transport is therefore around 10^{-6} , i.e. one fatality per million flight hours. The order of magnitude for general aviation is 2 million flights a year, i.e. one million flight hours during which accidents cause around a hundred deaths. The safety coefficient can then be evaluated at 10^{-4} , i.e. one fatality per 10,000 flight hours.¹"

"...Public transport companies are highly structured and have established accident prevention and flight safety programs. These programs include all types of information-gathering systems, in particular flight analysis through the systematic use of information contained in on-board recorders, the appointment

1. For both public transport and general aviation, only the power of 10 is estimated.

of flight safety officers, flight safety bulletins, the collection of voluntary reports...

Heavy investment is thus devoted to the study of incidents and minor events which frequently occur during operations (...) The high level of safety achieved by public transport means that accidents are very rare.

It is therefore difficult to find analogies between them, or to categorize them. Incidents provide information on isolated precursors to accidents, but the combination of factors that would lead to a catastrophe is unpredictable (...)

In general aviation, the level of safety is much lower. Most fatal accidents can be grouped, according to their causes, into three categories:

- *get-home-itis in poor weather conditions,*
- *low height flight,*
- *acrobatic manoeuvres."*¹

In addition to these categories, we can add flight phases in which the pilot is particularly vulnerable, for example rejected landings.

When a general aviation accident occurs, the investigators' investigations are facilitated by the fact that the same material phenomena

Accident to the JMB VL-3, identified 59DUJ on 19 June 2020 at Mortemer.



Accident to the
Mudry CAP10B
registered F-GPVI
on 28 March 2021
at Villeneuve-sur-Lot.



(ruptures, bonding defects, fuel pollution, etc.) are always implicated. On the other hand, the human element is much more difficult to analyse.

Investigations often come up against the same difficulties," , explained B. Boudou:

- *absence of flight recorders (data, conversations, etc.),²*
- *often uncontrolled activity leaving no trace,*
- *few written documents since the activity is not very standardized,*
- *pressure exerted by the social environment in which everyone knows everyone else,*
- *sometimes significant media presence,*

1. "The number of accidents remains more or less constant, and their classification by type of event varies little, all within a virtually unchanged volume of annual activity..." B. Boudou, afterword to "Les accidents en aviation générale", by Gille Vidal, Cépaduès éditions, 2021.

2. Today, personal digital equipment (tablets, GPS, FLARM, etc.) can provide information if it can be analysed.

- *legal implications disrupting the reliability of statements,*
- *disappearance or amnesia of front-line actors (pilots, passengers, etc.)*
- *often no eyewitnesses,*
- *leisure activity in an associative environment secondary to the professional activities of the pilots.*

Because of these difficulties, the human element aspects are often difficult to determine. These include errors, lack of knowledge, poor judgement, etc.

Yet they are at the root of the vast majority of general aviation accidents."

For the author of the study, "general aviation is characterized by:

- *a level of safety around a hundred times lower than in public transport,*
- *a perfectible accident prevention system, since it is almost always the same accidents that occur,*
- *difficulties in investigating accidents in depth, and consequently limited conclusions,*
- *no regulatory obligation to analyse minor incidents with a view to prevention."*

All these reasons led the BEA to set up a confidential reporting programme based on minor events, particular elements and unusual situations.

Bernard Boudou was commissioned to set up this very new system in France. He was to work on it for several years, as he first had to educate the general aviation community. Gradually, this community began to realize the value of informing their peers of an experience, so that



it would attract everyone's attention and avoid being repeated.

But the REC was going to encounter several obstacles. First in its transmission procedure, then in the fact that in 2011, the BEA was refocusing on its core activity (see Daniel Vacher's perspective below).

But it has proved its worth, and through the REX (the confidential reporting programme), piloted by sports federations, it is usefully pursuing its accident prevention mission by highlighting incidents that could be - or have been - the cause of a tragedy.

"Other avenues of prevention need to be developed. There are at least three. The first is set out in various official texts (regulation (EU) No 996/2010 and Annex 13). The second is feedback (REX).

In the course of their engagement in the aeronautical sector, every actor has been involved, one day or another, in an unusual or singular situation, not explicitly provided for in texts or safety studies. Studying this kind of situation makes a significant contribution to prevention (regulation (EU) No 376/2014 and Annex 19 to the Chicago Convention). The third avenue is the uncompromising examination of the conditions under which the activity is carried out. This is a proactive approach to identify weaknesses in our organisations. (see the FFA's "Aero Diagnosis" approach). In our eyes, these are extraordinary fields to explore, in terms of their scope and complexity..." writes Bernard Boudou, in the afterword to Gilles Vidal's book, *Les accidents en aviation générale*.

Perspective



Bernard Boudou: From 2000 to 2006 The REC (confidential reporting programme)

"The 1999 law on technical investigations provided a legal basis for the creation of a voluntary reporting programme, along the lines of the ASRS in the USA or CHIRP in the UK. The director of the BEA, giving me considerable freedom of organisation, suggested that I create and generate feedback by means of such a system in France, initially in general aviation,. This project was a once in a lifetime opportunity and adventure. The concept, commonplace in an Anglo-Saxon country, had to be adapted to a Latin culture. This required being creative, innovative and convincing. My immediate supervisors and all the BEA staff were of invaluable help."

Perspective

Bernard Boudou:
Innovate and convince**Innovate**

In 2000, there were a number of publications abroad similar to a REC bulletin. All you had to do was copy them... In France, many researchers and scholars had given the matter some thought. They offered to give advice. They all agreed on the need to set up the REC over a one-year period, with the recruitment of a director, secretary, analysts, editors, etc., and the training of staff, allocation of premises, etc. In reality, we had to keep things simple! I was alone in creating the system, and I had other duties within the BEA. The DGAC was attentive and a good advisor. For example, it was thanks to them that the system was given an Azur telephone number (number dedicated to information services in France).

We had to be reactive:

- commit to an initial response to the person reporting the event within ten days, or sooner if there was an emergency. The reporting person was now the system's best advocate.
- commit to providing information, notably via a "REC info" bulletin. The reader was convinced of the system's usefulness. This "primed the pump".

Convince

There's no substitute for face-to-face contact. I had to criss-cross France to go out and meet people. Presentation meetings were held in all the entities concerned by or interested in general aviation (administrations, unions, etc.). For the pilots, meetings were mainly organized on weekends (for example, in one region, four meetings were held in different locations, one on Friday evening, another on Saturday morning, another in the afternoon and finally one on Sunday morning).

Users were suspicious, as the system was being promoted by the Administration, or an administrative authority. As early as 2000, I drew up a REC operating manual to explain operations in detail, and to provide strong guarantees, etc. The system could be audited to obtain an ISO certification. Users didn't see the need, and doubted the usefulness of such a system. To convince them, examples had to be given, such as the accident to the Cap 10 registered F-GYZA on 6 August 2004 (collision with a high-voltage power line). The REC bulletin had circulated and highlighted a "premonitory" report in which a former trainee had mentioned his "uneasiness" during a flight at too low an altitude to be safe.



Accident to the Jodel D140
registered F-BMFV on 26 February 2022
on Saint-Roch Mayères
mountain airstrip

Importance of human factors in general aviation

Since the 1970s, air safety (expressed as the number of accidents per million flights) in the public transport sector has been excellent, but has stagnated over the last twenty years or so, set back often temporarily, by the arrival of new technologies such as automation and new means of communication.

In the 1990s, it was realized that at constant safety levels, the increase in traffic would lead to a rise in the number of accidents. At a rate of one accident per week forecast for 2010, the accident rate would become unacceptable to the general public. Was it therefore necessary to tighten the already stringent aircraft certification standards?

It was then noted that in around 70% of cases, a serious crew breakdown was a key causal factor. However, if we were to include other causes involving other front-line actors, as well as designers, managers and organizers, human causes would account for virtually 100% of accidents.

It was therefore decided to take a much closer look at human factors, by increasing the corresponding regulatory constraints. This explains why not only the regulations governing public passenger transport, but also those governing general aviation, including light aviation, call for higher standards in terms of human organization.

Perspective

Thierry Loo: “Get-home-itis” study¹

“I joined the BEA in 1994, after a brief spell with Météo-France and three years at ENAC, from which I graduated as an IEEAC (Engineer in civil aviation operations). So this was my first job. I fly a lot. Although at first I wasn't very happy about having to leave Toulouse to go to Le Bourget, I quickly integrated into a team of colleagues who shared the same passion for aeronautics as me.

The BEA was much smaller at the time, with around forty people when I arrived. I wasn't assigned to investigations, when I first joined the BEA, but to the Studies Division, where we produced statistics and safety analyses. For Mr. Arslanian, many light aviation accidents were linked to so-called “Get-home-itis”. So he locked me up in the archives for six months, so that we could examine all the events that had occurred over a ten-year period. A year's work was needed to produce the “Get-home-itis” study, which was subsequently modified and which we try to update on a fairly regular basis. It was interesting for a young investigator, even if it was office work, because it enabled me to immerse myself in numerous accident cases and the investigations undertaken, and to draw conclusions and analyses that were more global than those of a single event. The study was published in 1999, after 18 months to finalize it.

In France, we share a specificity with certain other countries which have a rich aeronautical history: the UK, the USA, Canada, etc. Many aviation professionals (technicians, engineers, pilots, air traffic controllers, etc.) discovered this world through general aviation (in France, through flying clubs). Most investigators cut their teeth by investigating general aviation accidents.

There's a lot to learn from working in general aviation. Many technical concepts (aerodynamics, flight mechanics, weather) as well as non-technical ones (human behaviour, judgement, communication) are covered from the very first hours of flight.

This strong link in France between general aviation and the professional world not only motivates young people, but also, if the training is of a high standard, gives them very early on the good habits they will often use throughout their career. In this respect, the instructor model is essential.

1. This category of accident designates those which occurred when the pilots tried by all means to get to their destination. The study covered general aviation accidents between 1991 and 1996.



Perspective

Thierry Loo

LET L-410 and customs control

"When I was working for the BEA at Le Bourget, I had a highly original investigation involving a LET L-410¹, a Czech aircraft that flew in Eastern European countries. The latter convoyed a certain number of these aeroplanes from Sweden to Venezuela, crossing French airspace.

On 22 April 1999, we found ourselves in Normandy, with a plane containing around twenty drums of kerosene, two or three of them were empty and the rest were full. The aeroplane had suffered a double engine failure, and the pilots had made an emergency landing in a field. A double engine failure means either a piloting problem or a fuel problem. In fact, we realised that it was a fuel management problem: during the flight, the crew only transferred half the fuel consumed by the engines from the drums to the wing tanks. After six or seven hours, the engines shut down. It was quite original, because these were people who only flew under VFR, without a flight plan. They had caught the attention of the customs control Cessna as they crossed the border. The customs officers were following them, and when both engines shutdown, they didn't understand what was happening. They witnessed the crash live. We were called. I had no idea what a LET L-410 was, but I saw this huge plane in a field in "Swiss Normandy".

1. The LET L-410 Turbolet is a 19-seat twin turboprop transport aircraft developed and built by the Czech company Let Kunovice.. 1,100 LET L-410s were built, making it one of the most used 19-seat twin turboprops in the world.



Power lines are a major hazard for hot-air balloon flights. Here, F-GLAU balloon is in a sorry position...

Perspective

Jean-Pierre Bonny

When the military and civilians are on the same Bordeaux airfield

"One event was one of the most memorable for me! The aeroplane concerned was piloted by one of my former young engineers from Bordeaux. The aircraft was cut in half - I assure you, the word is not too strong - by a French Air Force Mirage that had just landed at Mérignac. Of course, the pilot was killed. On the other hand, the military pilot hadn't noticed a thing. Or so he claimed. He'd landed without the slightest problem, and only marks on his aeroplane proved that it was indeed him who had destroyed "one of ours".

I came to the accident site in person for two reasons. Firstly, I wanted to offer my condolences to the young widow. Secondly, I wanted to have a serious talk with the general commanding the Air Region, so that landing procedures would be improved and Mérignac would no longer be considered the preserve of the French Air Force. Indeed, it was inconceivable that aircraft of such different performance levels could operate in the same airspace, without any particular constraints. Air traffic in this zone was governed by a single criterion: each pilot was responsible for avoiding collisions by complying with the "see and be seen" principle.

But how could you see a plane flying as fast as a Mirage, and how could you believe that the pilot of such a plane would have the time to see another? The accident in question provided the answer. New rules had to be established. I had often pointed this out when I was director in Bordeaux, but always in vain.

This time, I had greater powers, and I was determined to use them! Which is what I did. The affair caused quite a stir, but the French Air Force could no longer shirk its responsibilities and had to accept the constraints on what was essentially a civilian aerodrome. So our comrade's death was not in vain, for this tragedy undoubtedly averted many others!"

Perspective

Thierry Loo:

The ENAC TB 20 and the retracted landing gear: The human error was not on crew's side¹

"One event still gives me pause for thought. Two managers from the newly-created DCS - later to become the DSAC - were flying runway circuits at Muret aboard a TB 20 belonging to the SEFA (flight training school). They landed with the landing gear retracted. The passenger was, at the time, a field investigator. We suggested to him that he take note of the initial facts, as we couldn't immediately go to the site.

Very quickly, the crew and witnesses concluded that they retracted the landing gear while taxiing. A little later, we went to the site. The aeroplane had been moved. We noticed that there were propeller scuff marks on the runway. The position of the marks enabled us to calculate the point where the gear was retracted. This point was not consistent with untimely gear retraction by the pilot. We'd already seen pilots retracting the gear thinking that they were retracting the flaps. What's more, having already flown with this pilot, we knew that he didn't tend to rush his actions.

During the interview with the pilot and passenger, we noted that the afternoon's discussions with the instructors, the gendarmes... had convinced them that they had made a false manoeuvre while taxiing.

For our part, we were convinced that the sequence of events was not correct. If they had indeed confused the two controls, the propeller scuff marks would have been visible further back on the runway.

To have marks there, the gear would have had to be retracted within a second of touchdown. So there was something else going on. We grounded the aircraft, put it on jacks and called in SOCATA. The electrical harness was found to be broken at the ground/flight position

sensor.

In fact, during the previous take-off, the pilots had retracted the landing gear. The control was in the UP position, but the gear had not retracted due to the broken wiring. In the downwind leg, the pilots saw that the lights were green and did not position the control to DOWN. When the wheels touched down, the wire came into contact with the broken part, and the gear retracted as the control was set to UP.

We were thus able to confirm that you can unintentionally influence a witness. An excellent example of group compliance bias."

The SOCATA (now DAHER) TB20 with the ENAC's livery



1. Accident to the Socata TB 20 registered F-GTYH on 24 February 2004 at Muret.



Perspective



Daniel Vacher (French Aeronautical Federation) “Our good relations are geared towards flight safety”

Daniel Vacher is a former member of the prevention and safety commission in the French Aeronautical Federation. In his view, good relations between the Federation and the BEA, and greater attention from the authorities, are the key to improving safety in flying club activities.

(Interview with Jean-François Grassineau, Ariane Gilotte and Bernard Adès).

Bernard Adès:

Can you tell us more about your role at the FFA and the specifics of general aviation accidents, significant accidents and the origins of the REX (the confidential reporting programme)?

Daniel Vacher:

I have held a FFA licence since 1978. I'm in charge of the Federation's prevention and safety commission at national level. In this capacity, we carry out a certain number of actions. The aim is to reduce accidents in general aviation, particularly in flying clubs. The Federation represents almost all the flying clubs (nearly 600) which can vary in size in terms of membership and aircraft fleets.

B.A. : Who was your predecessor in this position, or was it you who inaugurated it?

D.V. : Yes I inaugurated the function. In the beginning, it wasn't very formalized, but year after year it became more structured.

The commission's first task is to record accidents.

When an accident occurs, we are informed very quickly via the MALGH (the DGAC's light aviation, general aviation and helicopter mission), which sends us the first-response investigation report. The BEA is a very important contact for us, with whom we work regularly through debriefing meetings on the number of accidents and their causes.

However, unlike us, the BEA does not make a difference between aviation accidents involving flying club pilots



The Cessna 172 is one of the aeroplanes most frequently used by flying clubs.



and those involving private owner pilots, whereas we do. We can tell whether the aircraft is operated by a flying club or not.

Our second mission is to inform and educate our members as much as possible about the nature of the accidents and how to prevent them. To achieve this, we rely on a network of regional contacts. We have 13 regional committees in mainland France and 2 overseas. In each regional committee, a prevention and safety contact has the advantage of knowing the area and its specificities much better than we do at national level. In addition, we publish themed documents and provide tools such as the *aérodiagnostic*, a tool for managers to carry out their own self-diagnosis in terms of flight safety, and the *REXFFA*, where pilots are invited to provide feedback on events related to their flights.

We also rely heavily on our monthly federation magazine, "*Info-pilote*". Every month, nearly ten pages are devoted to flight safety.

Our third mission is to provide assistance. In this respect, we are no longer in prevention but in the provision of a solution, namely repatriation assistance. This is a service we provide to our members so that they can return home safely if, for example, there is adverse weather for a return flight. In addition, psychological support is also available for managers in the event of a dramatic accident and for the victim's dependents.

B.A. : On the subject of feedback, did you have another system before the current REX system?

D.V. : We've had three reporting periods. First of all, from 2000 to 2011, we had the REC system managed by the BEA.

In 2011, the BEA refocused on its core activity, i.e. carrying out aviation analyses and investigation, which includes our light aviation activity. The CNFAS (National council of aeronautical and sports federations) then entrusted the associations with the task of providing their own feedback. Each federation set up a tool. It was a shared tool for aeroplanes, gliders and microlights, with specific features for each discipline. This reporting system, which we set up from 2011 to 2014, consisted of direct feedback on events. Each pilot had to report to the federation at national level, information about events experienced. Then, around 2013-2014, we realized that this feedback wasn't going through the flying club. The club was completely out of the loop. So we modified our tool and called it REXFFA. Reports first pass through the flying club so that they can be processed by it and we retain and disseminate at national level the most significant, instructive elements. This tool has been in operation since 2016.

B.A. : Do you have any examples of anecdotes about the specifics of general aviation accidents? What have you noticed over the ten years?

D. V. : When we carry out our analyses, we distinguish between two types of accident: those where





The FFA has also published three volumes of the book *Parlons sécurité*, compiling Michel Barry's articles published in the magazine, *Info-pilote*. In these articles, the author discusses not only technical problems, but aerodynamics, piloting, operations and behaviour.

"Sometimes, he goes beyond the report produced by the Bureau d'Enquêtes et d'Analyses, proposing hypotheses when the BEA, lacking factual elements, cannot formulate them explicitly. In all cases, there is food for thought, with a reminder of technical or regulatory concepts, supplemented by explanatory sketches or photos."

(F. Besse, aeroVFR.com)

there have been bodily injuries and those where there has been material damage. To date, year after year, we've recorded around a hundred accidents, including some fifteen with bodily injuries. The accidents with bodily injuries are mainly due to an in-flight loss of control, get-home-itis and, to a lesser extent, imprudent flying, particularly at low height. Unsurprisingly, the majority of material accidents occur during the take-off and, above all, landing phases, while 75% of accidents with bodily injuries are behaviour-related and 25% are due to a lack of skill. The opposite is true of material accidents. Three-quarters of material accidents are related to skill, and one-quarter to the pilot's own behaviour.

B.A.: I'd like to ask you a question on this point. I thought, rightly or wrongly, that a training problem might be at the root of this. Peer training can have its limits, and instructors are not chosen on the basis of their teaching skills. These are people who love flying, love aviation, but who don't necessarily have pedagogical knowledge. I wanted to get your personal opinion on this.

D. V.: You are completely right. Indeed, a pilot who has logged thousands of flying hours can be a very poor instructor. Conversely, we can find people who are, by gift or by nature, good teachers. All this is blurred by the fact that 98% of instructors are trained at ENAC, in specialised centres where, whatever happens, it takes seven weeks to train an instructor and where, to become an instructor, you have to pass a technical selection. A good part of these seven weeks is devoted to training instructors to be good teachers.

The result is that the instructors who come out of this system, around 60 to 70 a year, have the same level of technical and teaching skills.

But the problem isn't necessarily the initial training, as I've just described it. It's more the passage of time. Instructors are bound to find themselves in a flying club. Depending on how it's organized, they'll be supervised. This is necessarily the case at the beginning as they'll need to be supervised by an



instructor-supervisor for around a hundred flying hours. After that, as knowledge erodes over time, the performance of the instructor is bound to vary. That's why, for several years now, all instructors have been required to undergo refresher training every three years. There are two ways of doing this: either two days of theoretical training, or a flight with an Administration pilot-inspector, bearing in mind that every six years, an instructor must pass through the hands of a DGAC pilot-inspector. So there's initial training, continued training and monitoring of the instructor's competence and performance by the Administration.

Jean-François Grassineau: How was the prevention and safety commission initially received by the basic member? How has it evolved? Do you feel more listened to, or do you sometimes have the impression of preaching in the desert?

D. V.: That's a good remark. I've been in charge of this particular commission for over ten years. Over time, I have seen two phenomena: in the early years, it was a bit like preaching in the desert. Then, as time went by, we came to be better understood. I'm quite optimistic for two reasons. The first is that the Administration is playing a much more cooperative role than in the past. This is an important point. The Federation enjoys recognition from the authorities, and that's good for us.

The second point concerns the training centres, which we call flying clubs in our jargon, which have changed their status. This is a recent development. Flying clubs have gone from a declaratory status - before, all an association had to do to be a flying club was to declare it - to the requirement today to be a DTO (Declared Training Organization). This is still a declaratory status, but with more formalized oversight by the Administration, including the obligation to declare a safety policy. Clubs must now organize themselves to set up a committee, and they have a duty to carry out formal safety actions within their flying clubs. In my opinion, we're going to improve the situation. I think it will be



info-pilote, the FFA's monthly magazine devotes part of its pages to safety

Training and refresher courses for instructors, under the supervision of ENAC, confirm their skills over time.



The ENAC training centre at Muret (Haute-Garonne) trains future flying club instructors.



positive in the future.

J.F. G: Who was responsible for the REC when it was managed by the BEA?

D. V.: The driving force behind this tool was Bernard Boudou.

J.F. G: As head of the prevention and safety commission, have you witnessed any particularly significant accidents, or any that have left a lasting impression on you?

D.V. : There are dramatic accidents every year. The most important one I can think of is that of Renaud Écalles, the 2009 world aerobatics champion and 2010 European champion¹, on 3 October 2010. He was flying from Jonzac to Montpellier with his family, his partner and their two children. Despite his enormous experience, he was confronted with a dramatic type of accident known as the “Get-home-itis”. This is a mental phenomenon in which the pilot sets himself the goal of arriving at destination and wants to achieve it at all costs. Unfortunately, he got caught up in appalling weather conditions, with the consequences we all know about.

It left a deep impression on the private pilot community, because it was unimaginable that someone so skilled and experienced - he was a fighter pilot, leader of the French Air Force aerobatic team - could kill himself in such circumstances. Some accidents are all the more memorable because they are often linked to the actions of experienced people.

I suppose it's the same in the mountains. We see fatal accidents involving mountain guides every year.

J.F. G: In your work, what is your relationship with the BEA's local offices?

D. V.: The relationship is very good. To answer your question, I have a very good relationship with the national BEA. I sometimes pass on requests to them. The most recent was a report on accidents due to engine failure. We formally meet with the BEA twice a year, in the scope of the ISAL (light aviation safety body) meetings run by the DGAC.

1. Accident to the Jodel DR1050 registered F-BKBZ on 3 October 2010 at Lauroux (Hérault).



Around the table are the safety prevention contacts for each aviation activity, and the BEA. We take stock, comment and exchange views.

J.F. G: When was this safety body created?

D. V.: It was created in the 2010s, under the auspices of the *Aéro-club de France*. If I remember rightly, it was taken over seven or eight years ago by the DGAC. It was originally known as the Safety Review before being called ISAL. It's been in existence four or five years, and for a long time it was run by Alain Jamet. We meet twice a year.

J.F. G: Do you have any exchanges or feedback on safety with foreign countries such as England, Germany or Italy?

D. V.: There are no direct, personalized exchanges. We compare accident statistics through their magazines. For example, we have compared our accidentology with that of the United States, Australia, Canada, England and Germany, but not directly. We do it based on the publications they produce. It's a pity, because I think there's a lot we could learn from each other.

B.A.: You've been particularly active with regard to changes in European regulations concerning clubs. Were there representatives of the World Air Sports Federation (FAI) present, or was it as a Franco-French committee that you went to see the European authorities?

D. V.: We don't work with the FAI, whose mission is essentially sport-related, and when we do work with Europe, it's with EASA. Let me give you a concrete example of these exchanges with the European agency: I went to Cologne in November 2018 to present REXFFA.

B.A. Do you feel that other European countries - the UK, Germany, etc. - are as active or more active than we are? The situation isn't the same, because few countries have clubs like us, with private activities. They're more like professionals, aren't they?

D.V.: That's a very good point. We have totally different systems. In France, it's based on associations, i.e. flying clubs. In other countries, such as Germany, there are far fewer private pilots. Our associative system offers the advantage of training at a reasonable cost. In other countries, the system of flying clubs does not exist. The 1901 association law is typically French.

England, Germany and other countries have a similar aviation to ours, but with commercial structures. We don't find equivalent representatives in these countries. So there are no exchanges.

Ariane GILOTTE: With regard to relations with EASA, do you feel that the recommendations drawn up by Europe are something of a constraint? How do you see things from the point of view of the flying clubs' survival ?

D. V.: Your comment is interesting because we were very concerned that Europe would impose overly



A series of safety posters published by the DGAC raised awareness among flying club pilots.

restrictive regulations on us. This was somewhat the case at first. In 2015, Europe, in its generous move to harmonize everything, wanted to impose on us an organisation modelled on commercial aviation, which was not adapted to light aviation.

The FFA opposed this, helped by other countries, in particular the British I believe.

We succeeded in changing the course of events and transforming these requirements into a much lighter regulation, much better adapted to the activity. EASA thus moved from a proposal where we had to change our status from a declared organisation to that of an Approved Training Organization (ATO), not at all suited to our activity, to a proposal for a Declared Training Organization (DTO), with requirements much more suited to our activity, but with an obligation to organise ourselves, in particular to post safety information in all our associations.

So, at first, Europe was rather a “ball and chain”. Then, over time, in a reasonable manner, we came to have regulations that were much better adapted to our activity. Today, our activity is in no danger, whereas four or five years ago, we feared the worst.

In the 1990s, the in-flight rupture of a Robin DR400 wing almost put all French flying clubs at risk. A joint response by users and the authorities averted the catastrophe.

Jean-François Grassineau: Did you have to deal with - I did have to deal with this issue, but it may have been before you took over - the case of the Robin DR400 spars?

D. V.: You're right, it was before the 2000s, it was more in the mid-1990s.

It caused quite a stir, because for a time it jeopardized the very existence of flying clubs. The spar issue nearly grounded the majority of flying club aeroplanes. The problem arose shortly before I took my position, after a fatal accident in the Paris region.



There were four fatalities¹. The stakes were high, as we had to avoid grounding all the DR400s at the same time. After discussions with users, including the FFA, the DGAC issued an Airworthiness Directive requiring inspections and repairs to be carried out by specialist canvas workshops, depending on the aircraft's serial number.

1. The accident involved a DR400, registered F-GKQF on 22 June 1997 at Mespuits (Essonne). For no apparent reason, the right wing ruptured in flight. A bonding and assembly defect in the spar flanges was responsible for the failure.

Photo from the BEA investigation report, showing the spar, the cause of the accident.





EASA's 2018-2022 light aviation accident prevention plan.

I would like to conclude by emphasising the excellent relations we have with the BEA, I'm talking about flight safety, and with the Administration in general. With hindsight, I can see that our relations have improved a great deal due to the Administration recognizing more fully what we do than in the past. That's the first point. The second point, to answer a question you asked earlier, "Is the situation improving?" I'm relatively optimistic. We're going to have to get better organised, but on the face of it, things should be moving in the right direction. Lastly, I can confirm our good relations with the BEA, as we are in regular contact with their staff.



Vintage aviation and aerobatics require special skills and specialized supervision.



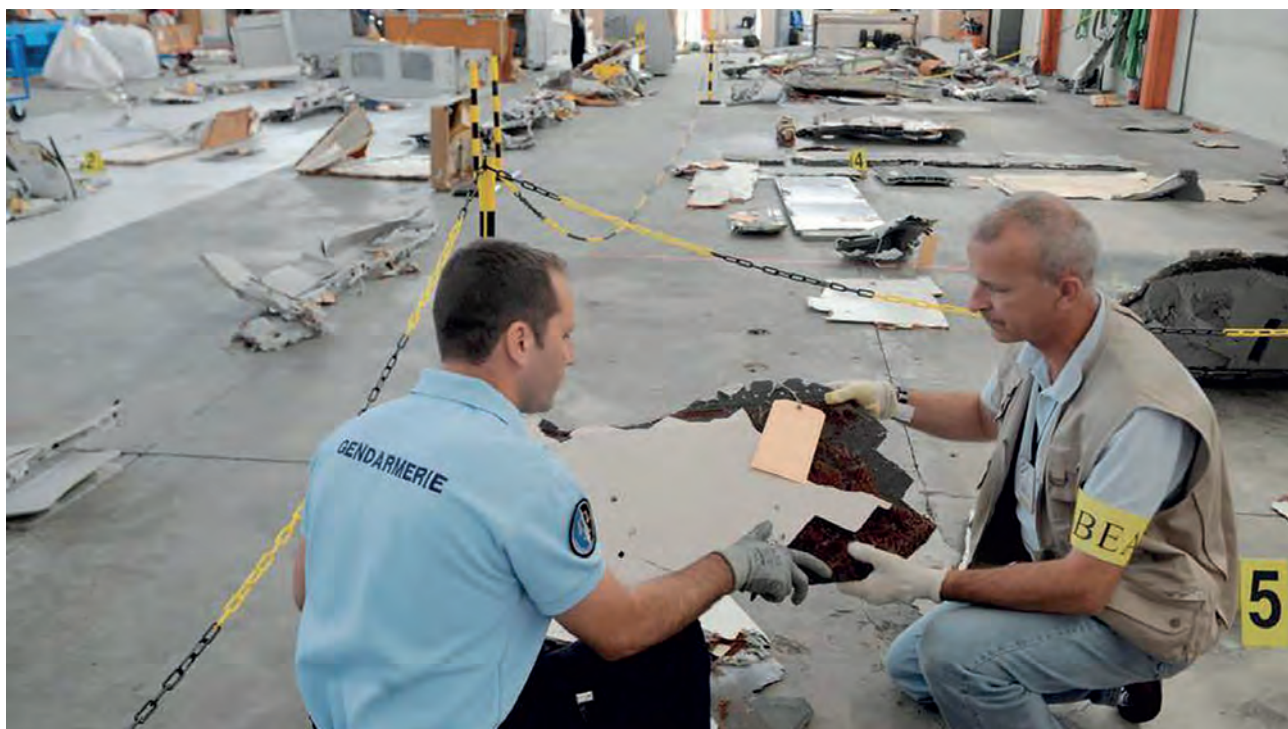
Chapter 7

The BEA and the judicial authorities



When an aeroplane accident occurs, two investigations are carried out in parallel: the safety investigation conducted by the BEA, sometimes with an investigation commission, and the judicial investigation, placed under the authority of an investigating judge. For decades, reconciling the imperatives of the two investigations was virtually impossible. The judicial investigation, based on the Penal Code, and safety investigation, based on Annex 13 of the Chicago Convention, regularly found themselves in conflict.

A balance was found through European regulation (EU) No 996/2010 and the BEA-judicial authorities agreement of 16 September 2014, which confirm the importance of the safety investigation with regard to the collection of information



A BEA investigator and a BGTA gendarme exchange information on the wreckage of the accident aircraft.



Since the early days of commercial aviation, in other words since the early 1920s, when an air accident causes injury or death, both the technical investigation and the judicial investigation are tasked with providing answers to the questions raised. In the case of the technical investigation, the aim is to determine the precise circumstances and causes of the accident, and to identify any technical elements that may have contributed to it, in order to make recommendations designed to prevent further accidents for the same reasons. The judicial investigation is carried out to determine who was responsible for the accident, and sanction any deviations from the regulations.

Difficulties of a double investigation

Annex 13 to the Chicago Convention, which defines the international agreements governing commercial aviation, provides a succinct framework for the relationship between the two investigations. Article 5.10. of this Annex lays down the principle of cooperation between investigations: *“The State conducting the investigation shall recognize the need for coordination between the investigator-in-charge and the judicial authorities.”* Governed by a ministerial directive dated 4 November 1946, supplemented on 7 June 1951, relations between technical investigators and representatives of the judicial authorities had not yet found a formula to harmonize their operation.

As a result, the history of investigations has been punctuated by incidents and even conflicts between technical investigators, examining magistrates and their appointed experts. It has also been punctuated by recommendations, often to no avail, from the authorities that each should strive to respect the prerogatives of the others.

But the authorities themselves sometimes threw oil on the fire.

As early as 13 May 1947, a circular from the Director General of National Safety extended (“abusively”, according to the author of an internal IGAC memo of February 1957) the Air Police’s remit to include accident investigations, whereas a decree of 10 April 1947 confined itself to instructing it to record infringements of the law of 31 May 1924 (...) and offences for which air locomotion is a means of execution.

A few years later, on 15 June 1951, the President of the Council and Minister of the Interior Henri Queuille issued a directive to the Prefect of Police and the Prefects, following incidents after the opening of a judicial investigation.

He emphasized that in accordance with the provisions of the law of 27 November 1943 creating a technical police service and the directives issued pursuant to this text, it is the responsibility of police officers to ensure the protection of evidence and to forbid access to the accident site to all persons with the exception of rescuers, members of the medical profession and experts appointed by the investigating judge.

He strangely “forgot” the technical investigators of the civil aviation investigation commission. He even placed them resolutely outside the law should they insist, as he added that *“police officers who are voluntarily prevented or hindered from carrying out their duties shall apply without weakness, the texts relating to rebellion, contempt, breaking of seals, etc.”*

This unfortunate directive, drafted in disregard of international conventions concerning the countries where a double investigation is the rule, was bound to give rise to almost insurmountable difficulties.



Interministerial directive of 3 January 1953

In response to the incidents reported almost systematically during investigations, and after several years of work and consultation between the various ministries concerned and their respective departments, a new interministerial directive - dated 3 January 1953 and published in the *Journal Officiel* of 28 January 1953 - attempted to provide a response in terms of good behaviour on both sides.

In his introduction, the Minister of Justice states: *"It is important that the magistrates in charge of judicial investigations ensure the application of the provisions of a circular, the purpose of which is to define the limits of the respective powers of the judicial authority and technical investigators. The latter's task is essentially to investigate the causes*

of accidents in order to prevent their recurrence, without worrying, from a criminal point of view, about any potential responsibilities. (...) I attach the utmost importance to the fact that, for the reasons set out in the interministerial directive, a trusting collaboration is established between the technical investigators and the judicial actors. The seriousness of certain air accidents and France's international commitments make this particularly imperative".

In a supplementary circular addressed to the Attorney General attached to the Court of Appeal, dated 6 May, the Minister of Justice even insisted: *"The main difficulties that have arisen in practice, particularly in connection with serious accidents involving passenger aircraft, result from the fact that the investigating judge and his expert must act at the same time as the technical investigators, while ensuring that the investigations relating*



The Gendarmerie's aircraft resources
sometime help BEA investigators get
to the accident site.



*to the wreckage and debris of the aircraft do not in any way delay, or even compromise, the investigating judge's investigations."*He also recommended that examining magistrates wait for the arrival of the technical investigators before starting their own investigations. *"In any case, it seems to me that these difficulties, if they arise, can be resolved to everyone's satisfaction if the examining magistrates are aware of the national and international importance of the technical investigation, the results of which can be communicated to them."*

Unfortunately, this interministerial directive does not escape the fundamental problem, in that it cannot give priority to the technical investigation, even though it stresses the need for it and even entrusts it with determining the "direction" to be taken, a somewhat vague term that does not really determine any powers. Indeed, it recalls that the judicial investigation is based on the procedures of the Criminal Investigation Code of the Penal Code, and that the judicial officials must therefore, in the event of an aviation accident, carry out urgent investigative acts if they consider that their investigations may lead to the discovery of a criminal or reprehensible act".

With this prerogative reaffirmed, police officers and experts appointed by the investigating judge would not hesitate to use it to their advantage. Technical investigators, on the other hand, argue that the requirements of the Penal Code must be met by the primacy of their action, which is likely to provide the investigating judge with the knowledge he needs to establish responsibility. But all was in vain. Despite its intention to bring about harmonization, Instruction 53 - as it came to be known - provided no solution to the problems encountered. However, it would remain in force until the arrival of the European regulations. BEA

investigators had to work within this framework, and with its imperfections...

In practical terms, two different cultures, which are difficult to reconcile, collide during investigations, with judges giving priority to preserving evidence, and technical investigators to examining and analysing it..

On the ground, friction persisted

On 6 July 1953, the air navigation Chief Engineer, director of Bordeaux-Mérignac airport, complained to the Engineer General Girardot, director of the IGAC, that the investigators Clériot and Cuvillé, in charge of the technical investigation into the accident involving the DC-4 registered F-BFGR operated by UAT on 7 February 1953, were interrogated by the police on several occasions, even at their own homes, even though they had complied, in their dealings with the judicial actors, with the provisions of the interministerial directive of 3 January 1953.

Mr. Girardot passed on the complaint to the Secretary General for Civil and Commercial Aviation. The situation on the ground remained tense, despite requests from higher authorities.

On 9 March 1953, when a decree implementing the reorganization of the Air Police was published (Art.IV), the Minister of the Interior expressed the wish that the Air Police should collaborate as closely as possible with all the other services whose activity was developing on aerodromes: the Air Safety Service under the Secretariat General for Civil and Commercial Aviation, Air Safety, Customs, Health Services, etc. In spite of this, accident sites were experiencing an ever-increasing number of complex, conflict-ridden situations. On 16 February 1957, Engineer General Girardot reported major crises



during investigations into the accidents to the DC-6 operated by the Italian company LAI on 24 November 1956, the Vickers Viscount operated by Air France on 12 December 1956, and the SE.2010 Armagnac operated by SAGETA on 29 January 29 1957. He described the incidents in detail and expressed his concern: *"For several years now, I have had the honour of drawing the attention of the higher authority to the tendency, first shown by the Department of the Interior (Air Police), then by the judicial authorities, to encroach on the remit of the Civil Aviation in matters of air traffic and accidents. We have reached the point where the Civil Aviation Department finds itself threatened and hampered in the exercise of the duty and mission imposed on it both nationally and internationally."*

The dichotomy between the technical and the judicial investigations did not seem to be resolving itself, despite all the virtuous incantations and reminders of the texts. Each side was adamant about defending its own prerogatives, a phenomenon exacerbated by a perception of "competition", as opposed to the complementarity that should have been the rule.

A Civil Aviation conference convened by Paul Moroni, Secretary General for Civil and Commercial Aviation, on 18 July 1956, raised the subject: *"Mr. Girardot stresses how difficult relations are with investigating judges, and especially with the experts they appoint. The conferees (sic) believe that the judicial authorities will never agree to base their decisions on the technical investigation, and that a specialized jurisdiction should be set up, based on the structure set out in Dutch law."*

In any case, this will be a long-term task, which could be undertaken by a commission comprising

representatives of the Ministry of Justice and the Secretariat General for Civil and Commercial Aviation. Mr. Moroni will raise the issue during a forthcoming visit to the Chancellery. The problem of experts is then raised, as they are generally incompetent or can be challenged because of the positions they hold. The difficulty is to find competent, independent individuals, whose names could be given to the judicial authorities. Mr Moroni asks Messrs Girardot and de Lagarde to think about this.

Maître Grimaud points out the susceptibility of magistrates in this area. Mr. Moroni will raise the issue during his planned visit to the Director of Criminal Affairs, a visit that will require careful preparation."

The idea of proposing a list of experts was not rejected by the Ministry of Justice, which replied on 28 April 1958, via a letter from the Director of Criminal Affairs and Pardons, which in its conclusion, once again referred to relations between the BEA and the judicial authorities: *"I would also like to hear your proposals concerning the establishment of a list of experts."*

With a certain wisdom, the July 1956 conference had noted that texts alone could not solve these problems, that mentalities had to evolve, and that it would therefore take a long time to reach an agreement.

The duty of the judicial authorities is to preserve evidence, and the duty of the technical investigation is to analyse and dissect it in order to learn from it.

As the investigation methods on each side are in contradiction with each other, the first attempt at harmonization would be to agree on a method that satisfied everyone. This would take decades to achieve...



Another idea put forward at the conference was that of a specialized section of the judicial authorities, with judges trained in aeronautics. This idea is still gaining ground...

While civil aviation investigators were often the target of over-zealous police officers, they were sometimes themselves at the root of conflicts. The field investigators, often aerodrome commanders or representatives of the aeronautical regional service, sometimes took unfortunate initiatives, in contradiction with the judicial procedure. The reactions of magistrates, air police commissioners and prefects were not long in coming...

The defence of each party's turf was followed by a long period of mistrust and misunderstanding. In his memo of November 28 1957, M. Girardot wrote, *"If, on the investigators' side, it was possible to observe the neglect of certain regulatory or legal forms, due to the imperative of research and analysis which the concern for the safety of this type of aircraft, still in service, made urgent, - on the judicial representatives' side, it was possible to note, at the same time as a lack of understanding of the duties imposed by ICAO international agreements, on the administrative and technical investigation, an excessively narrow conception of their rights..."*

He goes on to say: *"This was the first time that the antinomy between the legal texts giving full powers (sic) to the representatives of the judicial authorities and the very basis of certain delicate investigations was clearly revealed."*

This antinomy was to become more pronounced with the increased complexity of aircraft and their equipment, and air traffic organisation and its procedures. During the 1960s and 1970s, the antagonisms between technical and judicial investigations remained exacerbated, but changed in nature.

Summoned to the police station

In June 1957, two investigators were summoned by the Air Police, at the request of the Étampes public prosecutor, regarding certain alleged irregularities during the investigation of the Air France Viscount F-BGNK accident. The aeronautics engineer, Mr Pellet, a member of the investigation commission, was required to explain the facts, in a report dated 8 June 1957, to his head, Maurice Bellonte, who in turn had to report to the police commissioner. An illustration of the number of times police and safety investigators were at loggerheads.

"I have the honour of reporting the following facts:

I was summoned yesterday, 7 June 1957, to appear before the Jeannin air police superintendent for the following reason: irregularity committed during the investigation.

This irregularity consists in the breaking of seals affixed to hangar 248, where certain parts of the Italian DC.6 involved in an accident at Orly and debris from the Air France Viscount involved in an accident at Dannemois are stored.(...)

Having learned that the debris of the DC.6 which was outside hangar 248 had been sold to a scrap dealer, I made a point, as a member of the investigation commission, of making sure that the parts removed for examination were still in the hangar. On 16 or 17 May (...), I personally broke the seal, checked for the existence of the parts removed for the DC.6 investigation and locked the hangar. I returned the key to the gendarme guarding the debris in the Viscount hangar and informed him that I had broken the seal.

I didn't think for a moment that I would incur any reproach, given that the investigation into the DC.6 was practically over (...) and that it had seemed to be only a whim that had governed the placing of the seals on hangar 248, so I didn't hesitate to break them without recourse to a police officer.

In fact, once the Viscount parts had been collected from the accident site, they were transported to the aforementioned hangar by Air France without any police control.

Furthermore, once the seals had been affixed, the work of the commission members authorized to enter hangar 248 was carried out, at the start of the investigations, only in the presence of an Orly Air Police officer, who remained present during this work. He opened and closed the hangar after affixing the seals. This habit was quickly lost.; we'd go to the Orly Air Police to collect the key, but no superintendent would accompany us to open, monitor, close and seal the doors. The key remained in our possession throughout the day, and we returned it to the police in the evening.

For the sake of convenience and to avoid wasting time, this key was no longer even handed over to the Air Police, but entrusted by us to the gendarme who was guarding the wreckage in the Viscount hangar. Each member of the investigation commission could take it, and it should be noted that no comments were ever made on this procedure. "



BEA and air transport police: Data is shared at the beginning but there are two missions and two investigations with different purposes



The technical evolution of aeronautics was spectacular and, in the case of air accidents, required increasingly refined skills to understand, analyse and determine the measures to be taken to improve safety.

The impartiality of the BEA called into question

The BEA and any safety investigation commissions had the skills and resources to keep pace with these technological developments, including laboratories and engineers specializing in the latest techniques.

For their part, examining magistrates, often far removed from the aeronautical world and with no technical knowledge whatsoever, could only call

on appointed judicial experts on a list filed with the courts of appeal.

But most of the time, these experts were judged to be incompetent and called into question by BEA investigators. Judicial experts were quick to retort that the BEA, an emanation of the administration, lacked objectivity and independence. They even found certain politicians and elected representatives willing to voice these accusations ...

According to Daniel Soulez-Larivière¹, a lawyer specializing in aviation law, *"since the BEA was set up to manage aviation accidents in conjunction with the DGAC, in application of Annex 13 of the ICAO charter, an initial complaint was lodged by*



Perspective

When the BEA is suspected of partiality

In December 1957, the lawyer Jean-Louis Tixier-Vignancour, Member of Parliament for Basses-Pyrénées (now Pyrénées-Atlantiques), complained to Édouard Bonnefous, Minister of Public Works, Transport and Tourism, in a note about the application of the 1953 interministerial directive. In it, he emphasized *“the most deplorable consequences of the said directive (...) highlighted by our colleague Lapie, who pleaded on behalf of certain victims of the accident in March 1952 at Nice airport.”*

In this note, J.L. Tixier-Vignancour points out that technical investigators are appointed by the General Secretariat for Civil and Commercial Aviation. He deduces from this that *“technical investigators too often find themselves acting by proxy, as judge and jury. Moreover, we cannot ignore the influence which the national airline Air France, from its privileged position, and the various staff unions, the most active of which is that of the flight crews (Syndicat Nationale des Officiers de l'Aviation marchande) exert or attempt to exert .*

Under these conditions, it would seem essential, in order to enable the examining magistrate and the experts he has appointed to carry out their operations with complete freedom and with the sole aim of uncovering the truth, that a text should specify, if need be, that only the provisions of the Code of Criminal Investigation are applicable in matters of aviation accidents as in all other matters, and that the technical investigators can only have the role of observers and informers.”

This note represents one of the attacks most often levelled at the BEA and the investigation commission: partiality, suspicion of collusion with the aviation authority, and the influence of the major airlines and manufacturers, preventing a judicial truth from coming out, due to their privilege of “guiding the investigation” given by the 1953 interministerial directive. What until now had been whispered was now written down in black and white by deputy Tixier-Vignancour...

The reply from the Transport minister, was unambiguous: *“Far from being limited and restricted, the purpose of the BEA and the investigation commission is of paramount importance: accurate knowledge of the causes of accidents and incidents is the very basis of air safety, and is the only way to determine responsibility, which is the subject of legal proceedings. (...) Precautionary measures and de facto findings on the debris and the bodies of the victims still in position are crucial; they must be taken and carried out methodically by highly qualified personnel.*

Recent examples have shown that, in certain serious cases, in the current state of aeronautical construction, which is constantly evolving, specialists from a wide range of French and foreign organizations, such as technical departments, manufacturers, users and even workers who have worked on the accident aircraft itself, must be put to good use. They are all under the direction and control of the technical investigators of the Civil Aviation General Inspectorate, who alone have the power, by virtue of their functions and experience, and the statutory mission, to guide the investigation.

In so doing, they play a key role in ensuring the efficiency of the basic investigations, for the benefit of both the judicial investigation and the technical investigation.

In this first and most important phase, it does not seem possible to me to subordinate a group of investigators or an investigation commission having the best and largest technical resources, to one or two legal experts who cannot have, whatever their personality, references comparable to those of the investigators of the Civil Aviation, Military Aviation and, where applicable, foreign experts.”

Minister Bonnefous, who considers that *“the interministerial directive of 3 January 1953 appears to have established a wise principle”,* also points out that *“the examination of the files on the work carried out by the latest commissions proves to me that, when difficulties have arisen between technical investigators and legal experts (...) these difficulties have been caused by legal experts who have ignored or systematically disregarded the rules of collaboration specified by the aforementioned interministerial directive.”*

As for the suspicion of partiality, he insists that *“the independence is guaranteed by the fact that the members of the Bureau enquêtes-accidents, who lead the research, investigations, interrogations, various examinations and discussions, and draw up the conclusions, belong to the General Inspectorate, itself subordinate to the Minister and therefore independent of the air navigation, aerodrome and meteorology directorates.”*

An independence and impartiality that the BEA will have to defend vigorously for a long time to come. Until recent cases, the attacks suffered by the BEA on these subjects show that the fight against rumours is a continuous battle...



Perspective

Habsheim accident

Robert Davidson's notes, head of the BEA from 1986 to 1990

Robert Davidson, head of the BEA at the time of the Habsheim accident, noted for the trial:

"The difficulties encountered at Mulhouse are not exceptional. It happens with all accidents. Usually, the BEA negotiates with the judicial authorities and, at the cost of certain (regrettable) arrangements, resolves the problem and one of its agents brings back the recorders. The DGAC's involvement in the affair (the transport of the recorders), and its disclosure of the information they contained, led to the idea (immediately taken up by the unions) that it was the DGAC - judge and jury - who performed the readout and analysis. To the extent that the BEA was never mentioned. Similarly, since only the DGAC spoke, it appeared to many that the commission was the emanation of the DGAC, which confirmed the idea of "judge and jury". It also became clear that many DGAC agents did not feel bound by any notion of "discretion" and released what they had seen or heard without restraint.

Anomalies:

1. Agreement with Mr. Tamagnini to prepare the box overnight and carry out the readout in the presence of the BEA investigator, Vincent Favé on Monday from 08:00 onwards. However, given the good condition of the recorder, the CEV flight test centre carried out a complete readout during the night, without checking the results, and, contrary to all the usual rules, entrusted the listings and graphs to a person outside the BEA, Mr. Renaudie, who had apparently (at whose invitation?) participated in the readout. Although these documents were expected at the Convention for analysis, they were taken to Montparnasse and discussed without any prior verification. Gross errors were made.

Mr. Renaudie then left, taking with him the set of graphs and the most interesting part of the listing, giving me the other two parts, which did not include the fundamental parameters. A new printout had to be made in order to begin work. This situation is unacceptable and prevented the BEA from carrying out its role.

During a meeting with Europeans, Mr. Renaudie presented the documents and commented on them even though the BEA had not yet begun its work. We thus learnt of a great deal of information that we were not aware of. This is truly scandalous.

Conclusion

1. The BEA must be allowed to conduct its investigation, and higher authorities should only intervene if the former requests their assistance.
2. The BEA shall provide the Director General with the information necessary for him to fulfill his responsibilities as quickly as possible, and the BEA shall take responsibility for this information.
3. The BEA can no longer be dependent on other services over which it has no power or control. The BEA must be given the means to carry out its own readouts. The project has been drawn up, will cost around 6 million, and will require the assignment of three specialized agents.
4. The chairpersons of the commissions must be allowed to express their opinions.
5. The number of people from the DGAC and, above all, from outside the organization who participate in decision-making meetings must be limited.
6. The BEA's fundamental texts must be revised, and to do so, a lawyer must be made available, at least on a part-time basis.
7. Separate offices are needed to reduce comings and goings.

the SNPL (French airline pilots' union) against the director of the SFACT (French national flight school) certification office. An indictment was filed in 1981, preceded by a dismissal by the investigating judge. On appeal by the SNPL, the director was indicted and the case was again dismissed by the same court..."

D. Soulez-Larivière refers here to the 1979

1. Daniel Soulez-Larivière (born in Angers in 1942 and died in Paris in 2022) was a lawyer at the Paris Bar from 1965 onwards. From the 1980s onwards, he was very active in the aviation sector. He became the lawyer for the French Civil Aviation authority (DGAC), defending its officials when they were implicated in air accidents.

accident involving a Beechcraft that experienced a failure of the propeller pitch variation system. The SNPL blamed the SFACT certification office. The second landmark in this forward march in the judicialisation of investigations was the accident involving an Airbus A320 at Habsheim, near Mulhouse: *"In June 1988, during a demonstration flight with 75 passengers on board, a rash pilot, having cut off all the safety systems and approached to within ten meters of the ground, struck, at the end of the runway, an eleven-meter high forest that he had not seen because he had*



not carried out a sufficient reconnaissance of the area beforehand. The same evening, the Minister of Transport explained that it was a piloting error, to say the least..."

"But the story didn't end there. The legend of the black boxes having been tampered with or even exchanged was born, placing the BEA and the DGAC at the centre of the affair. According to the pilot and his supporters, the engines had not responded normally during the go-around, which turned out not to be the case.

But he also claimed that the flight recorder analyses were based on instruments that had been manipulated and even swapped. In addition to a conviction for the facts themselves, these statements earned the pilot and his lawyer a conviction for defamation."

These court rulings did not totally exonerate the authorities from having placed themselves in a critical position, putting the BEA in an uncomfortable one. Certain liberties taken with the procedure in force were to trigger the anger of the head of the BEA, Mr. Davidson (see box on page 148), who expressed it at the Habsheim trial.

In a memo dated March 1991 to the head of the IGACEM, Charles Géhardi, the civil aviation inspector general, provided a legal analysis of the 29 January 1991 judgement of the 17th Correctional Chamber, convicting Mr. Asseline and Mr. Jacquet, respectively pilot and forensic expert, of defamation, following accusations of manipulation of the recorders.

Charles Géhardi concluded that, *"Beyond any exegesis or legal argumentation, it is advisable to recommend scrupulous compliance with the provisions of the note from the Criminal Affairs and Pardons department dated 10 July 1989:*

1. A judicial police officer will hand over the black boxes to the BEA investigators who will formalize



the transfer of the black boxes.

2. The recordings will be rapidly duplicated.

3. The black boxes will then be returned to the original judicial police officer.

It is undoubtedly up to the judicial authorities to determine, in practical terms, the measures it deems appropriate to guarantee the conformity of the evidence thus submitted and returned: affixing seals, transfer under the escort of a judicial police officer, duplication in the presence of a judicial police officer, marking of recording tapes, etc.

In any case, it is important that the technical investigators comply with the requirements of the judicial authorities in demonstrating their concern to identify and preserve the integrity of these items of evidence in the custody of the courts.

It must be clearly understood that the execution of these measures, which do not appear likely to undermine the reputation or effectiveness of the investigation, are not the result of any suspicions against the BEA investigators, whose integrity no one would reasonably think of questioning.

Accident to the Airbus A320 registered F-GFKC operated by Air France, on 26 June 1988, at Habsheim (Haut-Rhin).

BEA and air transport police on the tarmac at the Paris air show in 2019.



On the contrary, the implementation of these provisions, which in any event comply with the law, aims to protect the service against any controversy, where the strength of the attacks would be all the greater in an incident where the responsibility of the air traffic control services, for example, might be called into question.

Charles Géhardi concluded by stating that, *"it is opportune to draft a specific legislative text for the organisation of the technical investigation, which would establish the prior intervention of the public prosecutor before referral to the investigating judge or the consent of the examining magistrate."*

Daniel Soulez-Larivière believes that, *"these trials have inflamed tempers and definitively marked the submission of all aviation activity to the rules of criminal law."*

The intervention of the judicial authorities in aviation accidents—as in many other areas—is systematic, with the possibility of opening a criminal investigation for manslaughter when there are injuries or deaths. But while the strict application of criminal law sometimes leads to convictions and even prison sentences, as in the Habsheim accident, it also gives rise to spectacular acquittals as in the Mont Sainte-Odile accident and the Concorde accident in Gonesse in 2000.

It should be noted that, during the Concorde accident trials at the court of first instance and on appeal, Paul-Louis Arslanian and Alain Bouillard, the investigator who led the investigation, attended all of the hearings, transitioning from witnesses to leading experts for the Court as the hearings progressed. It should also be noted that Mr. Jacquet would again be convicted of defamation against the BEA.

The issue of relations with the judicial authorities was addressed in two European texts, a 1994 directive and a 2010 regulation, as well as in the 1999 law transposing the aforementioned directive. The BEA was particularly involved in the drafting of these texts. Directive 94/56/EC and its transposition law of 29 March 1999, gave the BEA greater resources vis-à-vis the judicial authorities. This resulted in a circular dated 18 February 2005, from the Criminal Affairs and Pardons department concerning relations between the judicial authorities and the BEA. However, since a directive is only effective when transposed into national law, the balance of power between the Criminal Code and a law is very unbalanced.

This is why Paul-Louis Arslanian was one of the architects of a new European text, this time a regulation that is binding on states. In October

Perspective



Daniel Soulez-Larivière (lawyer):
"Justice does not ease the pain of victims."

The safety chain implemented in aviation is so complex that it puts its players beyond the reach of investigating judges, except in cases of deliberate violation of the law or gross negligence. Indeed,

the law of July 2000 removed simple negligence from the criminal sphere by introducing, in the absence of deliberate, i.e. intentional, misconduct, gross negligence as a prerequisite for conviction. Applied to aviation, it effectively prevents excesses," emphasizes Daniel Soulez-Larivière.

Another deviation implicit in criminal proceedings seems to have come to an end in recent years, that of the "domination of civil parties," according to Daniel Soulez-Larivière. "We saw an illustration of this in the Mont Sainte-Odile case, through a question posed by the president of the Colmar Court of Appeal to experts representing the victims who had come to explain their trauma: "Are you saying to the Court [...] that if the Court acquits the defendants, it will be an additional trauma for the victims?" It was a general acquittal.

"Is the criminal court the right place to help victims overcome their pain and grief? [...] The answer is no. Some of the unfortunate people who came to court wearing T-shirts bearing the photo of their deceased loved ones must have begun to wonder, fifteen years after the tragedy, whether the promise of closure through the judicial system that had been claimed was not a deception, or simply foolishness..."

Confronted with the judicial authorities, the BEA has had to assert its role over time, which has not been an easy task. The main obstacle is that the extremely technical nature of aeronautical events cannot be reduced to a Manichean view, often encountered among investigating judges during "major" investigations.

The BEA has finally regained its place after being considered first as imitating the administration, then for many years as a competitor to the judicial investigation, even though its purpose is not the same," emphasizes Daniel Soulez-Larivière. *It is not its role to seek out sins and faults, but rather to find the causes and remedies for the accident that occurred."*

2010, European Regulation 996/2010 confirmed the rights of safety investigations, requiring judicial authorities to enter into contracts with the authorities responsible for safety investigations, namely the BEA.

Maître Soulez-Larivière, "given the crucial importance of clearly guaranteed rights for safety investigations, Member States should, in accordance with existing legislation on the powers of the authorities responsible for judicial investigations and, where appropriate, in close cooperation with those authorities, ensure that the authorities responsible for safety investigations can carry out their duties under the best possible conditions, in the interest of aviation safety. Consequently, the authorities responsible for safety investigations should have immediate and unrestricted access to the accident site, and all the evidence necessary to meet the requirements of

the safety investigation should be made available to them, without prejudice to the objectives of the judicial investigation."

Since then, tensions appear to have eased, and freer cooperation has been established.

Among magistrates, the idea that air accidents are part of a complex chain of events has gained ground and that as Maître Soulez-Larivière emphasizes, "not everything is as simple as that."

As for the demand of victims or their relatives to know the truth of the events, it is more a matter of better communication of the work of the BEA as long as there is no external interference.

2014 BEA-judicial authorities agreement

With attitudes now changing, the BEA and the judicial authorities would clarify the scope of their relationship through an agreement signed by Rémi Jouty, director of the BEA, and Robert



Gendarmerie des Transports Aériens (Air transport police), The arm of the judicial authorities

Created in 1953, the GTA was initially structured into companies (one per aviation region), and brigades which operated in aviation districts. The rise of air transport justified this organization, which was originally set up to ensure the safety of passengers and crews, monitor compliance with the rules of the air by the pilots, and then to combat aviation-related crime (particularly various types of trafficking).

Gradually, it took over from the Air Police in judicial investigations of air accidents, with the latter refocusing on immigration issues by becoming the Air and Border Police and then, today, the Border Police. The increasing involvement of the judicial authorities in accidents saw the GTA being mandated by magistrates to search for responsibilities and possible faults committed by civil aviation actors.

Shortly before 1985, the GTA launched advanced training courses for its staff, the first steps towards training air accident investigators. Then, on 1 September 1996, the Research Brigade was created, the armed wing of the judicial authorities in the search for responsibility and possible negligence in the event of an accident. The rise in the number of flights, and therefore in the number of accidents with which the BEA was also confronted, justified the transformation of the Research Brigade into the Research Section on 1 September 2004.

Since its creation, the BEA operates within the framework of Annex

13 of the Convention on International Civil Aviation, and then Amendment No. 17 to that convention. In 1999, a European regulation supplemented its scope of action through Law No. 99-243 of 29 March 1999. However, the paths taken by safety investigations on the one hand and judicial investigations on the other are not always the same...

"For the GTA, the judicial enquiries really began to take precedence around 2004," says Major Jean-François Stork, head of the GTA's Research Section. "Previously, the judicial enquiries were not necessarily the GTA's main mission

From the 2000s onwards, its personnel came from external units, notably the departmental gendarmerie, with significant judicial experience.

The year 2004 is not particularly linked to a specific accident, but rather to an internal reflection on the need for a judicial structure for aircraft accidents. It was at this point that the Research Brigade became the Research Section, with a significant increase in staff numbers. This evolution continued until the BEA-Judicial authority agreement of 16 September 2014. From then on, we began to define a framework for the procedures.



BEA investigators, manufacturer experts and police working on accident site



Perspective

Jérôme Bastianelli:

“The Concorde accident was a moment of tension with the judicial authorities.”

"An unusual situation led our British colleagues to include an afterword in the report, in which they imply that the French judicial authorities had not been cooperative! For example, they were not allowed to examine the famous metal strip outside of its sealed plastic bag..."

Still on the subject of the Concorde accident, one of my tasks was to establish the cause of the fire. Looking at the videos and photos of the accident, it can be clearly seen that the flame was adhering to the landing gear bay. It was then thought that a spark in the broken cables had caused the fire. But this was actually quite unlikely, as we have shown, with two physicists who are experts in combustion, Denis Veynante and Luc Vervisch. This is because liquid kerosene is quite difficult to ignite. On the other hand, when the vapours pass through the hot gases at the rear of the engines, they ignite immediately—but how did the flame then travel up to the landing gear bay given the speed of the aircraft? Our British colleagues, as they wrote in their comments appended to the report, were convinced that the fire was caused by a spark in the landing gear bay – perhaps because, as the country that manufactured the engines, they did not want them to be implicated in the accident. But the reality is a little more complex, with both hypotheses having their strengths and weaknesses. The most important thing in an investigation is to learn all the lessons in terms of safety, and therefore to work on all the hypotheses that cannot be ruled out.

Gelly, director of Criminal Affairs and Pardons, replacing the 2005 circular. This document, signed on 16 September 2014, now guarantees the work of safety investigators and judicial investigators and is the "set in stone" reference. The purpose of this agreement is to clarify the relationship between the BEA and the judicial authorities in the event of accidents or serious incidents falling within the scope of regulation No 996/2010.

This agreement covers the following topics:

- access to the accident site,
- preservation of evidence and access to it,
- initial and ongoing reports on the progress of each operation,
- sharing of information,
- appropriate use of information with respect to safety matters,

- resolution of conflicts.

It serves as a framework for establishing specific protocols that may be agreed upon between the director of the BEA and the relevant magistrate during the two investigations and that may prove necessary for their coordination and the allocation of responsibilities and costs for operations of common interest.

European harmonization impossible?

In the late 1970s, the European Union, which then had nine member states, became interested in the problems posed by safety investigations into aviation accidents and incidents. In particular, it questioned the advisability of harmonizing member state procedures.

This led to the publication of Council Directive 80/1266/EEC of 16 December 1980 on future cooperation and mutual assistance between



the Member States in the field of air accident investigations. This directive was followed by various interventions *"which likely preceded a certain European dynamic on this subject,"* wrote Jean Lévêque, head of IGACEM, in a confidential memo dated 20 September 1990.

This note accompanied the publication of the study *"Approche communautaire en matière d'enquête technique sur les accidents et incidents aériens"* concerning a community approach to technical investigation into air accidents and incidents. In this work, Charles Ghérardi proposes a critical study and outline of a technical investigation system in France.

He discusses a profound change in the concept of investigation and its effects, *indicating that paradoxically, this new focus on the issue has been prompted by an increase in aviation safety. Advances in aeronautical technology have transformed the resignation once felt in the face of accidents, which were then considered the consequence of the "risks of flying" and the expression of "fate", into an aberrant and scandalous phenomenon whose causes must be discovered and those responsible, punished.*

This psychological shift has often been accompanied by impatience on the part of the media, which is quick to fuel suspicion and controversy and stir up public opinion. It is clear that an outdated compensation system, which gives rise to disputes, has contributed to giving investigations and examinations a greater importance and a harshness that go beyond simple scientific research for improved safety. It is equally certain that the intrusion of considerable financial interests, and even corporate disputes, keen to cast doubt on the reliability of new or competing aircraft, has ultimately exposed technical investigations to criticism and questions

about their reliability."

This is understandable when we recall the controversy that arose during the investigation into the Air France Airbus A320 accident during the meeting at Mulhouse-Habsheim, which continued until the Court of Cassation's ruling on May 23, 2000 (almost twelve years after the accident!), making the captain's conviction final.

Cooperation between the various national services is therefore essential, but without encroaching on what is considered to be the exclusive domain of each member country. This study presents three national issues related to safety investigations that are believed to be obstacles to a Community approach: the problems posed by dual investigations (judicial and safety), cooperation and pooling of available resources for accident investigations, and the voluntary incident reporting system.

Jean Lévêque, in the aforementioned note, expresses the fear that *it may be assumed that the ultimate goal of the Commission or some of its members is to create a community accident investigation service.* The growing influence of the BEA in Europe and the United States from the 1990s onwards was such that the creation of a European investigation service could not have been achieved to its detriment.

Quite the contrary, given the contribution made by the director of the BEA to the drafting of European texts, both the 1994 directive and the 2010 regulation. As for the three issues indicated in the IGACEM study, these were resolved through the BEA's international, European, and national action.

The problem of a double investigation

The wide disparity between the judicial systems of member countries makes the standardization



of the contributions of technical investigations and judicial investigations unrealistic. Each state must therefore seek a balance between the two types of investigation, guaranteeing the investigator's rights to access the wreckage and recorders, and interview witnesses, etc. The total independence of the investigating body from the government authorities of each country is also a strong point of the French BEA, whose independence was highlighted in the Wilkinson report. Lastly, France takes a very dim view of the presence of an observer appointed by the [European] Commission within a technical investigation commission," which it describes as "premature."

Technical Cooperation

Starting with the harmonization of regulations based on ICAO Annex 13, France recommended the creation of a "task force" made up of investigators from countries with well-structured accident investigation authorities (Germany—still West Germany at the time—the United Kingdom, and France). This was referred to as "consultation" with reference to the 1980 directive, still with the fear that a Community accident investigation service would exacerbate difficulties with the judicial authorities.

A community information system

In this chapter, the IGACEM at the time noted the disparity in regulations and practices regarding the reporting of incidents. However, it declared itself very much in favour of creating a confidential community system that would preserve the anonymity of the informant in cases of unintentional misconduct, similar to those already in place in the United States, Canada, Great Britain, and Australia.

These reports highlight the difficulties in complying with the different laws applied in

member countries, and J. Lévêque points out in correspondence with the Director-General of the European Commissions that these reports sometimes contain certain proposals that are not entirely consistent with the fundamental principles of French law...

European regulations

Regulation (EU) No 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation and repealing Directive 94/56/EC, published in the Official Journal of the European Union on 12 November 2010, entered into force on 2 December 2010

This regulation is in line with the Convention on International Civil Aviation and gives legal force to the provisions of its annex in all Member States of the European Union. It establishes the authority of the safety investigation bodies and their national character, institutes a network grouping these authorities, organises the participation of the European Union Aviation Safety Agency (EASA) and the national civil aviation authorities of the member States in the investigations and establishes new procedures for the exchange of information between actors involved in aviation safety, as well as between them and the public.



Chapter 8



The BEA communicates with its partners

Having become independent, the BEA set up a “Communications” cell which naturally supported the dissemination of the BEA's investigation reports, and gave a professional polish to the BEA's communications in an increasingly media-oriented society. It also implemented a dedicated information service for victims' families, for which the BEA is one of the pioneers in Europe.



Filming a report
with Agence France
Presse (AFP) within
the BEA
laboratories



First missions: Investigation reports and the Internet

In 1998, Hélène Bastianelli, one of the BEA's first women investigators, was tasked by Paul-Louis Arslanian with setting up a "Communications" cell, whose initial missions were to improve the publication of reports and communications with the press and the general public. *"Other air investigation services around the world had a communications department. The Americans had a website. We needed to issue press releases; it was a natural progression,"* explains Hélène Bastianelli today. *"When it was created, there was no particular crisis, just a need to organise and structure publications and get online..."*

Catherine Loisy joined her and offered to take charge of standardising investigation reports. *"Because of my IT skills, Hélène said to me: 'You know how to make report templates. That's what I want'..."* recalls Catherine Loisy. *"At the time, I was doing it with whatever I had available. I had asked for a scanner. We got a scanner equipped with OCR (optical character recognition) software. The director supported us; we needed equipment and he listened to us."*

In the early 1990s, the BEA only published a few reports per year. There was no obligation to investigate all occurrences or to publish a report on each investigation. Only investigations that could improve safety terminated with the writing of a final report, which was submitted to the Minister of Transport, who decided whether to publish it. This changed with European Directive 94/56, which, although it was not transposed into national law until five years later, allowed the BEA to free itself from this political decision and make its investigation reports public. The number of reports published each year thus increased

steadily, exceeding 100 reports from the mid-2010s onwards.

That year, 2010, was marked by a change in European regulations: the 1994 directive was replaced by Regulation 996/2010. The latter did not revoke the obligation for Member States to investigate any accident or serious incident occurring on their territory, but added the obligation to publish a report at the end of each investigation opened, recommending a target period of twelve months for the publication of the report. The obligation to inform the victims' relatives of the findings of the investigation before making them public is also included in the regulation.

From "Bulletin" to "REC"

In the 1990s, the BEA began publishing simplified general aviation reports in the form of one- to two-page double-sided sheets, compiled in a "Bulletin". The Bulletins contained reports on accidents that had occurred during the same period the previous year. Each Bulletin contained sheets relating to accidents that had occurred one year earlier. The Bulletins were green, the colour assigned to simplified general aviation reports (grey being used for preliminary or interim reports, blue for ICAO reports and red for reports concerning serious incidents in commercial transport).

In parallel with the Bulletin, the BEA created the REC, a confidential reporting programme, which allowed pilots, particularly those in general aviation, to describe an event that had occurred during their flights so that everyone could learn from it.

Both the Bulletin and the REC were highly appreciated by flying clubs, and many of them approached the BEA to ask that these publications continue to be printed at a time when the BEA



Perspective



Hélène Bastianelli:

Creating the logo: not that easy ...

Hélène Bastianelli: *"As soon as we decided to open a website, we recruited Albert Manson for his expertise in this field. It was necessary to design a logo. The first one represented a sort of V rising towards the sky, a symbol intended to express that after an accident, safety increases... It was an in-house creation.*

Paul-Louis Arslanian was worried: "Hélène, don't you think they'll take us for Nike?"

Then there was a competition for ideas, and we received a proposal from a graphic designer. This time, the logo looked too much like the Rexona brand!"



was moving towards a fully digital format.

All the reports were put in envelopes and posted by the Communications unit. This task was enjoyed by all the unit's staff. All those who participated have fond memories of it. *"In the mid-2000s, we were sad on Friday evenings and happy on Monday mornings..."*

Subsequently, the REC was entrusted to the DGAC before its management was transferred to sports federations under the name of REX.

Visibility on Internet

The BEA was duty bound to enter the digital age by being present on the "web", as the Internet was becoming inevitable and offered it the opportunity

of becoming better known to the public.

Albert Manson created the website's home page with the logo and name of the parent ministry on a midnight blue background. As the parent ministry often changed with ministerial reshuffles, the creators found a clever way to make updating easier: they created files that allowed them to stay up to date without having to completely redo the page.

In 2007, the first redesign of the website was also carried out entirely in-house, with subsequent redesigns being developed by subcontractors specialising in this field.

At that time, Alain Guillardou had replaced Hélène Bastianelli after a few months of working together. With the publication of reports now a well-oiled activity, Alain Guillardou, who was very interested in international affairs, developed the BEA's representation at this level.²

Media pressure

Pressure from journalists was exerted on the communications cell, but also on some of the investigators themselves.

Hélène Bastianelli recalls that, *"bilateral contacts were sometimes difficult, with people who had found my number calling me. I was completely unprepared to deal with this other than as if it were my own family, so I spent hours listening to them at the expense of my other work, trying to manage it all... There were no barriers,"* she continues, *"we had to put up our own."*

I received four days of training to learn how to write press releases.

A press release is rational; it follows specific writing techniques...

1. See also chapter 6 "General aviation"

1. See chapter 9 "BEA and international cooperation"



The evolution of the communication division

After four years, the communication actions needed to become more professional. *"Personally, I needed a change of profession, to go back to being a safety and technical engineer. So it was a good move to recruit communication professionals for the communication actions,"* says H     Bastianelli.

2002 and 2003 saw the Communication division grow to a team of around ten members. Two people were recruited, one for the media, the other for information to victims' families and the management of the archives. Martine Del Bono took up her post on 15 April 2002, to develop the BEA's image in the media, while Jean-Philippe Arslanian joined the team in July 2003, with the task of handling relations with third parties, i.e. all members of the public who come into contact with the BEA without being involved in the investigation process. Naturally, this includes relations with victims' families. Appointed deputy head of the Communication department in 2017, he is still fulfilling this mission at the time of publication.

The BEA is a forerunner in Europe when it comes to informing families. Two events are at the origin of this. The first was Paul-Louis Arslanian's meeting with Hans Ephraïmson-Abt, spokesman for the International Association of Victims' Families, which he had founded following the death of his daughter aboard the Korean Boeing 747 shot down by Russian fighters in 1983. After the collapse of the Soviet Union, the Boeing's recorders were handed over to ICAO, which had them analysed by the BEA. Numerous meetings took place between these two men until the death of Mr. Ephraïmson-Abt in 2013.

The second event that led the BEA to professionalize its relations with the families took place in the late 1990s. An investigator told a DGAC reprography agent that the accident that had claimed his wife's life was certainly of technical origin. However, he forgot to inform him of the completion of the investigation. By a pure coincidence, the agent discovered that the report he was printing was that of his wife's accident, and that the conclusions of the investigation pointed to an operational cause.

Until the early 2000s, BEA reports were printed by the DGAC. Subsequently, the BEA awarded contracts to private printers for its



The BEA is a member of the AJPAE, the association of professional aeronautics and space journalists whose members are regularly invited to report on investigations in progress.

publications, but not for the mailing, which remained the task of the BEA's Communication department until the end.

At the time, three agents were working on improving the Internet and digital publication of reports. Three other agents were responsible for formatting the reports: this may seem a large number, but at the time, this department was publishing an increasing number of reports since the 1999 law made it compulsory to investigate all accidents and serious incidents, and sending by post, reports, studies, Bulletins, REC and the air transport incident review (ITA), which was to passenger commercial air transport what the REC was for general aviation.

The Communication department would have up to eleven staff, plus a clinical psychologist who would be there half a day a week. In addition to the head of the department and the agents responsible for press relations and relations with third parties, the department was staffed by a secretary, who left the BEA after passing an administrative examination, computer graphics designers, IT specialists and translators.

The Internet part was subsequently separated from the Communication department to form a new BEA IT team, and the formatting of reports was reduced.



We had very good relations with all the specialist press, in particular Pierre Sparaco, who has since passed away, and Michel Polacco. Pierre Sparaco was the Aviation Week correspondent in France at the time. After the Concorde accident, and even before, we had worked together a lot. Being an investigator myself, I was able to discuss technical aspects with them. I got on very well with the specialist journalists.

Our first contacts with the media were in July 1998, after the mid-air collision between a commercial air transport aeroplane and a flying club aeroplane over Quiberon Bay."

Misinterpretations

A little over a year after H  l  ne Bastianelli's appointment, the communications cell's first press release was published in response to the Pristina accident in September 1999 in Kosovo, involving an ATR42 chartered by the United Nations. During this investigation, led by Alain Bouillard, the BEA closed the airport in this territory, which at this time was administered by a United Nations mission, the UNMIK.

In order to forge links with the specialist press, the BEA organised its first breakfast meeting with the Association of Professional Journalists in Aeronautics and Space (AJPAE), an event that has since become a regular fixture. The arrival of Martine Del Bono, head of press relations, enabled the BEA to better understand media pressure and gave new impetus to relations with the press, particularly the general press.

With the non-specialised press, the BEA often encountered unexpected publication requirements: *"We had clear instructions about what we could say and, above all, what we absolutely must not say, not because we wanted*

to hide anything, but to avoid misinterpretations..." recalls Catherine Loisy.

For example, during the investigation into the Sharm el-Sheikh accident in January 2004, two journalists from *Le Monde* conducted a lengthy interview with Paul-Louis Arslanian and published a long article on the investigation. On the same day, he wrote to the families of the victims: *"The Le Monde edition of Friday 6 February contains a sentence incorrectly taken down in an interview I gave to the newspaper. The sentence reads as follows: "At no point did the pilot or co-pilot call the flight attendant or cabin crew." In reality, I said that at no point did the cabin crew call the pilots."*

More annoyingly, nearly a month later, *Le Figaro* published an article containing incorrect information and presenting a scenario of the accident, which was in fact speculation by the journalist based on his interview with Paul-Louis Arslanian and then with the head of the Technical Department, who had given him a general overview of the work on the recorders.

The director of the BEA reminded the victims' families of this in a letter sent on the same day the article was published: *"At present, no new information is available that could provide further explanation. You will, of course, be informed first by the BEA and the Ministry of Equipment, and not by the press, of any significant developments."*

Another unexpected aspect would fall to the cell following the accident between an Air Libert   MD88 and a Short aircraft, which collided on the ground at Roissy on 26 May 2000. The accident, which received little media coverage, was nevertheless of great importance from a safety point of view.

A simple press release would suffice, but the cell had to intervene with the judicial



authorities: *"At that time, we were responsible for organising meetings with public prosecutors to try to convince them of the importance of good relations between the judicial authorities and the BEA, as the safety investigation and the judicial investigation were sometimes in conflict... We took a number of steps in this direction, as we did not have a secretary general at the time,"* continues Hélène Bastianelli. *"This position was temporarily vacant following the sudden death of Jean-Paul Lavictoire, who was subsequently replaced by Jean-Luc Bénesse."*

Gradually, as the communications cell gained experience and became more structured, it succeeded in providing the BEA with what it was looking for: a more confident tone with the press, better management of relations with journalists and the tension inherent in press relations, as well as a modernisation of these relations.

It should be noted that at that time, a transport

users' federation, through its president, regretted the lack of information provided by the Paris transport authority after an accident, particularly in view of the information made public during the investigation into the Concorde accident.

The era of professionalisation

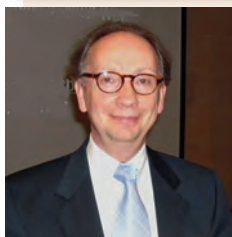
While the lack of training among the cell's members was evident when dealing with journalists' requests, it was even more glaring when responding to the families of victims. No one was prepared to see, listen to and inform people in complete distress who were seeking to understand the causes of the tragic event that had turned their lives upside down. A decade later, the 2010 European regulation made it mandatory to provide information to the families of victims.

Alain Guillardou joined the BEA on 1 May 2001. Six months later, Decree 2001-1043 on technical investigations into civil aviation accidents and

Perspective

Alain Guillardou

Three communication branches



"My division also had a bilingual English/French translator of English nationality. His daily presence was invaluable. He enabled us to publish press releases in English at the same time as in French. Later, when it came to awarding contracts, both for translations into English and into other languages, he was in charge of searching for translators, validating bids and carrying out transactions," explains Alain Guillardou.

The original communications cell became a division, then a "department of information and international cooperation", comprising three divisions, respectively in charge of the BEA director's communication, the publication of reports and studies, and relations with victims, their families and associations.

"This specifically involved

- disseminating information on BEA investigations,
- controlling the quality of reports and other publications, translating

them into foreign languages, and monitoring their publication and distribution,

- the quality and reactivity of information for the media, victims' families and their associations,
- exploiting and promoting the BEA's physical and digital archives.

"My responsibilities also included working alongside the director of the BEA. This consisted of :

- developing institutional relations with foreign investigation authorities, particularly in emerging countries that would seek assistance from France,
- organising seminars in France and abroad, aimed at training safety investigators,
- preparing meetings, conferences and presentations in France and abroad on the BEA's activities."



incidents stipulated that: *"The BEA comprises a general secretariat, departments and divisions. It includes a unit responsible for communication."*

The cell thus became the communications "unit" and Alain Guillard was appointed head of the "communications division" shortly after Hélène Bastianelli's departure.

Over time, further restructuring took place at the BEA, eventually elevating communications to the status of a "department", on a par with investigations and laboratories.

Perspective

Face to face with families

Hélène Bastianelli: *"I remember the day when I received a couple with Caroline, the psychologist. We were so focused that we didn't realize she had a recorder in her bag. The family was recording our meeting without our knowledge. We finally discovered it and were able to retrieve the tape. It wasn't malicious, just a need to listen again to what had been said. It's a bit like going to the doctor's, when faced with a complicated pathology, you might want to hear what was said again. We mustn't forget that we're dealing with families who are in a great deal of pain..."*

Jean-Philippe Arslanian: *"During a discussion with a pilot's widow during the course of our investigation, she told me that her teenage daughter was having a very hard time dealing with her step-father's accident. She had put him on a pedestal, and the accident reflected back to her the image of a "bad pilot". When the investigator told me that this man had flown for almost half an hour, whereas the life expectancy of a pilot in the same conditions is no more than five minutes, I knew that I would have to organise a meeting to present the report to the pilot's relatives, and convince this young girl to come along. A few days after the meeting, her mother wrote to thank the BEA for organising the meeting, and to say how important it had been for her daughter."*

Hélène Bastianelli: *"I was on the phone for hours with the mother of a pilot. She could hear him walking in the attic in her house. It was terrible. I understood her..."*

"The Concorde accident was the beginning of the BEA's communication with modern tools. The preliminary report was sent by e-mail to 50 or 60 journalists. It was also the early days of the e-mail, and messages were sent one after the other. We started sending the report at 10:00, it would take twenty minutes. However, by 10:02, some journalists were already calling to complain that they hadn't received it!"

The Families cell was created in 2002, initially led by Martine Del Bono, in addition to her press relations duties, and Catherine Loisy, pending the recruitment of a dedicated officer for this task in July 2003. In this area, relations with families also needed to be modernised. Actions would be coordinated with INAVEM, now *France-Victime*, for the relatives of general aviation victims.

Other media besides paper would also be introduced: reports and photos on CD and then DVD, USB keys, etc. On the website, the Communication Division offered not only the report itself, but also documentation, a media library, animations and related documents.

One of the tasks of the officer responsible for relations with families is to identify general aviation reports that require some technical knowledge in order to be able to understand them and to ensure that the victims' relatives have this knowledge. If this is not the case, he proposes and organises a meeting to present the report before publication. Initially, this presentation was made by the then head of the Investigations Department, Stéphane Corcos.

However, it was not possible to answer specific questions about the investigation. It was therefore decided that the investigator who conducted the investigation would make this presentation alongside the officer responsible for relations with third parties. Over time, it became apparent that these presentations should bring together three officers: the head of the Investigations Department, or an investigator representing him, the investigator who conducted the investigation, and the officer responsible for relations with the victims' families.

Hélène Bastianelli began recruiting a clinical psychologist to work with the BEA in the 2000s.



For commercial transport, the investigation into the Sharm el-Sheikh accident in January 2004, even more so than the Concorde accident, was a key moment in terms of providing information to the victims' families. This was the first time that a family association had real political clout.

It attempted to get involved in the investigation in several ways (lawyers tried to interfere in the investigation, the first family meeting was extremely tense, with a letter written to Gilles de Robien, then Minister of Transport, recommending that he not attend for his own safety, and even a relative of one of the victims tried to get hired by the BEA!). These were also the first exchanges with the families via email and the first forums that are still freely accessible.

A dedicated email address for the families was set up for the investigation. The cell dedicated to relations with the families monitored the forums, which were not yet locked, and Facebook for any actions by families or pilot unions. These direct and indirect relations with the families would be of great help to the BEA.

Media frenzy and the investigation timeline

The summer of 2001 was mainly devoted to continuing the investigation into the Concorde accident (25 July 2000), but on 11 September, many media outlets called the BEA to ask for its opinion on the events in New York, while videos of aeroplanes crashing into the towers in Manhattan were shown over and over again.

It is highly unlikely that,

prior to the Concorde investigation, many media outlets would have thought to seek the BEA's opinion. However, the BEA generally refuses to act as an expert or commentator: it only provides information on the investigations it conducts or, for those in which it participates, with the agreement of the foreign authority leading the investigation. *"This refusal had a direct consequence: the media sought out interviewees who were willing to comment, often the same ones, who then engaged in speculation that was all the more risky because they were not involved in the investigation and therefore did not have consolidated information,"* regrets Alain Guillardou. The BEA has always refused to engage in speculation, *"but as time went by, I saw a growing gap, and sometimes misunderstanding, between the media's need for rushed information 24/7 and the pace of the investigation, which seemed too slow from the outside. To the point that when certain reports were published, even those*



Rémi Jouty, BEA Director, interviewed 13 March 2016 at the end of the press conference for the publication of the final report on the accident to the Airbus A320-211 D-AIPX operated by Germanwings, on 24 March 2015, at Prads-Haute-Bléone (Alpes-de-Haute-Provence).



Perspective

Hélène Bastianelli:
The minister

"After the accident at Quiberon, I was asked to brief the Transport Minister, Jean Claude Gayssot before he flew from Le Bourget to the accident site. It so happened that I was seven months pregnant. He wasn't interested in the accident at all, only in the baby. He wanted me to come with him because it would look good on camera. We have a few memories like this one at the Communications Department, which are a little unusual..."



As soon as the media learns of the occurrence, cameras are set up in front of the BEA...



relating to major events, media interest would have almost completely died down if it hadn't been for the insistence of the victims' families and their associations.

We are in a better position today than we were at the time to see the amount of "fake news" we are inundated with. When it came to traditional media, if they made a mistake, they could always correct it later, without any consequences for them."

The BEA believes that it does not have the right to risk spreading errors by hastily releasing non validated information. However, validation often takes a long time. Television unashamedly shows supposed computer reconstructions of aircraft flight paths, which graphic designers skilfully make appear true to life. The BEA only shows them when a report is published, when everything is certain, but less interesting to the public, who have already moved on to other things.

"In the early 2000s, we had few means of communication at our disposal. The Internet was in its infancy, and mobile phones were for the exclusive use of the director and division and department heads. And we were still, in this regard as in others, too dependent on the DGAC. Even though it was not mandatory, I would submit our draft press releases to the DGAC's communications department for their opinion and so as not to take them by surprise. Unless they granted an exemption, only the director of the BEA was authorised to communicate about an ongoing investigation."

Sharm el-Sheikh accident

For the BEA, 2004 got off to a fast start with on 3 January, a disaster that remains etched in people's memories: the accident to the Flash Airlines flight 604 in Sharm el-Sheikh, Egypt. The death toll was very

Perspective

Hélène Bastianelli:
Telephone and site saturated

One of my difficult memories in the communications department dates back to the Concorde investigation. On 15 August 2000, Paul-Louis Arslanian and I were alone at the BEA preparing the recommendation to suspend Concorde operations, which was to be published the following day with the accompanying press release. The Concorde had not flown in France since the accident, but it was still in operation in the United Kingdom.

There was a perfect understanding between us and the British investigators from the AAIB and we knew that they would adopt the BEA's recommendation. Concorde's British operator, having been informed, saw fit to ground the aircraft immediately, as 15 August was not a public holiday in the UK. And then, all of a sudden, the whole world started calling us. When I hung up with one caller, I had 66 messages waiting.

I felt completely overwhelmed by events. Then, when the preliminary Concorde report was published, we had a website running on the technology of the time, a report of considerable size, which the entire international press was trying to download at the speed of the Internet at the time.

There were calls from the Quai d'Orsay because the Japanese couldn't download it and thought it was a deliberate move against Japan... As if I could do anything about it.

We had set up several mirror sites to handle the flood of instant requests.

It's not very pleasant to have outside influences like that when you're doing the best you can with the resources you have. But it was really exciting work, and the atmosphere was very good."

high: 148 people died, including 134 passengers, all of whom were French.

For the BEA's communications department, this marked the beginning of endless media coverage and difficult relations with some of the victims' families. Sharm el-Sheikh will remain in the BEA's history as a textbook case, incubator of various controversies: association of families with conflicting aims, intervention by politicians, creation of "blacklists in civil aviation", a divergence between the investigation analyses by the State of occurrence and the BEA, language issues in the final report, media frenzy and the distress of the victims' families who no longer knew who to trust...

This air disaster illustrates the intervention of politicians in the media coverage surrounding such an event. Their eagerness to offer support to the families is, of course, their prerogative. Unfortunately, as most of them have only a vague idea of how an international safety investigation

is conducted and what the exact purpose of such investigations is, there is a significant risk that they will make erroneous statements.

In the days following the Sharm el-Sheikh accident, the families of the victims were invited to travel to the coast of the Red Sea where the plane had crashed.

Before their departure, an information meeting was held in the VIP lounge at Orly Airport, where the director of the BEA, among others, explained to the families how the investigation was being organised in accordance with international recommendations.

In this case, Egypt, as the State of occurrence, was heading the investigation, with the NTSB participating as the State of manufacture of the aircraft. The BEA, representing France, did not participate by right, in accordance with the provisions of Annex 13. However, in addition to the fact that France was the State of the majority of the victims, a status that was poorly defined in international texts at the time, the BEA's



experience and technical expertise could be very useful.

The Sharm el-Sheikh accident also illustrates another phenomenon that the BEA regularly has to face, that of media hype.

This accident and the banning of the airline by the Swiss aviation authority, reinforced by a series of subsequent accidents, led to the creation of the famous “blacklists”, banning operators that did not comply with aircraft safety and maintenance rules from French territory.

Dominique Perben, Minister of Transport at the time, had spoken of a blue list—he wanted to highlight the best airlines. In the wake of the disasters, the blue lists were transformed into blacklists.

“Everyone had their own agenda,” observes Martine Del Bono. *“Everyone came up with a blacklist. Journalists drew one up, the DGAC drew one up, but they weren’t finalised until the EASA finally put a stop to it...”*

At that time, the BEA signed memoranda of understanding with French operators to report incidents. In the interests of transparency, the BEA published the list of incidents reported by airlines. But this desire to hide nothing quickly backfired on the BEA. *“Suddenly, journalists were using the incidents reported by operators to point the finger at specific French airlines!”* explains Martine Del Bono.

However, it was precisely the opposite conclusion that the BEA wanted to reach: *“So we had to explain that what scares the BEA are companies that don’t report incidents. The companies that say nothing are perhaps the most dangerous, not those that report incidents and take measures to remedy them. This called nearly everything into question, both the way we worked and the good faith of the airlines...”*

Language problem

The Egyptian report sparked controversy. The BEA and the American NTSB had shared their observations and differences of opinion during the consultation on the draft report, and these comments had been appended. Unfortunately for the families, the report consisted of three volumes in English, totalling nearly 1,500 pages, making it a completely unreadable document, especially in English! In addition to the amount of work that would have been involved in translating the Sharm el-Sheikh report for the families, and therefore the waiting time they would have found difficult to bear, the English text was not always of sufficient quality to produce a flawless translation.

Truth versus diplomacy

The BEA, like other investigation authorities, often finds itself between a rock and a hard place when dealing with families. The latter are always supported by the media, which may see them as a marketing opportunity. And they are often disappointed by the length of the investigation, or even its conclusions.

For example, in the case of the Mont Sainte-Odile accident on 20 January 1992, the trial did not take place until 14 years later!

Another example relates to Sharm el-Sheikh in an article that speaks volumes: *“Twelve years after the crash, on 18 January 2016, the French courts ruled that there would be no further legal proceedings. The judicial investigation produced 37 procedural reports. The court found that the pilots were “responsible for inappropriate manoeuvres and incorrect calculations” and that Flash Airlines, which has since gone bankrupt, had recruited a crew “whose expertise was highly questionable”.*



As both pilots had died, the court declared the investigation closed."

What can the families of victims feel when faced with such a judgement, other than cheated?

In this accident, one woman lost seven members of her family. In a television interview six months after the tragedy, she spoke calmly, saying: *"What I expect from the judicial authorities is for it to tell me who I can blame... All this hatred I have inside me, I would like to be able to direct it towards just one or two people, it would be easier for me."*

In short, most families want names, which is not the purpose of the safety investigation. This explains the dissatisfaction of most of these families with the publication of a report by the

Perspective

Alain Guillardou: An unfortunate remark

"Suddenly, during the presentation, the doors of the reception room opened and President Chirac entered. He warmly shook hands with the families present with his characteristic empathy before taking the floor. There were two brief moments in his speech that stuck with me. 'I promise you that you will know everything...'

This was obviously what the families wanted to hear, except that the investigation was not in France's hands. I am not saying this only because Egypt was leading the investigation, but because certain elements would never be known...

So, in my opinion, he was speaking on behalf of another country... Then President Chirac finished his sentence by adding '... and very quickly', which is always an unfortunate thing to say in the context of an investigation that, by its very nature, needs time to reach its conclusions. The two words 'very quickly' obviously had a particular resonance for the families of the victims, who sometimes bitterly reminded us of this presidential promise."



Memorial stone commemorating the accident to the Boeing 737 registered SU-ZCF operated by Flash Airlines on 3 January 2004 in Sharm el-Sheikh.

BEA (or a foreign investigation authority). And the media add fuel to the fire after this publication by repeating the families' question, *"When will we know the truth?"* as if the investigation authorities were hiding something.

The families of the victims want to understand the facts and know who is responsible. As the investigation progressed, the Egyptians distanced themselves from the BEA team, who were pointing out facts that did not correspond to the version that Egypt wanted to present to the world, to the point of dissociating themselves from the French investigators, whose assistance had nevertheless been preferred to that of the Americans.

The BEA stood firm: it had gathered evidence from various working groups showing that the accident was due to the pilot's spatial disorientation and that the aeroplane was not at fault.

Paul-Louis Arslanian courageously asserted that it was necessary to *"convince the Egyptians not to release the report they are planning to publish"*. He travelled to Egypt several times with his communications team and even met with the country's Minister of Transport, but to no avail. The challenge was to ensure that journalists

Perspective



Martine Del Bono :
Difficult meetings with the victims' families

"The accident to Flash Airlines flight 607 at Sharm el-Sheikh really came as a shock to everyone, both because of the circumstances and consequences of the accident and because politicians immediately got involved. A controversy even arose in France because a representative of the Swiss civil aviation authority stated within a week of the accident that this operator had been blacklisted in Switzerland – and was therefore banned from its territory – and that she did not understand why France had authorised it.

Following these statements, the National Assembly set up a fact-finding mission on passenger air transport safety. This mission, chaired by Odile Saugues, did not question the expertise and actions of the BEA in its conclusions.

Although the victims, apart from the crew, were almost all French, the investigation was the responsibility of the Egyptian authorities, as the accident had occurred in Egypt. A commission was set up for this purpose, which accepted the participation of the BEA.

The chairman of the Egyptian Investigation Commission, Shaker Kelada, a captain who was very close to the Minister of Civil Aviation, immediately understood that it was in his interest to invite the BEA to participate in the Sharm el-Sheikh investigation so that he would not have to investigate just with the NTSB. The contact with Shaker Kelada was good, and he was convinced of the importance of communication. Shaker Kelada had participated in the NTSB's investigation into the EgyptAir Boeing 767 accident shortly after it took off from New York. He had not forgiven the Americans for their surprise announcement that the co-pilot had committed suicide. When I met him, he told me, 'I have a counter-report, I wrote a counter-report...'

A first interministerial information meeting, with the participation of the BEA, was organised by the Ministry of Justice one month after the accident. The meeting went well, but the families were divided on the issue of the search for bodies: some wanted it to stop, others wanted it to continue.

A second information meeting for the families, held at the time of the publication of a preliminary report by the Commission, went badly. The families were invited to Le Bourget in the morning, for a meeting in a room in the Air and Space Museum, before being received in the afternoon at the Paris Courthouse by the judges conducting the judicial investigation.

Overall, the families, traumatised by the disaster, felt that the investigations were not progressing quickly enough and blamed the Egyptian and French authorities for this. The situation was made all the more complex by the fact that many people gravitated around the association, including lawyers and self-proclaimed experts, who did not hesitate to try to discredit the work of the investigators in order to promote their own theories.

All the BEA staff worked to organise this meeting, which was unprecedented in more ways than one. Discussions had even taken place with the Red Cross to ensure medical assistance was available. On the podium that day, the BEA director Paul-Louis Arslanian and the French accredited representative Gérard Legauffre presented the Egyptian preliminary report in the presence of Shaker Kelada, who understood French. The tension that had built up over the previous days gave way to disappointment and anger among the families, as the preliminary report contained nothing significant that they did not already know."

Following this particularly tumultuous meeting, the BEA questioned the advisability of holding another meeting when the final report was published, as it was first to be presented in Egypt to the press and the families. However, discussions with several families, who were genuinely seeking answers in their suffering, were reported to the director of the BEA, who decided to go ahead with the meeting. This new meeting was also organised by the BEA at the Air and Space Museum, again in the presence of Shaker Kelada. It went much better than the previous one and the discussions were useful to many.

The circumstances were different, however, with



several voices speaking on behalf of the families and new information provided by the final report of the Investigation Commission and the comments appended by the American and French investigation authorities.

Several lessons would be learned from this investigation by the French authorities. Firstly, the importance of appointing a national coordinator after a disaster, who would be the main point of contact for the families and responsible for facilitating their contacts with the various authorities likely to be involved. Secondly, at the BEA, the importance of maintaining constant contact with the families and associations to ensure a good flow of information in both directions.



Rémi Jouty giving a press conference

would take the BEA's statement into account following the presentation of the report by the Egyptian authorities and that the families would also be able to hear it.

"In March 2006, the Egyptian report was presented on a Saturday, and we planned to meet with the victims' families the following Monday at the Air Museum," recalls Martine Del Bono. In just five years, the investigation into the *Concorde* accident and three investigations into accidents on the African continent, in Tamanrasset, Cotonou and Sharm el-Sheikh, enabled the BEA to gain experience in providing information to the families of victims. This experience would prove useful in the summer of 2005.

2005, a terrible summer for the BEA

On 2 August 2005, Air France Flight 358, an Airbus A340 (F-GLZQ) from CDG, veered off the runway in very bad weather while landing in Toronto. Fortunately, there were only a few injuries despite the fire that broke out. The BEA immediately sent a team as the State of Registry, State of the Operator and State of Manufacture. Fearing that the BEA would be accused of collusion, the director of the BEA refused Air France's offer to fly the investigation team to Canada free of charge.

On 6 August, Tuninter Flight 1153 made an emergency landing off the coast of Sicily. Sixteen of the 39 occupants were fatally injured. The aircraft was an ATR-72. The BEA was the accredited representative as the State of Manufacture.

On 14 August, the Hélios Airways crash occurred near Athens. The recorders would be analysed by the BEA.

On 16 August, a team was sent to Martinique

Perspective

Alain Guillardou

Venezuela leads the investigation

"The black boxes would be sent to and analysed by the BEA, which, according to Annex 13, had no official role to play, but almost all communication was carried out in Martinique, which was why we were there. I quickly met François Baroin, sent by the Élysée palace. He was the only one who could say to the families, 'I understand you,' because he had lost his father in a plane crash.

As the State of occurrence, Venezuela complied with Annex 13. But the investigation it was conducting did not directly concern it: it was not the State of departure, destination, registration or manufacture, and there were no nationals on board. I believe that Venezuela declined the offer to delegate the investigation to the BEA.

President Chirac attended a memorial ceremony, as did President

Chávez. A flight took 300 family members and two people from the BEA to Maracaibo, Venezuela, for this memorial service. It was a round-trip within the day.

The victims' families were organising themselves into associations. One of them would visit the BEA many times to share their doubts and actions with us. With its experts, it drafted an interim report of more than 300 pages. It opened a website, enriched with songs written for the victims and information as it becomes available. The association did not trust the professionalism of the Venezuelan investigation and regretted its slowness: five years to complete the investigation, as I recall."

Accident to the MD-82 registered HK-4374X
operated by West Caribbean Airways,
on 16 August 2005 in Venezuela.



following the accident in Machiques, Venezuela. The McDonnell Douglas MD-82, operated by West Caribbean, coming from Panama bound for Fort-de-France, crashed in a marshy area, killing 160 people, including 152 passengers from Martinique. Emotions on the scene were running high, heightened by the announcement of the victims' names, one by one, at Lamentin Airport by a local authority.

Perspective

Alain Guillardou:

"For the various Rio-Paris reports, we always had translations done in English, German and Portuguese to satisfy the countries that had the most victims. I remember a comment from Brazil saying that this translation was in European Portuguese, not Brazilian Portuguese. For many families, we can never do enough. It is sometimes difficult to accept, given the efforts we make, but we have to deal with it. We do not know how we would react in their situation."



2009, two disasters in less than a month

The year 2009 remains particularly tragic in the collective memory, with two disasters occurring in less than a month.

On 1 June, Rio-Paris flight AF447 disappeared in the middle of the Atlantic Ocean, becoming one of the most high-profile accidents before the disappearance of flight MH370 in 2014.

The media frenzy in countries around the world meant that there was no respite. As we know, the sea searches took a long time, a time that the families could not bear. In this book, we have addressed many aspects of the BEA's work regarding this air disaster.

On 30 June, another tragedy unfolded off the coast of the Comoros. A Yemenia Airbus A310 crashed into the sea in the middle of the night, killing 152 people.

The media focused on this accident primarily because a survivor was rescued after more than nine hours in the Indian Ocean. The BEA went to the site to participate in the sea search while continuing the search for AF447 in the Atlantic Ocean. Media controversies surrounding the crashed plane—it was banned from flying in Europe and had only been used for the Sana'a-Moroni flight after a stopover—strained relations between the Comorian and Yemeni authorities and affected the provision of information to the victims' relatives. On the aeroplane, most of the passengers were Comorians living in France or

(Continued on page 172)

Perspective

Alain Guillardou:

When the politician “contaminates” communication

In 2007, another example illustrates the involvement of politicians in an investigation. An accident occurred on 19 July off the coast of Moorea (French Polynesia). A Twin Otter operated by Air Moorea crashed into the sea seconds after take-off, killing 20 people, including the pilot..

The occurrence immediately had a considerable impact locally, and the BEA sent a team, of which I was a member. In fact, a mission had been planned in Tahiti for several months to provide training to general aviation pilots, as well as commercial pilots, and our departure date was scheduled for the day after the accident, so we had our tickets in hand and were ready to leave immediately. As luck would have it, we ended up travelling on the same flight as Christian Estrosi, then Secretary of State for Overseas Territories. Of course, we weren't travelling in the same part of the aeroplane as him, but we made our presence known to a flight attendant so that we could talk to him. So we met him a little later in the middle of the aeroplane in the galley, and we told him about the difficulties that the search at sea would entail, how the BEA planned to handle the investigation and maintain close contact with the local authorities, etc. The Secretary of State was grateful to us. Knowing that journalists were waiting for him when he arrived, he even said to us, 'This way, I won't say anything stupid...'

A key point in relations with 'politicians' is that they are almost always called upon to speak and answer questions from journalists without having had the time or taken the trouble to be 'briefed' beforehand. One can imagine that their massive use of Twitter today has not helped matters!

For the families of the victims, over time, the legitimate demand 'We want to know what happened' has evolved into 'We want the truth.'



Perspective

Alain Guillardou:
"Cold war" with the NTSB

"To return to the subject of the 2001 terrorist attacks, this event did not concern us as the BEA, but it was soon to have a certain impact on our work.

On 12 November 2001, we learned that American Airlines flight 587 had crashed into a neighbourhood in Queens, New York, at 15:15 French time. The aeroplane had taken off from Kennedy Airport bound for Santo Domingo. All 251 passengers and 9 crew members were killed, with an additional 6 victims on the ground and numerous homes destroyed. The aircraft involved was an Airbus A-300-605, which meant that the BEA had to take part in the investigation as State of Manufacture. As the accident occurred in New York exactly two months after the World Trade Centre terrorist attacks, both the media and the authorities initially assumed was that it could be another attack.

It was 09:15 in the morning in New York, and the authorities immediately decided to close New York's bridges and tunnels, as well as the city's three airports, while helicopters and fighter jets circled overhead the city.

In the United States, the investigation of a civil aviation accident is entrusted to the NTSB, the American equivalent of the BEA.

Accident to the
Airbus A300
registered N14053
operated by
American Airlines on
12 November 2001
at New York.



However, in the event of a confirmed attack, the FBI takes charge. Before it could be established that the accident was indeed an accident, the BEA decided to put together a team of investigators and send them to the United States as quickly as possible. This was where the BEA ran into a major difficulty, as there were no longer any international flights to the United States. The idea was to go via Canada and hire vehicles to drive down to New York.

From what I remember, a sort of modus vivendi was found with Airbus and the United States. An aeroplane chartered by Airbus in Toulouse quickly landed at Le Bourget to pick up two investigators and the manufacturer's team of technical advisers. The aeroplane was exceptionally authorised to land at La Guardia Airport. The rest of the team would take the first departing scheduled flight once it had been confirmed that the accident was clearly an accident, and that air traffic could resume.

The next day, the director of the BEA sent me to New York with the investigation team to liaise on communication. We all left for CDG in a hurry, and it was in the departure lounge that the BEA driver came at the last minute to give each of us our envelope to pay for our accommodation and food on site.

There were several things that struck me about this event. It was the first major accident I'd had to deal with since joining the BEA, both in terms of my experience of being in the thick of it in the office (as we were about to publish the final report on Concorde in December 2001), and at the accident site and NTSB premises. It was also the first Airbus accident in the USA. We quickly understood the significance of the event for Airbus and the BEA, as the American investigation authority would do no favours for the European manufacturer, then in the midst of a trade war with the American aircraft manufacturer Boeing, and therefore to the French investigators and their technical advisers. Without wishing to speculate on the possible attitude of the American authorities during the investigation that was about to begin, I had in mind a case I had heard a lot about at the BEA, that of the accident to an ATR-72 at Roselawn on 31 October 1994. The investigation, it was said, had been



particularly tense and had resulted in a total disagreement between the NTSB and the BEA, to the point that the director of the BEA, when the NTSB published its final report, drew up a veritable counter-report which the NTSB was obliged to append to its report.

It was a “cold war” for a long time. I also learned that years later the NTSB reopened the investigation and came to the same conclusions as the BEA. In an informal discussion with an NTSB contact we knew well, I heard him say that the American investigation had been a disgrace for the NTSB. It was, I imagine, this experience and this dispute that made the director of the BEA, Paul-Louis Arslanian, decide to put together a “reinforced” team. If I remember rightly, ten or eleven of us travelled over, something I never saw again, no matter how serious the accident. I think eight (or nine) investigators went to New York and two to Washington D.C., where the NTSB laboratories are located and where the flight recorders were to be analysed.

The other reason for the large number of investigators sent to the United States is the way in which the NTSB organises its investigations, in particular the way it sets up its - often many - working groups. If you don't have a representative in each group, important elements of the investigation may be lacking later on. As I recall, the NTSB set up seven groups, which required the presence of just as many French investigators.

The other “major” aspect of the NTSB is its communication. The importance of the media in the United States has been well known for decades. An air accident in a city as important as New York was bound to attract journalists and their incessant questions. So, in the early stages, the NTSB agreed to hold three press briefings a day at the hotel where we were staying, which put pressure on the investigators to provide new information on a regular basis. It is true that the NTSB is a master in the art of this type of communication, as it is multimodal and therefore has to communicate almost every day following an accident involving a train, school bus, boat, etc. I had a lot to learn from this.

I was taken to the accident site. It looked as if part of the

neighbourhood had been bombed. There was nothing but rubble, from which investigators were collecting anything that might be useful to the investigation. I remember with emotion a teddy bear that had escaped from a torn suitcase, and my astonishment at a local resident who looked at us with indifference as he rocked in his rocking chair on the veranda of his house, still decorated for Halloween...

I was briefing the BEA on media reports about the accident when the director asked me to answer questions on the spot for a France 2 news programme.

As soon as it became clear that the strategic centre was going to move to Washington, several of us took a night bus to the capital. I will leave the technical aspects of this accident to the investigators concerned.

I have learned various lessons from this accident:

Two months after I joined the BEA, the director insisted on introducing me to the American NTSB in Washington and the Canadian TSB in Ottawa, as well as taking me on a visit to ICAO in Montreal. Mr Arslanian sent me on a mission to build relations accompanied by H       Bastianelli, whose position I was soon to take. This made my job much easier when I had to talk to the American communications officers after the accident in New York. We were ‘on familiar ground’. International relations outside of accidents were therefore key, if not to success, then at least to facilitating the smooth running of an investigation. This would become apparent in the years that followed.

Communication about an accident can vary greatly depending on the countries you are working with, in terms of immediacy and frequency. The USA over-mediatized everything. France was clearly lagging behind. I would like to emphasise that I am referring to the early 2000s.”



French nationals of Comorian origin. "I attended several meetings of the Ministry of Foreign Affairs' crisis cell on this subject," explained Alain Guillardou.

"It was very interesting and revealing. To understand the reaction of the families of the Yemenia passengers, several things must be kept in mind. In the case of the Rio-Paris, France was the State of Manufacture and the State of Registry, and was responsible for leading the investigation into an accident that occurred in international waters. As such, the BEA was entitled to communicate on the progress of the investigation. However, in

the case of the accident in the Comoros, the BEA were subordinate to the Comorian authorities for communication. This was a source of enormous frustration for the victims' relatives."

The BEA was participating in the investigation as State of Manufacture and, despite the nationality or status of the victims, could only communicate after the Comorian head of the investigation had himself communicated, which was not without reluctance on the part of the Yemeni authorities.

"I remember the victims' families saying that the BEA was doing everything for the Rio-Paris because it was Air France and the passengers

Perspective

Alain Guillardou:

Concorde: the resentment of British investigators towards the judicial authorities

"My division had a French/English translator who was British and bilingual. His daily presence was invaluable. He enabled us to publish press releases in English at the same time as in French. Later, when it came to awarding contracts, both for translations into English and into other languages, he was in charge of searching for translators, validating bids and carrying out transactions."

About the Concorde investigation:

"I wasn't involved in the investigation at the outset, but I heard a lot about it. When a final report is ready, ICAO Annex 13 requires the authority responsible for the investigation to send it to the countries that participated in the investigation for their comments. These countries have 60 days to respond. Depending on the value of the comments, they are either taken into account in the report, which is then adjusted accordingly, or appended to the report at the request of those who submitted them."

In the case of Concorde, the British AAIB had no specific comments on the investigation, proof that the work had been carried out in a spirit of mutual understanding. Nevertheless, the British accredited representative was keen to express his resentment towards the French judicial authorities, which "did not allow the AAIB Investigators full access to all relevant evidence as soon as possible", insisting that "The French judicial authorities specifically

prohibited Advisors to the UK Accredited Representative from participating in the examination of major components for which the United Kingdom had primary airworthiness responsibility." Lastly, he pointed out that "these obstructions to United Kingdom participation were in contravention with the State of

Occurrence's obligations under the Chicago Convention (Annex 13)."

These comments were appended to the final report. I am raising this issue because I found that the judicial authorities which conduct their own investigation in parallel, were not always very supportive of our relations with the families of the victims, particularly due to their slowness in reaching their conclusions or their disclosure of information that the BEA was withholding out of respect for the victims, particularly the pilots, such as the publication of complete CVR transcripts. For its part, the BEA only transcribed the recorded exchanges that were relevant to the investigation."

I don't have any particular memories of the publication of the final report on the Concorde investigation. The discussions in the media at the time focused more on the commercial future of the aircraft type than on differences of opinion about the conclusions of the investigation..."



Perspective

Martine Del Bono:

The presentation of the report on the Sharm el-Sheikh disaster, a difficult communication experience

Two public presentations of the final Egyptian report on the Sharm el-Sheikh disaster were organised, first in Cairo, of course, and then, for the families, in France at the Air and Space Museum. At the Egyptian Ministry of Civil Aviation, which is right next to Cairo airport, the investigation commission chaired by Commander Shaker Kelada was present, along with the families of the Egyptian crew, the US ambassador to Cairo, and the main association of French families of victims whose president was extremely hostile towards the BEA. There were chief news reporters from TF1 and France 2, as well as correspondents from all the major media outlets in Cairo, including *Libération*, *Le Figaro* and *Le Point*, and there were radio stations such as RTL, etc. The Egyptians had provided a French-Arabic translator and an English-Arabic translator. Shaker Kelada began, offering his condolences and then giving a detailed presentation of his report and conclusions.

Paul-Louis Arslanian had previously asked if he could say a few words after this presentation, and this was, of course, granted. The director thanked the Egyptians and emphasised the quality of the cooperation with the investigation commission, and then briefly presented the differences in our analysis with that of the commission's, since it had not taken on board our main comments, nor those of the Americans, which were similar, merely including them in the report. At this point, the first intense moment occurred when a chief news reporter from TF1, a Lebanese who spoke Arabic, stood up and said, 'The translator is not translating what Mr Arslanian is saying.' There was great commotion in the room. Mr Arslanian had an extraordinary reflex and said, 'No problem, I'll speak in English if it's easier for the translator.' He then continued in English, "We agree on the facts, but we don't explain them in the same way. For us, there was no aircraft failure. Nor is it a question of questioning the captain's competence. Everything shows that he was the victim of severe spatial disorientation, which is a rare phenomenon but that does unfortunately exist and one that all pilots must be warned about." At this point, the captain's family stood up and started shouting in Arabic. I was standing next to the TF1 reporter, who translated for me, 'Shut him up, shut him up, he's saying horrible things about my son, my husband... Shut him up.'

Shaker Kelada tried to interrupt Mr Arslanian, but he concluded

his short speech without being intimidated.

Camera flashes were going off everywhere, and cameras were pointing in all directions.

This commotion lasted a few minutes, then Mr Arslanian stepped down from the podium. All the microphones were on him, and I heard him say, 'No, not now, go and see Mrs Del Bono.' I looked at him and said, "There is only one thing left to do: we have to leave, we can't afford to discuss this here." So we left and I arranged meetings at the hotel. That evening, Mr Arslanian was able to answer questions, the idea being that his explanations could be presented at the same time as the coverage of the publication of the report. It was extremely important that our point of view be heard.

The backlash came from the Egyptian ministry, which informed us that the chairman of the investigation commission would not be attending the families' meeting in Paris. It was already very late. On Sunday, Mr Arslanian and I had another difficult moment, but we finally managed to persuade Shaker Kelada to honour his commitments and come to Paris to present his report in France as well. We were unable to talk to him much during the trip and did not see him on Monday morning before his arrival at Le Bourget at the end of the morning. Our relations remained cordial but rather formal. We were able to hold the family briefing... how shall I put it... normally. Shaker Kelada was very good. There were also disagreements among the families, and everyone was able to express themselves.

Despite the tense international context and difficult relations with some families, the investigation into the Sharm el-Sheikh accident remains a key episode for the BEA in terms of communication and the development of a communication strategy with families, prior to the arrival of European regulations on the subject. The team's cohesion and mutual trust proved to be worthwhile. Paul-Louis Arslanian demonstrated the value of his vision for the BEA's mission, remaining faithful to it and, without compromising it in any way, integrating the need to structure relations with the media and to systematically take into account the delicate issue of families"



were wealthy (or something similar), while it was doing almost nothing for the victims of the Yemenia Airbus. This was an understandable feeling, as the communication surrounding the Yemenia accident was somewhat concise, but it was obviously not intentional on our part." This further demonstrates that keeping victims' families informed is a particularly difficult task.

2009 was also marked by an event, this time in-house: in early October, Paul-Louis Arslanian, who had been the director for two decades, was forced to retire after reaching the age limit in the middle of the two investigations, leaving his successor, Jean-Paul Troadec, with the difficult task of immersing himself in these highly publicized investigations and making himself known to BEA staff.

However, at the request of the Minister of Transport, Paul-Louis Arslanian stayed on several months to provide support to the new director, particularly for these two major investigations.

A few weeks beforehand, a meeting was held at the BEA for all diplomatic representatives from the countries with victims. The consuls designated to transmit information to the families were thus able to have the safety investigation and the initial validated elements explained to them.

The BEA's Communication department would innovate for the presentation of the final report in 2012, three years after the accident, but one year after the discovery of the wreckage and the recovery of the flight recorders. Given the large number of nationalities on board the aircraft, the meeting would be held remotely: the presentation was filmed and broadcast live via a channel protected by user names and passwords previously provided to the victims' families.

A modernized website

The two terms of office held by Rémi Jouty, who succeeded Jean-Paul Troadec in 2014, were marked by several major disasters that the BEA investigated or in which it participated, including the accident in Mali of a Swiftair flight chartered by Air Algérie, the suicide of a co-pilot on a Germanwings flight, and the disappearance at sea of an Egyptair flight. During these investigations, informing the victims' families remained a constant priority.

Following the departure of Martine Del Bono in 2017, Sébastien Barthe, as head of the Communication department, continued to modernize its various missions. Three major redesigns of the website would be launched between 2018 and 2023 to better meet the expectations of the BEA's stakeholders. These changes have made it easier to search for investigation reports with the development of more than a dozen new filters as well as enabling direct access to the safety recommendations issued by the BEA and to follow their processing. Institutional pages more in line with the BEA's mission and activities were also developed.

In terms of the accessible content on the site, two important decisions were taken. Firstly, the website was to include a page for each event in which the BEA is involved as an accredited representative, in order to make visible the ever-increasing workload that these investigations place on the investigators.

The site was to become fully bilingual French/English. Nicola Gawthorpe was recruited to carry out this mission, assisted by subcontractors for the less "strategic" documents.

Social networks

In addition to the ongoing modernization of





Direct and public access to investigation reports is possible on the website <https://bea.aero>.



its website, the BEA strengthened its other communication channels. YouTube, hitherto used mainly to make recordings of press conferences available to the public, was to become a dedicated communication channel, with information videos being put on-line to support certain key investigation reports. The idea was to make the sometimes highly technical content of BEA publications more accessible, and to encourage Internet users to read the report referred to in the video.

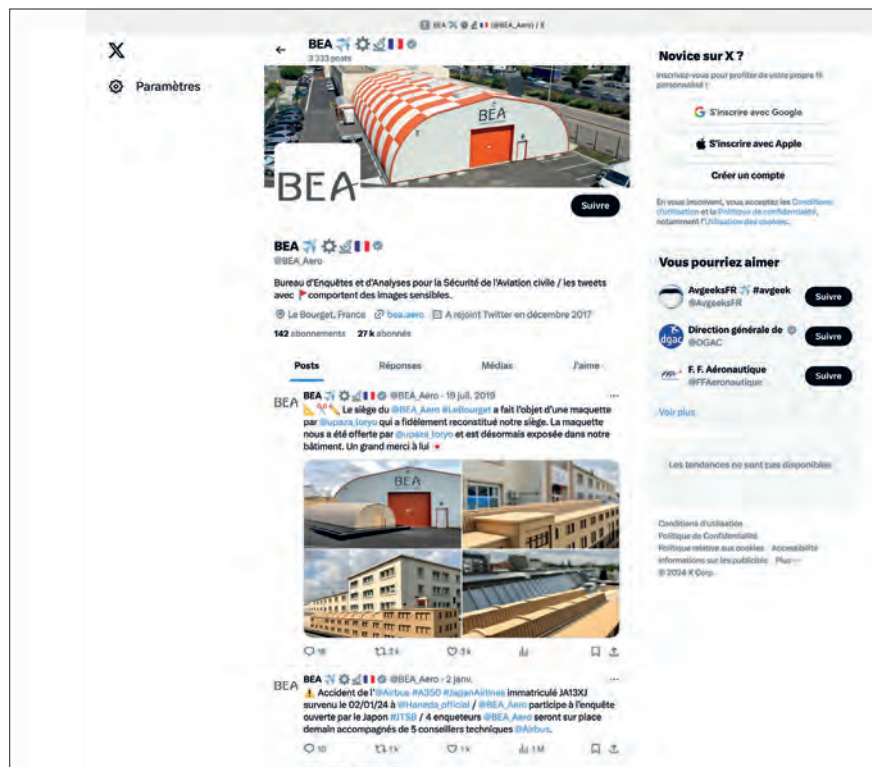
After several years of hesitation, the BEA now also communicates using social networks. Quite apart from the debate about the advantages and disadvantages of these networks, we can't help but note that the state and aeronautical ecosystems are present, and that priority is given to these channels in any so-called crisis communication. To be absent from them is to run both the risk of leaving the floor to other parties eager to occupy the space to defend their points of view, as well as the risk of losing essential contact with the aviation community.

The BEA would open its Twitter account (now X) in December 2017 and would use it actively from February 2018.

Information about the opening of an investigation, sending of a "go-team" and any BEA publications is now given first on X before any other channel. In 2024, the BEA also opened accounts on BlueSky, Threads & Mastodon, all featuring the same content.

The Communication department also runs a number of in-house training courses to make investigators aware of the communication stakes, particularly on site. The advent of 24-hour news channels and social networks requires a prior understanding of the risks, and a good knowledge of what information an investigator can or cannot share with the media.

But as Sébastien Barthe reminds us, *"While these actions to modernize our communication channels are essential in a world that is changing ever more rapidly on these subjects, they must be complemented by monitoring the way in which society reacts and talks about an aeronautical event."*

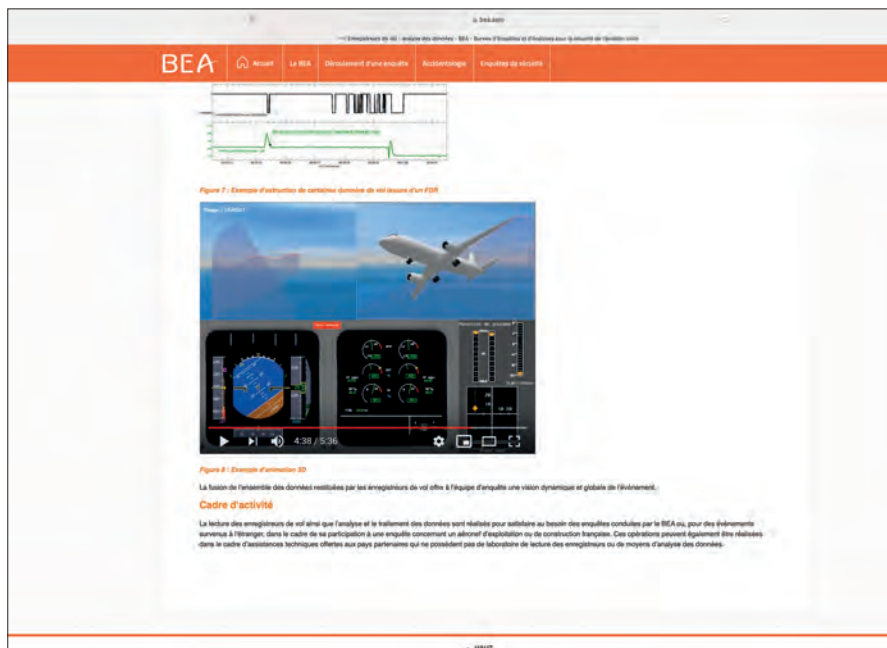


The BEA's daily activities and news can be viewed on the X app (formerly Twitter).

For example, the BEA's communication policy - to speak only of validated facts - is regularly undermined by the almost real-time availability of flight data, or by the publication of photos or videos by passengers or witnesses. For example, for the accident involving the Airbus A380 registered F-HPJE operated by Air France on 30 September 2017 while cruising over Greenland, the crew's conversations with air traffic control, videos of the damaged engine in flight or the emergency landing were available just a few minutes after the event, forcing the BEA to react even though it had not yet been officially informed of the event.

Sébastien Barthe adds that he is often asked the question, mainly by stakeholders potentially put in a difficult situation by an investigation, "why

does the BEA communicate?" His reply to this is that "as an independent investigation authority, communication is our main tool for publicizing our reports, safety recommendations and studies. And while the communication is primarily aimed at the institutional and industrial parties concerned, we must not overlook the societal impact which, in some investigations, may have a direct influence on the reactivity of a recipient of a safety recommendation, for example."



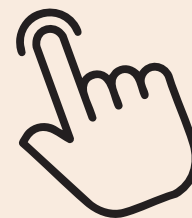
1998. Collision between the Proteus Airlines BEECH 1900D F-GSJM and the Cessna 177 F-GAJE over Quiberon bay (Morbihan)

On 30 July 1998, the twin-engine passenger transport aeroplane flying between Lyon and Lorient collided with a single-engine tourist aeroplane in Quiberon Bay. A passenger had expressed a desire to see the *Norway* (formerly the *France*), which was in the bay at the time, so the commercial flight crew obtained permission from Lorient air traffic control to deviate from its route in order to fly over the ship. The crew then cancelled their IFR flight plan and switched to visual flight rules. The Cessna pilot was in contact with Quiberon AFIS and had not activated his transponder. The two aircraft collided at almost a right angle, with the Beech 1900D at the end of its turn, still banking slightly to the left, and the Cessna 177 in descent. Fifteen people died in the collision.

The investigation showed that the collision was due to the failure of both crews to visually detect the other aeroplane in uncontrolled airspace, where collision avoidance relies exclusively on pilots monitoring the outside environment (the 'See and Avoid' rule), and to the improvised and unusual flight situation for a commercial transport aircraft. Among the contributing factors was the transponder being turned off which prevented the Lorient controller from seeing the Cessna on his radar screen.

Ten recommendations were issued by the BEA covering the following points:

- restrict access to the cockpit to technical personnel from airlines and official services;
- prohibit changes to an IFR flight plan during flight;
- protect published IFR flight paths;
- equip all aircraft carrying out passenger commercial air transport flights with TCAS,
- remind general aviation pilots of transponder use procedures and ensure that control units do not request that a transponder stops emitting unless it is for safety reasons.



The website <https://bea.aero> places emphasis on prevention and safety on its home page.



Chapter 9

The BEA and international cooperation



Cooperation agreements, international presentations and participation in working groups enable the BEA to take its place within the global aviation safety ecosystem.



Inevitably international investigations

By its very nature, a safety investigation is inevitably international. The organisation of the investigation, as defined by ICAO, requires the country responsible for the investigation to invite the main stakeholders to participate.

For example, if a Boeing has an accident on French territory, it is obviously the BEA that will investigate, but technical advisers from Boeing and the NTSB, the BEA's American counterpart, will be invited. The same principle will be applied for each aeroplane part or component that might be implicated in the event scenario. Thus, the engine manufacturer, the manufacturer of an electronic component or a cabin element could also be invited to participate.

Commercial transport aeroplanes are also the result of international design. For example, 50% of an Airbus A350 is produced by suppliers outside the manufacturer, and this figure rises to 70% for a Boeing 787. These suppliers can come from all over the world, depending on the manufacturer's calls for tenders or the choices made by the customer when it placed the order. The same type of aeroplane may, for example, fly with American or British engines.

The international dimension of an investigation is therefore based both on the application of applicable regulations and on the globalisation of the aviation industry.

It is therefore essential for the BEA, as an investigation authority, to have made contact with as many stakeholders as possible in order to ensure effective and proactive collaboration in the event of a major occurrence.

International relations are therefore both a challenge and a necessity, and the BEA has almost always dedicated specific personnel within its organisation to this area.

The most obvious collaboration to put in place and cultivate concerns its main counterparts within the major aeronautical nations such as the United States and the United Kingdom and within major economic alliances such as the European Union. The same principle applies to the industrial world. It is essential for the BEA to be familiar with Airbus, Boeing, ATR, Air France and Safran, to name but a few. Having Flight Safety, Technical or Communication contacts is a major asset in the event of a crisis, as it will be more effective to activate there pre-established contacts.

Collaborating with institutions

The BEA regularly works with European and international authorities and associations to advance common issues aimed at improving civil aviation safety, such as following up on safety recommendations issued by the BEA or its international counterparts:

ICAO,
ECAC/ACC,
ENCASIA



Collaboration between investigation authorities

Each ICAO member country has its own safety investigation authority. The BEA may be called upon to work with its counterparts, either by inviting them to participate in a BEA investigation as accredited representatives of the country that designed or built an aircraft, or conversely by being invited to participate in a foreign investigation. Collaboration therefore takes place on an almost daily basis, depending on the various safety investigations.

Beyond the strict framework of investigations, investigators from the various "BEAs" also share their experiences and recommendations within international structures such as ISASI (worldwide) or regional structures such as ESASI (Europe) or MENASASI (Middle East) in order to pool their investigation processes and share advances serving aviation safety.

While the investigation framework defined by ICAO remains the main vehicle for collaboration between investigation authorities, technical assistance is also available. In some cases, for technical (capability or competence) or geopolitical reasons, the BEA may be asked to provide technical assistance on a specific aspect of an investigation or have it delegated to it completely, either officially or unofficially.

One example of technical assistance is the safety investigation into the accident involving the Boeing 737Max registered ET-AVJ operated by Ethiopian Airlines on 10 March 2019 in Ethiopia. The Ethiopian authorities entrusted the BEA with the task of repairing the flight recorders and downloading and analysing the data.

Perspective

Alain Guillardou:

Long-term investment in international relations

In 2001, when Alain Guillardou joined the BEA, the director asked him to develop international relations. The late 1990s and early 2000s saw a significant increase in sales of French aviation-related products. Airbus, ATR and Eurocopter recorded significant sales abroad. This meant that in the future, the BEA would be more involved in investigations around the world. The main new buyers were in Asia, where the number of air operators was growing rapidly. However, while there was no question of focusing all of the BEA's attention on the Far East, its director wanted to develop communication efforts with certain countries due to socio-cultural differences that could hinder the smooth running of an investigation.

In the early days, Alain Guillardou, who took over as head of the Communications department, was "coached" by Nicolas Rallo, a multilingual BEA investigator who was fluent in English, Italian, Spanish and Portuguese and had extensive experience working abroad. Alain Guillardou considers that he was a first-rate trainer, explaining that, *"He set me an example. Our first trips, which were not related to any investigation, were to Brazil, India, China, Hong Kong and Macao..."*

The purpose of these visits was to provide information about the BEA, underline the importance of having an independent investigation authority and provide examples of investigations carried out, both from a technical and relational point of view. The BEA also set



itself the task of trying to understand how these countries operate in terms of safety investigations. The second part of these missions was to sign a Memorandum of Understanding, an agreement on information exchanges and possible mutual assistance between our countries.

China was approached in the summer of 2002: *"The first mission was to forge links on the ground, particularly in Beijing. We were quickly able to arrange a visit by a Chinese delegation to the BEA that same summer, and to send several investigators to China shortly afterwards to familiarise themselves with the complex Chinese system. We received unfailing support from Airbus' permanent representatives in Beijing, who had a large number of contacts there,"* recalls Alain Guillardou. China, then in the midst of rapid growth in the aerospace industry, was considering creating its own model.

"I remember hearing that China was buying an Airbus every two days, and the same for Boeing."

The director of the BEA was invited to Beijing to meet with the civil aviation director general and the minister of transport. Although the titles are the same as ours, they do not cover the same responsibilities. The Chinese were very keen to engage in exchanges and training for their investigators. Over time, this collaboration has never faltered. Many of these relations have become friendly, which has obviously made dialogue even Boeing."

In addition, the BEA conducted a week-long training course in Beijing and another session in Kunming, in the south of the country, for regional investigators.

I was also in regular contact with ICAO

representatives for the COSCAP (Cooperative Development of Operational Safety and Continuing Airworthiness Programme)¹. The two main COSCAPs in this part of the world are: COSCAP NA, based in Beijing, which includes China, Mongolia, North Korea and South Korea, and COSCAP SEA, based in Bangkok, which includes Brunei Darussalam, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Papua New Guinea, the Philippines, Singapore, Thailand, East Timor and Vietnam."

A steering committee was organised each year in a different country to review international relations and any issues that needed to be resolved. The main manufacturers were involved, as well as the representative of the DGAC. This meeting was an excellent opportunity for the BEA to meet with important representatives from these various countries without having to send members there in person.

Each year, there was also a conference of director generals from Asia-Pacific countries (APAC/ICAO). This was another great opportunity for the BEA to meet civil aviation management from many countries.

When this conference was held in Nouméa, Patrick Gandil, then the civil aviation director general, was in charge.

"Over time, I took the initiative, supported by the director of the BEA, to propose joint presentations with one or more countries. This was the case with China, Japan, Singapore, and also with Hong Kong China.

Preparing these presentations also helped to

1. Cooperative Development of Operational Safety and Continuing Airworthiness Programme:



strengthen our bilateral relations,", explains Alain Guillardou.

These initiatives were all the more well received because the BEA and the DGAC's international relations team worked together in a remarkable spirit of cooperation, under the leadership of Élisabeth Dallo. Emanuela Gellini and the Africa manager also supported the BEA's actions in this area. The only weak link in this network of relations was the Americas, where the same results were not achieved, *"as if nothing ever happened there..."* laments Alain Guillardou.

At his request, the director of the Australian investigation authority was received at the BEA. He wanted the BEA to become a member of the ITSA (International Transportation Safety Association), whose members were normally multimodal services. In this case, it was the BEA's experience that earned it this invitation. The BEA thus participated in these meetings, which were attended by the ATSB, the NTSB (United States), the TSB (Canada), the JTSB (Japan), the ARAIB (South Korea), the ASC (Taiwan), the TAIC (New Zealand), two AAIBs (India and the United Kingdom), the NSIAN (Norway), the DSB (Netherlands) ... and the TSIB (Singapore) as an observer.

Of course, the Far East was not the BEA's only focus. At the request of foreign countries, relation-building and training missions were conducted, most often with teams of three people, for example in Mexico, Chile, South Africa, North Africa and India.

"For reasons of its own, Japan did not participate

in the COSCAP-NA, which made it difficult to access unless there was a direct meeting. Japan was not yet an Airbus buyer. It took a long time to sell them to Japan, as far as I can remember. But of course, it is not only Japanese operators that serve the archipelago. Air France, among others, has two flagship destinations there: Osaka and the two airports in Tokyo. The Japanese archipelago is also the mandatory stopover between mainland France and New Caledonia and even Tahiti, two destinations favoured by Japanese honeymooners, but also and above all by French tourists from mainland France, some of whom do not speak English," Alain Guillardou also points out.

"The fear of an accident in the deep waters of the Pacific between Japan and one of France's overseas territories hung over the director of the BEA. It therefore made sense to get to know our Japanese colleagues.

Several missions were then organised from 2002 onwards to build relationships, which was not easy at first, particularly given the poor level of English of most of the Japanese people we met. Sometimes an interpreter was present to ensure that we understood each other properly. In 2005, several days of meetings in Tokyo with the director of the BEA marked the culmination of these contacts. The team was able to meet face-to-face with representatives from Aircalin, Air France and Air Tahiti Nui, and organise a crisis management day at the JTSB premises, during which each participant was able to share its situation and concerns.

Our Japanese colleagues also invited Japan



Airlines and All Nippon Airways to this event. From then on, relations with Japan have been regular and friendly...”

Relations with Singapore were easier to establish. The director of the local investigation authority had studied in Paris and spoke perfect French. He established close ties with the BEA and strengthened relations with a view to developing the department he headed, which was under the Ministry of Transport. The TSIB (Transport Safety Investigation Bureau) was growing in size and expertise.

The city-state is small geographically, but extremely dynamic in the aviation sector, a real hub, particularly for flights to Australia. In order to perfect their knowledge, Singaporean investigators were regularly sent to various parts of the world whenever an accident occurred to learn from how investigations were handled. They did this with the BEA, of course, and ended up developing a real laboratory and, above all, training themselves in underwater searches by participating, among other things, in sea search exercises organised by the BEA in the Mediterranean.

The Singaporeans have accumulated sufficient knowledge to assist neighbouring countries, such as Indonesia, which has had to deal with several accidents requiring underwater searches. This is a source of pride for the BEA in terms of its relations with Singapore and its regional success.

At the same time, the BEA participated in international meetings such as ISASI (International Society of Air Safety Investigators)

and the Flight Safety Foundation. Not to mention the large number of foreign delegations that visited it.

Perspective

Alain Guillardou: Cultivating relations

“My missions abroad included a meeting with the French embassy to inform them of the circumstances under which the BEA might be called upon to participate in an investigation opened by the country. I had also designed a leaflet summarising all this, which I left behind. Depending on the importance of the country, I was received by the consul, the communications officer or the ambassador himself.

I would also try to meet with the local station manager of Air France and other major airlines serving France. Due to the turnover among investigators in certain countries, but especially among directors of investigation services and ministers, it was necessary to work tirelessly to maintain good relations. This was the ‘policy’ of the director of the BEA at the time.

When Jean-Paul Troadec succeeded Paul-Louis Arslanian, he wrote a message at my request to our foreign colleagues to inform them of his desire to continue along the path laid out by Mr Arslanian. He also made China a priority, and we visited twice to further strengthen our relations...”





28 July 2022.
Signature of a memorandum of understanding between the BEA director Rémi Jouty, and Mr Charles Bagabo, Director of the Rwandan AAID.



11 April 2024.
Partnership meeting between the BEA represented by Pierre-Yves Huerre (Director) on right with Philippe Plantin de Hugues (International Affairs) on left and EUROCAE represented by Mrs Anna von Groote (Director General).





9 April 2019.
Visit to the BEA by Mrs Fang Liu, ICAO Secretary General.
From left to right, Mr Philippe Bertoux (Permanent Representative of France to the ICAO Council), Mr Rémi Jouty (Director of the BEA), Mrs Fang Liu, Mrs Silvia Gehrler (Director of EUR/NAT), Mr Patrick Gandil (Civil Aviation Director General), Mr Bertrand De Lacombe (Europe/International Deputy Director to the DGAC).

14 May 2019.
Signing of a cooperation agreement between Rémi Jouty, Director of the BEA and Mr Akin Olateru, Director of the Nigerian AIB



5 September 2019.
Remote signature of a memorandum of understanding between Rémi Jouty, Director of the BEA and Mr Taketsugu Shinobe, Director of the JTSC.



Chapter 10

“*In Search of Flight AF447*”

Presentation by Galaxie Presse of the film by Simon Kessler and Fabrice Gardel



1 June 2009. Flight AF447, flying between Rio and Paris, suddenly vanished from radar screens. Somewhere in the middle of the Atlantic Ocean, the Air France Airbus A330 disappeared below the surface of the water with 228 people of 32 nationalities on board. Where was the plane? What had happened? Were there any survivors? From the outset, it was a complete mystery. The film, produced by Galaxie Presse in collaboration with the BEA's communications department, offers a unique insight into the early stages of this investigation: the underwater search for the aeroplane.

The search operations began immediately, involving huge air and sea resources. They would last nearly two years. Conducted under the responsibility of the BEA, this investigation, unique in the history of aviation, was filmed in its entirety, a world first for an investigation authority.

Based on previously unseen images and the accounts of those who took part, this documentary film, co-produced by the BEA, retraces for the first time, the five search campaigns undertaken to find the wreckage of the aeroplane, and above all its black boxes, the sole means of revealing the true causes of the accident.

Using footage shot by the BEA and ECPAD¹, accounts from investigators and spectacular 3D reconstructions, the film offers a rare glimpse behind the scenes of an investigation that took

place far from any land and under intense pressure. It takes us to the heart of the decisions made by the investigators, who for months were faced with a nagging question: how to find the wreckage of the AF447 in depths completely unknown to man, with a search area of more than 17,000 km², twice the size of Corsica?

We are able to follow each stage of their work, gain insight into their decision-making process and share with them the hopes, disappointments and successes that punctuated their search.

The film gives a voice to the investigators and experts, of course, but also to the relatives of the accident victims. Nearly ten years later, they revisit their memories of those twenty-four months of uncertainty, despair, and sometimes mistrust of the BEA's work.

Through their accounts, we enter, with discretion, into the intimacy of their daily lives.

How can an accident be accepted without

1. Établissement de communication et de production audiovisuelle de la Défense.



Emmanuel Delbarre,
Alain Bouillard,
Marc Lever and
Frédéric Walbrou,
BEA investigators.



The moment when
the flight recorders
were discovered.



Raising aeroplane debris, here one of the Pitot tubes

knowing what caused it? How can experts be trusted without understanding their work? How can a loved one be mourned without proof of their disappearance? Beyond the technical aspects, the film raises profoundly human questions.

This film took nearly two years of work by the teams at Galaxie Presse and the BEA to produce a comprehensive record of the investigation. It was decided to include this documentary in this book for two reasons.

The first is that the investigation into this accident is one of the longest and most complex in the history of the BEA and that its media coverage was unprecedented. Along with the investigation into the *Concorde* accident in 2000, it gave the BEA international recognition and largely contributed to throwing light on its values of perseverance and scrupulousness in uncovering the truth and establishing the facts, despite a very complex industrial, political and societal context.



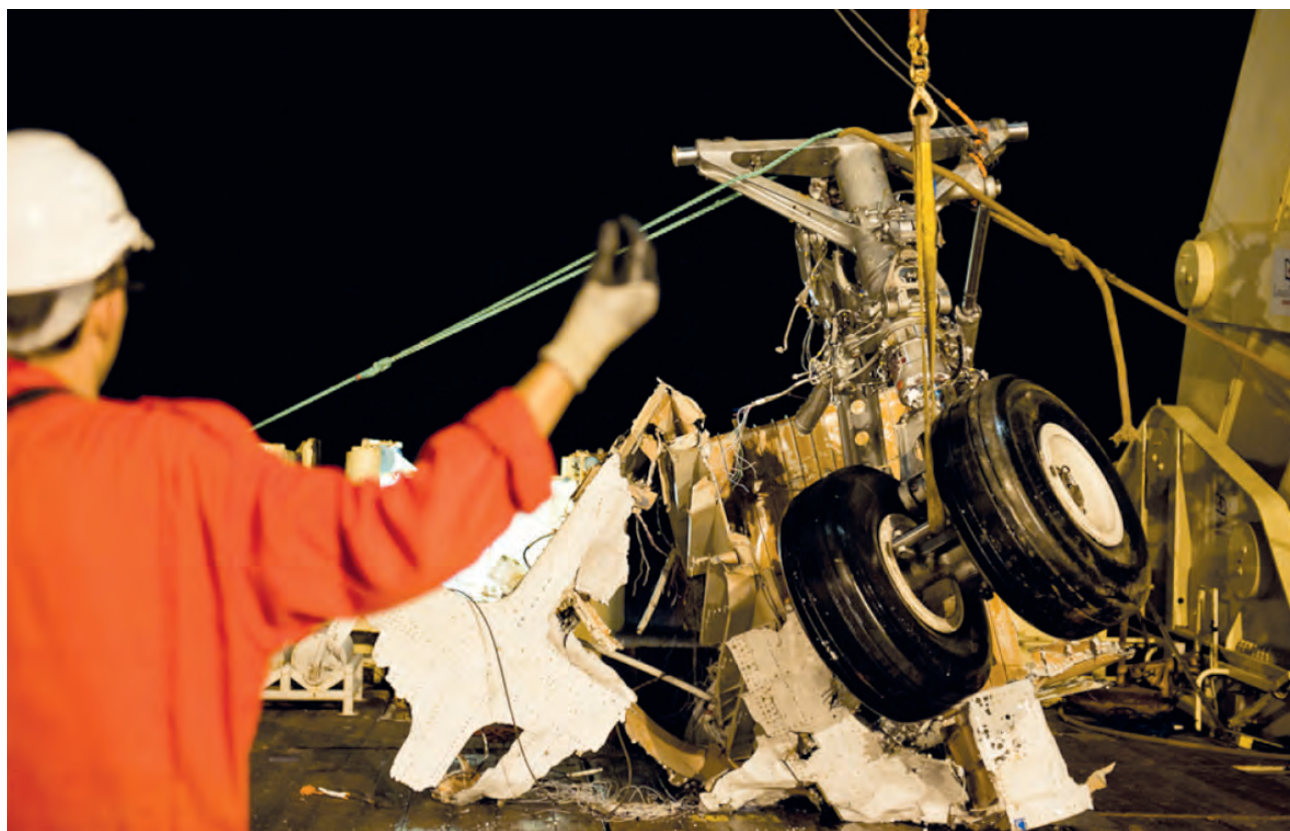
The second reason is that this film was intended to be as realistic and transparent as possible. The BEA is thus presented objectively. Both mistakes and successes are discussed, and the BEA is never presented as solely responsible for the latter. The film clearly illustrates that an investigation of this scale and complexity is the result of collective work, where coordination is at the heart of every decision.

The BEA would like to thank Galaxie Presse and its president Bernard Vaillot for allowing this film to be included in this publication.

Documentary

"In Search of Flight AF447"

For a limited time after the initial publication of the book, the reader can access the film by Simon Kessler and Fabrice Gardel, produced by Galaxie Presse, by scanning the QR code below with their smartphone.



Raising one of the landing gear



BEA_____



Postface



by Pierre-Yves Huerre,
Director since 2024

A few months after being appointed Director of the BEA, I have the honour of concluding this book on the history of the BEA, a task I undertake with great pride and humility.

I am convinced that every reader will have been struck, as I was, by the determination of each of my predecessors to build and then develop this institution, and I would like to pay tribute to them all.

Each of them, accompanied of course by their teams, worked to professionalise the BEA's activities and forge the national and international reputation it enjoys today in the 21st century.

In nearly 80 years, the BEA has become a benchmark within the global aviation ecosystem. Its reputation extends beyond the aviation world, and the BEA is known to the general public through its investigations into air disasters.

However, its work is not limited to commercial air transport, and the BEA's efforts have contributed to improving the safety of pilots year after year, whether they fly for a profession or for their own pleasure and the pleasure of their loved ones.

To date, nearly 7,000 investigation reports have been published, and this figure does not include our sometimes significant contributions to investigations conducted by our counterparts abroad. Like the changes, some would say upheavals,

that are reshaping our society, current and future technological developments in the aviation world require the BEA to continually develop its human skills and technical capabilities while maintaining those already acquired. Whether or not the aircraft of the future uses the same technology as those flying today, the BEA must be ready to conduct any investigation involving them.

But as essential as the technological watch and development are, nothing is or will be possible without the commitment and willingness of each and every one of our agents. The BEA's activity is by nature dynamic and unpredictable, with alternating periods of relative calm and periods of a very heavy workload. It therefore requires us to be always ready in order to be as responsive and effective as possible when an event occurs.

The history of the BEA is therefore also the history of its agents, past and present, and will be the history of all those who join it in the future. Their passion, their dedication, and their relentless pursuit of facts, sometimes in the face of societal, media, and industrial pressures, are the major strengths of this investigation authority.

I am therefore following in the footsteps of all the directors who preceded me in order to uphold the BEA's mission: to investigate, explain, and improve civil aviation safety.



Appendices

Perspective

A few considerations about aviation safety

by Claude Abraham, civil aviation director general from 1976 to 1982



"Back in the distant past (more than forty years ago), when I was head of the DGAC, I often used a slogan, or rather a quip: "Air travel will be dangerous for as long as you need a car to get to the airport". To reassure those who were afraid of flying, I explained to them that they were more likely to die in a car

accident on their way to the airport than during the flight they were about to take. I believed, perhaps wrongly, that this type of statement, whose scientific rigour was questionable to say the least, was more convincing than the classic one that compares the risks of accidents on a given journey according to the mode of transport.

To be valid, this quip should have specified the location, or at least the country of departure, the distance to be travelled by car, and even the type of road taken. In fact, in 1972, the worst year for road traffic accidents, there were 8,627 deaths in France involving private cars for 235 billion vehicle-kilometres, i.e. for a 30-kilometre journey to the airport (an arbitrary but not implausible figure), the risk of a fatal accident was $1.1/10^6$. For commercial aircraft with more than 20 seats, it could be assumed as a first approximation that the risk in France was the same as throughout the world, i.e. 6.5 fatal accidents per million flights. The quip was indeed just a quip. The risk of flying was six times higher than the risk of travelling by car to the airport. Since then, the safety level in air transport has increased considerably, as has that of road traffic, at least in France, although to a much lesser extent, especially off motorways. However, the risk of flying is still three times higher than the risk of a fatal accident when travelling by car to the airport.

When it comes to safety, we cannot afford to rely on quips. Another more traditional approach compares road and air travel, or rather all modes of transport. The figures show that air transport, at least in Europe, is the safest mode of travel, but it is not clear that they really influence users' choices: fear of flying is probably not swayed by statistics. When we talk about safety in aviation, we immediately think of passenger commercial air transport, an area in which accidents are rare but spectacular, making headlines in the newspapers and where the families of victims seek answers, want to understand and, in some cases, want to blame someone, because there is no accident without someone being responsible, and being responsible means being guilty.

But it would be wrong to forget other aviation activities. An EASA investigation clearly shows that investigation activities only marginally concern commercial aviation, at least in terms of the number of investigations, but probably not their volume.

An important question arises: how is the safety level evolving? But what do we mean by safety level? Is it represented by a number? Or a ratio? If it is a number, is it the number of accidents, in which case we need to define what we mean by that? Or are we talking about the number of accidents that have caused at least one death? Or the number of deaths and injuries? Do we only count paying passengers? Or all occupants of the aircraft? Or do we include ground personnel?

Which categories of aircraft are taken into account? For example: commercial flights with passengers? (Which are of particular interest to the public and the media). From what size?



If the level of safety is defined by a ratio or a rate, what do we put in the denominator once the numerator has been specified? For example, for passenger transport: number of flights? Number of flight hours? Total number of kilometres travelled? Number of passenger kilometres? More generally, given the evolution in the number of accidents or victims, we need to find a way to define the volume of the activity in question and how it has changed over time.

For passenger commercial air transport, almost all published analyses give the number of accidents or the number of victims to the number of flights, with two types of justification. Either by noting that less than 10% of accidents occur during the cruise phase. Or, as Boeing indicates in its 2021 safety report, in general, the term “accident rate” is a measure of the number of accidents per million departures, used because there is a stronger correlation between the number of accidents and the number of flights than between accidents and flight hours, or between accidents and the number of aircraft in service, or between accidents and passenger miles or freight miles. This rate can be calculated for all accidents; or for accidents resulting in at least one fatality; or for accidents resulting in the death of at least one passenger. Between 1977 and 2017, the latter rate, valid for the whole world, fell by an average of 9% per year. That's a considerable figure!

For general aviation, the United States published a rate, number of fatal accidents per 100,000 flight hours, which varies from 3.25 in 1960 to 1.04 in 2020, representing an average annual decrease of 2% per year.

Similarly, in its 2019 report, EASA published another rate for general aviation in Europe, the number of fatal accidents per million passenger-kilometres, which varied from 7.49 in 2015 to 5.41 in 2019, although it was not possible to draw any conclusions given the short period studied. EASA re-examined this estimation in 2020, using the number of flight

hours as the denominator, revealing a deterioration in the situation...

While it is certain for commercial air transport, and possible for general aviation, that safety levels have improved, no one knows whether this statement is true for helicopters or gliders, for which no figures characterising the volume of activity and its evolution over time seem to be available.

The often spectacular advances in safety, when known, are largely due to feedback from investigations by the relevant authorities. Their analyses and recommendations are studied in depth by all those who can take action on safety issues: manufacturers, engine manufacturers, equipment manufacturers, operators, pilots and regulators, who draw all the necessary conclusions. The technical advances made by the former are undoubtedly decisive, although it is impossible to know how much of this progress, which is undoubtedly significant, is due to the conclusions drawn from investigations.

It should also be noted that the analysis methods developed in the aviation sector have often inspired analyses and investigations relating to other modes of transport. In several countries, they are carried out by the same authority.

The history of the BEA is a remarkable illustration of the ongoing struggle to improve aviation safety, to which its analyses have made an exceptional contribution since its creation, with its expertise now recognised throughout the aviation world.



Biographies of former BEA directors from 1990 to 2023

Paul-Louis Arslanian



Paul-Louis Arslanian headed the BEA from 1990 to 2009.

An Officer of the Legion of Honour, he graduated from the *École Polytechnique* and the ENAC. He worked for seventeen years at the DGAC, first in a regional division and then, after a stint in the office of the Minister of Transport, in the directorate for civil aviation programmes.

In 1980, he also took charge of the international aspects of noise abatement policy for the DGAC, which familiarised him with international relations and the workings of the ICAO.

In October 1986, he joined the BEA, a small team attached to the General Inspectorate, first as deputy and then as head.

Under his leadership, the BEA grew, both in terms of personnel and investigation tools, and established a reputation for competence and neutrality in the exclusive service of aviation safety, becoming one of the most respected safety investigation authorities in the world.

Over a quarter of a century, Paul-Louis Arslanian took part, either directly or in a supervisory capacity, in several thousand investigations in France and abroad. From the Habsheim accident to the disappearance of Rio to Paris flight AF447, from the counter-report on the ATR accident in Roselawn to the report on the *Concorde*

accident, he has been involved in some of the most significant air disasters in history, all over the world.

As chairman of the ECAC's group of experts on accident investigations from 1991 to 2011, he was committed to developing European and international solidarity for better handling of air safety and continuous consideration of the suffering of victims and their families. He played an important role in the organisation of a structured network of investigation authorities in Europe and in the adoption, at ICAO and European level, of regulatory texts aimed at promoting the effective and independent conduct of investigations into aviation accidents and incidents.

In 2011, the Flight Safety Foundation presented him with the prestigious Aviation Safety Lifetime Achievement Award, which recognises individuals who have made a significant contribution to aviation safety. Other recipients include academic James Reason, a theorist on human error, and pilot James Sully, who landed an Airbus A320 on the Hudson River. The International Society of Aviation Safety Investigators (ISASI) also honoured him with the Jerome F. Lederer Award. To date, he remains the only French person to have received both awards.



Jean-Paul Troadec



Jean-Paul Troadec headed the BEA from 2009 to 2013. An Officer of the Legion of Honour, he graduated from the *École Polytechnique* and the ENAC.

He began his career in the certification office of the air transport directorate (DTA) before joining the directorate for civil aviation programmes (DPAC), first as head of the engines, equipment and research office and then, until 1985, as manager of the Airbus and CFM 56 engine programmes.

In 1985, he was appointed head of the aeronautical training materials department (SMFA), which later became the flight training school (SEFA). In 1993, he joined the DSNA, first as head of the air traffic control service (SCTA) and then as deputy director of the air navigation division (DNA). From 1998 to 2002, he was responsible for the DGAC's strategic plan, before being appointed head of the human resources department (SRH).

In 2005, at the request of the minister of transport, Jean-Paul Troadec left the DGAC to create the EPSF, the national railway safety authority, whose principles are based on proven methods used in civil aviation. Due to his extensive aeronautical experience, Jean-Paul Troadec was appointed director of the BEA in October 2009, at which time there were

two investigations in progress, started less than six months previously, into major air disasters: the accident to Rio to Paris flight AF447 and the accident to the Yemenia flight from Sanaa to Moroni.

Under his leadership, the BEA conducted several search phases for the wreckage of the Rio-Paris flight, the first challenge being to estimate the accident zone using calculations established by a group of academics, mathematicians, statisticians and marine current specialists.

When these initial campaigns failed, a new search campaign was launched based on a new estimation using statistical calculations. It was during this campaign that the wreckage of the aeroplane was discovered, lying at a depth of nearly 4,000 metres in an abyssal plain surrounded by high ground. The recovery of the flight recorders and parts of the wreckage, which was carried out quickly after the discovery, made it possible to understand the circumstances of the accident and to draw up the final accident report.

It was because of this experience that Jean-Paul Troadec was consulted by the Malaysian investigation authorities as part of the investigation into the disappearance of flight MH370, which has still not been found to this day.





Rémi Jouty

Rémi Jouty headed the BEA from 2014 to 2023. An Officer of the Legion of Honour, he graduated from the *École Polytechnique* and the *École Nationale de l'Aéronautique et de l'Espace*.

He began his career in aeronautical research, first at NASA and then at the French defence procurement agency (DGA).

In 1995, he joined the DGAC to lead the international certification teams with respect to new Airbus models (A330/A340, A380) and then supervised the transfer of this activity to EASA. He also provided technical support to the BEA's investigation into the *Concorde* accident and legal support to DGAC personnel under investigation, all of whom were acquitted.

He first joined the BEA from 2006 to 2008 as head of investigations. During this period, he formalised the investigation process by introducing the organisation and procedures manual for conducting investigations. He returned to the DGAC as deputy director of the DSAC, where he was involved in the quality process for risk assessment and management.

A little over a year after returning to the BEA as director, he was confronted with two major disasters: the Air Algérie accident in the Malian desert, where the BEA provided significant

support to the Malian authorities' investigation, and the suicide of the Germanwings co-pilot in the Alps. Both investigations would be carried out under tight deadlines and intense public pressure.

He also worked to ensure that the role and prerogatives of the BEA were taken into account in national crisis management plans and worked within ICAO working groups to develop international standards so that all safety investigations would result in the publication of a report.

He was elected in 2017, and re-elected in 2020, as president of the European Network of Civil Aviation Safety Investigation Authorities (ENCASIA). The main objective of this network, to which the European Commission is very attached, is the provision of assistance between European investigation authorities.

Under his chairmanship, a voluntary mutual assistance mechanism was tested in order to distribute the assistance effort by making the best use of the skills and capabilities available in Europe, foremost among which are those of the BEA.

Rémi Jouty was a glider pilot and has logged 1,000 flight hours on twin-engine aircraft, under instrument flight rules.



Regulatory texts

- Law dated 31 May 1924.
 - Law dated 27 November 1943.
 - Order dated 10 April 1947.
 - Circular dated 13 May 1947 from Director of National Security.
 - Annex 13 to the Chicago Convention.
 - Ministerial directive dated 4 November 1946 supplemented on 7 June 1951.
 - Ministerial directive dated 15 June 1951.
 - Decree dated 16 January 1952.
 - Interministerial directive dated 3 January 1953.
 - Directive No 200 from the Secretary of State for Transport dated 11 December 1953.
 - Directive No 300 from the Secretary of State for Transport dated 3 June 1957 which gives a broad concept of the BEA's powers.
 - Ministerial decree dated 20 June 1962 establishing the organisation and powers of the BEA, attached to the Civil Aviation General Inspectorate, under the authority of the President of the Safety and Air Navigation Section.
 - Ministerial decree of 1971 concerning the obligation to carry recorders.
- Council Directive 80/1266/EEC dated 16 December 1980 on future cooperation and mutual assistance between the Member States in the field of air accident investigations.
- Council Directive 94/56/EC dated 21 November 1994 establishing the fundamental principles governing the investigation of civil aviation accidents and incidents.
- Law No 99-443 dated 29 March 1999 on technical investigations into civil aviation accidents and incidents transposing the 1994 directive.
- Decree No 2001-1043 dated 8 November 2001 establishing the name and organisation of the BEA.
 - Regulation EU No 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation.
 - Order No 2012-872 of 12 July 2012 for the application of Regulation 996/2010 in overseas collectivities.
 - Regulation EU No 376/2014 of the European Parliament and of the Council of 3 April 2014 on the reporting, analysis and follow-up of occurrences in civil aviation.
 - Annex 19 to the Chicago Convention.
 - Decree No 2014-530 of 22 May 2014 setting out common rules for the BEA, BEA met and BEA TT.
 - Decree 2023-1008 dated 31 October 2023.



Glossary

AAIB: *Air Accidents Investigation Branch*, UK authority responsible for safety investigations into civil aviation accidents and incidents. The AAIB was created in 1915.

ACCREP: *Accredited representative* Under Annex 13 of the Chicago Convention, the State of Registry, the State of the Operator, the State of Design and the State of Manufacture participating in an investigation each have the right to appoint an accredited representative (with or without associated advisers) to participate in the investigation.

EASA: European Union Aviation Safety Agency. The EU certification and regulation authority, EASA was created in 2002.

ASRS: *Aviation Safety Reporting system* (see REC), voluntary and confidential reporting system of the United States Civil Aviation Authority (see FAA).

ATN: *Aeronautical telecommunications network*

ATO: *Approved Training Organization*, a pilot training organization approved by the European Union Aviation Safety Agency (see EASA).

ATSB: *Australian Transport Safety Bureau*, Australian multimodal authority responsible for safety investigations. The ATSB was founded in 2003 through the merger of the aviation accident investigation service (BASI) and the maritime accident investigation service, both of which were established in the early 20th century.

BFU: *Bundesstelle für Flugunfalluntersuchung*, German authority responsible for safety investigations into civil aviation accidents and incidents. The BFU was created in 1998.

Black box: A popular term for flight recorders.

TSB: Transportation Safety Board of Canada, a multimodal authority responsible for safety investigations. The TSB was created in 1990.

Multimodal authority Authorities responsible for investigating accidents and incidents involving various modes of public transport: trains, aircraft, buses, etc.

CEAT: *Centre d'essais aéronautiques de Toulouse*, now known as *DGA Techniques Aérospatiales*, is a centre of expertise and ground testing for aeronautical systems and equipment. It is an establishment under the authority of the Directorate General of Armaments (DGA) within the Ministry of the Armed Forces.

CEPr: *Centre d'Essais des Propulseurs* known today as the *DGA Essais propulseurs*. This is the centre for testing aircraft engines under simulated flight conditions, an establishment under the authority of the DGA within the Ministry of the Armed Forces.

CEV: *Centre des essais en vol* known today as the *DGA Essais en vol*. This is the centre for testing military and civil aeronautical equipment, an establishment under the authority of the DGA within the Ministry of the Armed Forces.

CFIT: *Controlled Flight Into Terrain*. An accident in which an aircraft strikes the ground, water surface or an obstacle without the pilot at the controls having lost control.

CHIRP: *Confidential Human Factors Incident Reporting Programme*, (see REC), voluntary and confidential reporting programme of the UK Civil Aviation Authority (CAA-UK).

Rogatory commission A legal document delegating powers issued by a judge to a third party vested with authority, most often a police or gendarmerie authority, requesting and authorising them to investigate and collect evidence during an inquiry. When the delegation is addressed to a foreign authority, it is referred to as an international rogatory commission.

COSCAP: *Cooperative development of Operational Safety and Continuing Airworthiness*. COSCAPs are part of the global aviation safety oversight system



established by ICAO, which is based on the Global Aviation Safety Plan (GASP).

CVR: *Cockpit Voice Recorder.*

Spatial disorientation: loss of orientation that an aircraft pilot may experience under certain conditions.. It manifests itself in sensory impairments. The perception of spatial information such as the position, altitude or direction of movement of the aircraft and the vertical axis may be impaired. Spatial disorientation is a possible cause of air accidents.

DFDR: *Digital Flight Data Recorder.*

DGAC: *Direction Générale de l'Aviation Civile* (French civil aviation authority).

DSAC: *Direction de la Sécurité de l'Aviation Civile* (French civil aviation safety directorate). The DSAC is one of the DGAC's three technical directorates responsible for oversight. Formerly known as the SFACT and then DCS, this directorate was previously responsible for certification, which has been transferred to EASA.

DSNA: *Direction des Services de la Navigation Aérienne* (French air navigation service provider). The DSNA is one of the DGAC's three technical directorates. It is responsible for providing air traffic control, communication, navigation and surveillance services, as well as aeronautical information services, to aircraft operating in French airspace.

DTO: *Declared Training organization*, training organisation declared to EASA. DTOs prepare student pilots for non-commercial pilot licences.

ECCAIRS: *European Coordination Centre for Accident and Incident Reporting System.* ECCAIRS is a cooperative network of civil aviation authorities and safety investigation authorities in Europe. The network is managed by the European Commission in close cooperation with EASA.

Flight recorder: This is a data recorder on board an aircraft designed to record flight parameters and pilot conversations and which are used for analysing the circumstances of an accident. Flight recorders are protected by an impact-resistant, fire-resistant and waterproof casing that is orange or red in colour to make them easier to locate among aircraft debris.

There are two types of flight recorder: the cockpit voice recorder (CVR), which records conversations, aural warnings and noises in the cockpit. The flight data recorder (FDR or DFDR for the most recent models, but also QAR for maintenance) which records flight data: positions of control surfaces, operation of engine and systems. Recorders are usually located at the rear of the aircraft.

Safety investigation: The purpose of the safety investigation is to determine the circumstances and causes of aviation accidents or serious incidents and, where appropriate, to make safety recommendations. It should not be confused with a judicial investigation.

Field investigator: Field investigators Their role is to quickly go to the site of an aviation accident to carry out the initial investigation actions and collect as much information as possible immediately after the event.

FDR: *Flight Data Recorder.*

Flight Safety Foundation: An international non-profit organisation founded in 1945 to provide safety advice and resources to the aviation and aerospace industry.

IATA: *International Air Transport Association*, founded in 1945.

IEEAC: *Ingénieur des études et de l'exploitation de l'Aviation civile*, Civil aviation operations engineer. IEEACs are civil servants in the French administration, recruited through competitive examinations and trained at the ENAC.



IGAC/IGACEM: *Inspection générale de l'Aviation Civile et de la Météorologie*, Civil aviation and meteorology general inspectorate. Until it became independent, the BEA was attached to the Inspectorate.

ILS: *Instrument landing System*. The ILS consists of two elements: the localiser (LOC), which provides the aircraft's deviation from the runway axis, and the glide path (glide), which provides the aircraft's deviation from the nominal approach slope (usually three degrees).

The glide and LOC are radio waves transmitted by a radio beacon. Acquiring the glide and LOC means that the aircraft has picked up these radio waves and knows its position in the approach corridor.

IMASSA: *Institut de médecine aérospatiale du service de santé des Armées*, replaced in 2009 by the *Institut de recherche biomédicale des Armées* (Armed forces biomedical research institute).

ISASI: *International Society of Air Safety Investigator*, founded in 1964. ISASI promotes aviation safety through the exchange of ideas, experiences and information on aircraft accident investigations.

ISAL: *Instance de sécurité de l'aviation légère*, Light aviation safety body. It brings together twice a year the chairpersons of the safety commissions of the eight federations of the *Conseil national des fédérations aéronautiques et sportives*, the BEA, the DSN, OSAC and the MALGH. At these biannual meetings, each party presents a safety report on its activities and presents or proposes initiatives to improve safety.

ITSA: *International Transportation Safety Association*, composed of independent investigation authorities founded in 1993. Bringing together sixteen independent safety investigation authorities in 2024, the ITSA covers all modes of transport.

JTSB: *Japan Transport Safety Board*, Japanese multimodal authority responsible for safety

investigations into air, rail and maritime accidents and incidents.

xxx xxx

Go Team Team of specialists called on to quickly respond to and investigate an accident.

xxx xxx

MALGH: *Mission aviation légère, générale et hélicoptères*. The MALGH is the DGAC's single point of entry for non-commercial aviation users. It also advises the Director General on policies to be implemented with regard to these users and monitors the implementation of these policies on his behalf.

OM The operations manual describes the procedures for operating aircraft and regulatory requirements, and includes operational procedures that ensure safe operations.

MATLAB: Numerical matrix calculation software with simple syntax.

NTSB: *National Transportation Safety Board*, United States multimodal authority responsible for safety investigations into air, rail and maritime accidents and incidents.

ICAO: The International Civil Aviation Organisation develops policies and Standards, undertakes compliance audits, performs studies and analyses, provides assistance and builds aviation capacity through cooperation between member states and stakeholders. This international organisation is part of the United Nations.

Get-home-itis: Strong determination on the part of the pilot to reach his flight destination or the goal he has set himself, and consciously or unconsciously disregarding the dangers. Get-home-itis is a major cause of air accidents in general aviation.

OCV *Organisme du Contrôle en Vol*, Flight control organization. The OCV ensures compliance with regulations and procedures governing the operation



of public transport aircraft within the DGAC.

Draft final report: Provisional version of an investigation report sent to the States that participated in an investigation for comments, not intended for publication. These States have 60 days to submit their comments, which will be taken into account or, if rejected, appended to the final report.

QAR: *Quick Access Recorder*, maintenance recorder.

Simplified investigation report: Report whose structure does not correspond to the ICAO model defined in Annex 13.

REC: *Recueil d'événements confidentiel* (confidential reporting programme). BEA publication created in 2001 in collaboration with the SFACT (now DSAC), the FNA (now FFA), the FFVV (now the FFVP), the FFPLUM, the ANPI, the AOPA, the SNIPAG (now the GIPAG), the GFH-SNEH and France Voltige, which aimed to share feedback mainly from pilots on occurrences that may or may not be the subject of an investigation. In 2011, the REC was replaced with the REX, run by the three main federations (FFA, FFVP and FFPLUM).

Safety recommendation: A proposal made by an investigation authority on the basis of information resulting from an investigation or study, with a view to improving safety and preventing future accidents or incidents.

AFTN: *Aeronautical Fixed Telecommunication Network*. This network provides a messaging service with recording and retransmission functions, enabling messages to be sent in text mode.

SEFA: *Service d'exploitation de la formation aéronautique*, This flight training school, spread over nine centres, succeeded the SFACT in 1993 before merging with ENAC in 2011.

It was the direct heir to a long tradition of state involvement in supporting light aviation, dating back to the popular aviation sections created by the Popular

Front in 1936 and the SALS, whose mission was to provide flying clubs with aircraft and instructors.

SFIM: Founded in 1947 by François Hussenot, the inventor of the first flight recorders, this company produced the HB-type photographic flight recorder, the predecessor of the FDR.

SNPL: *Syndicat national des pilotes de ligne*, French airline pilots' union

STNA: *Service technique de la Navigation aérienne*, Air navigation technical service, responsible, until its dissolution in 2005, for defining, implementing and installing major air navigation systems and assisting air traffic control for the DSNA.

Trim: A tab or trim is an aerodynamic or mechanical system that keeps a control surface in a position that keeps the aircraft balanced in a given position.

TSEEAC: *Technicien supérieur des études et de l'exploitation de l'Aviation civile*, senior technicians in civil aviation operations. TSEEACs are civil servants, recruited through competitive examinations and trained at the ENAC.

TSIB: *Transport Safety Investigation Bureau*, Singaporean multimodal authority responsible for safety investigations into air, ground and maritime accidents and incidents. The TSIB was created in 2016.



Bibliography and sources

Monographs

KROES Romain, *Erreurs humaines? Contre-enquête sur une catastrophe annoncée*, Éditions De Magrie, Les Nuées volantes, 1993, 112 p.

LANGUMIER Philippe, *Rapport d'activités de la commission de navigation aérienne - délégation de la France auprès de l'OACI*, 1997.

LANGUMIER Philippe, *Commission de navigation aérienne - Rapport de la 147^e session (janvier-mars 1998)*, 1998.

BOUDOU Bernard, *Création d'un système de retour d'expérience basé sur les facteurs humains pour la prévention des accidents en aviation générale*, Université René Descartes, UFR Biomédicale, 2000-2001.

SAUTER Servane, *Étude de la perception des messages de sécurité émis par le BEA au travers de ses publications par les usagers en aviation générale, perspectives d'évolution* - Mémoire de fin d'étude ENAC TSEEAC, École Nationale de l'Aviation Civile, Toulouse, 2007.

CHAMBOST Germain, *Le BEA, Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile, les enquêteurs du ciel...à la loupe*, éditions Altipresse, 2012.

VIDAL Gilles, *Les accidents en aviation générale*, éditions Cépaduès, 2021.

Ouvrages collectifs

Organisation de l'Aviation Civile Internationale, *Manuel d'investigations sur les accidents d'avion*, 1971.

Organisation de l'Aviation Civile Internationale, *Programme des travaux techniques (TWP) de l'organisation dans le domaine de la navigation aérienne 2^e partie*, 1999.

Organisation de l'Aviation Civile Internationale, *Programme des travaux techniques (TWP) de l'organisation dans le domaine de la navigation aérienne, 2^e partie*, 2000.

Conseil Général des Ponts et Chaussées, *La Communicabilité des rapports du CGPC*, 2002.

Organisation de l'Aviation Civile Internationale, *Programme des travaux techniques (TWP) de l'organisation dans le domaine de la navigation aérienne, 2^e partie*, 2004.

Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile, *Études de sécurité*.

Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile, *Enseignements de sécurité (depuis 2021)*.



Magazines distributed by the Ministry of Transport and Sustainable Mobility

Aviation civile Magazine

LABADIE-LARROUDÉ Christine, *Profession enquêteur (le BA ba du BEA)*, October 1996, Number 282.

BASCOU Daniel, *Enquêteurs-accidents: l'alpha et l'oméga de la sécurité*. 1 March 2001, Number 305, March 2001.

CHAMBOST Germain, *Les boîtes noires à l'heure de l'image*, 1^{er} October 2001, Number 309, October 2001.

De LESTRAC Evelyne, *Les recommandations du BEA à la DGAC. Efficacité renforcée, temps de réponse réduits*. 1 March 2004, Number 323, March 2004.

BASCOU Daniel, *Enquêteurs plongeurs du BEA. Repousser les limites de l'enquête technique*, 1 March 2004, Number 323, March 2004.

NOYE Régis, Olivier Ferrante, expert du BEA, détaché à la FAA (Seattle), 1 April 2007, Number 340, March-April 2007.

Bulletin de liaison et de documentation du SGACC

LEVIS-MIREPOIS Charles-Henri de, *Étude sur la sécurité aérienne*, No 30, dated 20 October 1947.

BENZIMBRA Léon, *Les accidents d'avions et leurs relations avec la discipline des équipages* - Report presented 15 Juin 1948, Number 41, November-December 1948.

DGAC Informations

HENNEQUIN Philippe, *Le BEA: partenaire pour la sécurité*. 1 June 1992, Number 244, June 1992.

WIENER Earl L., *Les trente dernières minutes ou les mystères de la boîte noire*, 1 November 1992, Number 248, November 1992.

HENNEQUIN Philippe, *Le BEA: un laboratoire pour la sécurité*, 1 November 1992, Number 248, November 1992.

Revue du S.G.A.C

BELLONTE Maurice, *La sécurité aérienne dans l'aviation de transport à l'âge de la turbine*. 15 September 1961, No 110.

BONTE Louis, *Les enquêtes sur les accidents d'aviation*. 1966.



Transports

ABRAHAM Claude, *Les enquêtes accidents dans le secteur des transports – vers un NTSB à la française ?* 1 March 2002, Number 412.

Voies

Spécial Sécurité, Number 7 supplement, 1980.

Reviews and Periodicals

Académie nationale de l'Air et de l'Espace, *La sécurité aérienne, 1^{er} Colloque International Toulouse, novembre 1984*, Éditions Cépaduès, May 1985.

Aéroports magazine

ROY Gil, *Bureau Enquêtes-Accidents - Le délicat apprentissage de la communication*, 1^{er} July 2000, Number 310.

Air et Cosmos

SOULEZ-LARIVIÈRE Daniel, *Quarante ans de traitement pénal des accidents d'avions en France, résultats et perspectives*, Number 2718, of 15 January 2021.

NOYE Régis, *Des résultats du Bureau Enquêtes-Accidents*, 31 October 1987, Number 1162.

JASSOGNE, *Initiatives communautaires dans le domaine des accidents d'aviation*, Number 1382, June 1992.

DUPONT Jean, *Décryptage des boîtes noires*, 19 October 1992, Number 1396.

JASSOGNE, *Accidents et incidents aériens: la CEE veut une directive*, 22 February 1993, Number 1414, February 1993.

BREAND André, *Les pilotes ne volent pas assez*, 18 October 1996, Number 1583.

COCHENNEC Yann, *Le BEA épingle la sécurité de l'aéroport du Bourget*, 18 April 1997, Number 1609.

DUBOIS Thierry, *Un projet de loi pour les enquêtes accidents*, 5 February 1999, Number 1689.

BROSSELIN Serge, *Aviation générale. Comment améliorer la sécurité ?*, 20 October 2000, Number 1767.

COCHENNEC Yann, *Projet de loi pour soulager le BEA*, 18 June 2010, Number 2223.

Aviation Week and space technology

SPARACO Pierre, *Conditioned reflexes cited in Tarom A310 incident*, 3 April 2000.



ITA Magazine

RAPP Lucien, *Vers une troisième catégorie d'enquête au cas d'accident d'avions*, March 1990, Number 60, March-April 1990.

Pilote de ligne

BASTIANELLI Jérôme, *Retrouver l'information disparue dans les enquêtes-accidents*, 1 December 1998, Number 20.

ARSLANIAN Paul-Louis, *Coexistence des démarches de sécurité et de justice. État des lieux* 1 March 2003, Number 38.

Journal de l'O.A.C.I.

POOLE Michael R., *Des animations par ordinateur peuvent contribuer à l'analyse et à la prévention des accidents*, 1 March 1997, Volume 52, Number 2.

FROSTELL Caj, *Une réunion va étudier des amendements aux SARP relatives aux enquêtes sur les accidents*, 1 January 1999, Volume 54, Number 1.

Assemblée Nationale (documents)

GAYSSOT Jean-Claude, *Projet de loi relatif aux enquêtes techniques sur les accidents et les incidents dans l'aviation civile*, 1998.

SAUGUES Odile, *Rapport fait au nom de la mission d'information sur la sécurité du transport aérien de voyageurs*, 2004.

Sénat

BLAZY Jean-Pierre, *Rapport fait au nom de la commission de la production et des échanges sur le projet de loi, modifié par le Sénat, relatif aux enquêtes techniques sur les accidents et les incidents dans l'aviation civile*, 1999.

Juris-Avia

BEA. 1 June 2004, Number 9.

National archives

Ministry of Transport and Sustainable Mobility collection.

DGAC collection.

General Inspectorate for the Environment and Sustainable Development collection.



Acknowledgements

We would like to thank the following individuals for their contributions and participation in this publication:

Paul-Louis Arslanian, Jean-Pierre Bonny (†), Robert Davidson (†), Pierre-Yves Huerre, Rémi Jouty et Jean-Paul Troadec.

Claude Abraham, Guillaume Adam, Alain Agnesetti, Xavier Barral, Hélène Bastianelli, Jérôme Bastianelli, Anne-Marie Blanc, Jean-Luc Bénesse, Jean-François Berthier, Bernard Boudou, Alain Bouillard, Martine Del Bono, Olivier Ferrante, Alain Guillardou, Marc Lever, Thierry Loo, Jacques Pageix, Bernard Palayret (†), Jean Pariès, Philippe Plantin de Hugues, Yann Pihan, Jean-François Stork, Daniel Soulez-Larivière (†) et Daniel Vacher.

Photo credits

Pages: 6, 17, 24 (bas), 26, 27, 29, 31, 32, 33, 39, 40, 42 (2 du bas), 43, 44, 52, 54, 55, 56, 57 (2 photos du bas), 62, 64, 69, 74, 7, 76, 81, 82, 83, 84, 85, 92, 95, 96, 99, 100, 101, 104, 105, 106, 109, 117, 120, 121, 122, 123, 124, 126, 128, 136, 138, 140, 144, 148, 150, 154, 157, 161, 167, 168, 175, 176, 177, 178, 184, 185: BEA

Pages: 48, 49, 53, 54, 55, 57 (2 top photos), 58, 65, 66, 67, 79: Pascal Guittet/Usine Nouvelle

Page 18: ADP Archives

Page 22 (2 photos): Musée de l'Air et de l'Espace

Page 30: Beutter/Sipa

Page 41: Henrard Roger/Carnavalet museum

Page 70: Aljazeera

Page 72: Le Parisien/Olivier Lejeune

Page 73: BA Istres

Page 86: SupAreo

Page 89: L'Est Républicain

Page 91: Le Parisien/Philippe de Poulpique

Page 93, 147: L'Alsace/Daniel Schmitt

Page 97: AFP

Page 111: TSB

Page 118: Michel Gilliant

Page 129, 133 and 137: Gilbert Neel/DGAC-STAC.

Page 130: Patrick Perrier.

Page 162: France Télévisions

Page 170: NYPD/Getty Images

Page 186: Galaxie Presse

Page 187: BEA/ECPAD/Galaxie Presse







Work co-edited by the Mission Mémoire de la DGAC and the BEA.

Mémoire de l'Aviation Civile collection
© 2024 Mission Mémoire de l'Aviation Civile/BEA
50, rue Henry Farman 75720 Paris cedex 15

Legal deposit: December 2024

ISSN: 1956-8746

ISBN: 978-2-11-179150-3

All rights of translation, reproduction,
and adaptation reserved for all countries.

 **mémoire**
de l'aviation civile

