

The investigation process following major technological accidents

State of play and avenues for improvement

Discussion Group 'The investigation process following major technological accidents'

Publication coordinated by Daniel Darets

n° 2018-04



SEVESO, Bhopal, Enschede, AZF, Fukushima... we can all recall examples of accidents or incidents that had a major impact on the environment, devastated families, or jeopardised the economic activity of a particular area.

Given the technical complexity of the subject, the challenges associated with safety, and territorial development imperatives, all stakeholders need to play an active role in the risk management process.

Progress in industrial safety must come from all actors, which is why it is crucial for them to acquire and develop a true safety culture.

That is the mission of the **Institute for an Industrial Safety Culture (ICSI)**, a French non-profit organisation founded in 2003. ICSI is the fruit of a joint initiative between industrial companies, academics, researchers and regional/local authorities working together to:

- ▷ improve safety in companies by taking into account all aspects of industrial risk: technical, organisational and human,
- ▷ promote open and participatory debate between high-risk companies and civil society, through better risk management and safety improvement “education”,
- ▷ encourage all members of society to become familiar with the problems surrounding risks and safety.



Publisher: **Institut pour une culture de sécurité industrielle**
(Institute for an Industrial Safety Culture)

A French non-profit organisation (Association de loi 1901)

<http://www.icsi-eu.org/>

6 allée Emile Monso – BP 34038
31029 Toulouse Cedex 4
France

Phone: +33 (0) 534 323 200
Fax: +33 (0) 534 323 201
E-mail: contact@icsi-eu.org

This document

Title	The investigation process following major technological accidents: State of play and avenues for improvement
Key words	Major accident, safety investigation, event analysis, technological risks, experience feedback
Date of publication	November 2018

This *Cahier de la sécurité industrielle* analyses the question of how safety investigations are conducted in France following major technological accidents occurring in Seveso-type facilities. It is the outcome of the work of ICSI discussion group in which some 20 participants from very different backgrounds: trade union organisations and associations, regional communities, schools, universities, research institutes and centres, industrialists and industrial federations, and experts met over a period of two years.

From the analysis of international and multi-sectoral models, points of view put forward by the stakeholders of any initial plan and discussions between participants, this *Cahier de la sécurité industrielle* provides an overview of the safety investigation process, distinct from the judicial inquiry. Avenues for improvement are identified from the feedback compiled by the discussion group.

This document is intended for all stakeholders interested in industrial safety: representatives of public authorities, local communities, companies, trade union organisations and inter-professional organisations, associations of victims of a disaster, representatives of hygiene, security, environment (HSE) organisations, legal and insurance companies, etc. It will also be of interest to the academic community and students.

To quote this document

ICSI Working Group ‘The investigation process following major technological accidents (2017)’ *The investigation process following major technological accidents: State of play and avenues for improvement*. Number 2018-04 of the collection *Les Cahiers de la sécurité industrielle*, Institut pour une culture de sécurité industrielle, Toulouse, France. Downloadable free of charge from: <http://www.icsi-eu.org/>. The original French version of this document is also free downloadable from ICSI’s website.

Foreword

The theme for this document, the investigation process following major technological accidents, was originally proposed by the CFDT, a French trade union. It has been recognised as being of primary importance by all the colleges represented in the bodies of governance of the ICSI: trade union organisations and associations, regional communities, schools, universities, research institutes and centres, industrialists and industrial federations.

In the opinion of ICSI and of the 20 or so participants who have contributed to the discussion group over two years, this document fills a gap. It also raises expectations about the action that will be taken to improve the conduct of safety investigations carried out on French territory.

As society develops it requires a number of production activities on industrial sites that present significant risks. In a socially responsible approach, it is appropriate to cope with these risks regionally but also to optimise their control permanently.

The risks generated by industrial sites often extend beyond the strict perimeter of the premises. The actions taken to prevent accidents causing serious consequences mean that their number is relatively low. However, when they do occur, the analysis of the causes can quickly become very complex with several investigations being carried out in parallel by different organisations, pursuing lines that are quite different and sometimes conflicting.

Some of these conflicts cannot be resolved; judicial investigations will always seek to identify who is responsible so that they can be punished while other stakeholders will seek all the causes so that they can suggest solutions to avoid the repeat of the sequence of events or the emergence of similar situations.

For all that, it is necessary to cope with these conflicts and to arrive at a *modus vivendi*.

These conditions are indispensable to achieve satisfactory results, essential elements to obtain the confidence of all stakeholders, those who participate in investigations, but also all other parties (victims, the public, etc.).

No less important will be the confidence that the people who were present at the accident, or even contributed to it, have in the structure of the investigation so that there is no doubt that it can get to all the relevant facts.

Toulouse, 4 September 2017

Daniel DARETS, Secretary General of ICSI and FonCSI

Acknowledgements

This *Cahier de la sécurité industrielle* is the outcome of the work of the discussion group ‘The investigation process following major technological accidents’ set up by ICSI and which met between 2014 and 2016. This discussion group was chaired by Daniel DARETS and Claude FRANTZEN.

The ICSI wishes to thank the following people who, by their participation in the debates, their evidence and their assistance with the drafting, have contributed to the achievement of this document.

The members of the discussion group

Antoine AUGUSTIN	Engie
Anne BARES	SNCF
Cédric BAUDRIT	Inra Bordeaux
Didier BENETEAU	Engie
Paul BERTRAND	FENVAC
Ivan BOISSIERES	ICSI
Jean-Pierre BOIVIN	Cabinet Boivin & Associés
Denys BREYSSE	University of Bordeaux 1
Sylvain CHAUMETTE	Ineris
Jean-Paul CRESSY	CFDT
Jean DANGUY DES DESERTS	Ufip
Nicolas DECHY	IRSN
René DELEUZE	ICSI
Michel DESCAZEAX	ICSI
Yves DIEN	EDF
Jérôme DUPONT	Total
Frédéric DUPRAT	Insa Toulouse
Jean ESCANDE	UTC
Chrystelle FERRAND	Total
Stéphane GICQUEL	FENVAC
Michel GUILLOUX	Amaris
Gérald HAYOTTE	CFDT
Daniel HORN	GRTgaz
Marc-Xavier JOUBERT	Suez
Bernard JUMEAU	Air Liquide
Michel LAFON	Cabinet MLC2
André LANNOY	IMDR
Jean-François LECHAUDEL	Total
Georges LE CORRE	AITF
Julien LEPRÉ	FO
Yves MORTUREUX	IMDR
Jean-Jacques OUDRY	FO
Claire PELEGRIN	Airbus
Manuel PENNAFORTE	Cabinet Boivin & Associates
Gérard PERROTIN	Amaris, Irma, District of Salaise-sur-Sanne

Yann SEGUILLON	Vinci Energies I&S
Franck TAILLANDIER	University of Bordeaux 1
Bruno TOSTAIN	TIGF

The people who appear, with their framework of professional experience, in the list above have participated in the discussions which have led to the drafting of this *Cahier de la sécurité industrielle*. These people and, where appropriate, their organisations are not committed by the proposals and conclusions contained in this document.

The author

Jean ESCANDE has prepared this *Cahier de la sécurité industrielle*.

The scientific reviewer

François DANIELLOU has contributed by his suggestions to different versions of the document.

The external contributions

This *Cahier de la sécurité industrielle* has benefited from the presentations and the comments of Claude AZAM (Former Director of the Accident Investigation Board for Ground Transportation - BEA-TT), Éric MAITREPIERRE (Magistrate, Deputy Prosecutor at Bobigny High Court), Annie NORMAND (BARPI) and Jean-Paul TROADEC (Former Director of BEA Civil Aviation).

ICSI committees

The members of the Committee of Guidance and Evaluation and of the Board of Directors of the ICSI have enriched the *Cahier de la sécurité industrielle* with their comments during the sessions of 18 May and 29 June 2017.

The ICSI coordinators

François DANIELLOU and Daniel DARETS have coordinated the different steps of the publication of this *Cahier de la sécurité industrielle*.

English translation



The translation was kindly funded by the European Union Agency for Railways (ERA).

Graphic design and layout

Sandrine ARRIBEUX - LesZines

Proofreading

François DANIELLOU, Éric MARSDEN, Christèle CARTAILLER

Contents

Introduction	3
1 Approach followed	5
2 State of play	7
2.1 Benchmark in the ESReDA framework.....	7
2.2 Other examples in France, abroad or international.....	16
2.3 Existing approaches in French organisations.....	23
3 The connection with the legal world	41
3.1. The regulatory context of the safety investigation carried out by the operating company.....	41
3.2 The organisation of the judiciary when faced with a major accident.....	43
3.3 Lessons: two complementary objectives.....	46
4 Areas for improvement	51
4.1 Make possible an initial joint collection and its coordination.....	51
4.2 Give a European basis to this investigation process.....	52
4.3 Create an office of investigation after an accident.....	52
Conclusion	55
Bibliography	57
Abbreviations	59

Introduction

This *Cahier de la sécurité industrielle* is the outcome of the work of the ICSI discussion group on the investigation process set up today on the French territory following major technological accidents. It provides an overall vision of the concept of a **safety investigation**, separate from the judicial inquiry. Avenues for improvement have been identified from the abundant scientific literature and the experience compiled by the Discussion Group.

This document is intended for all the stakeholders of the organisations interested in industrial safety: representatives of public authorities, communities, companies, trade union organisations and inter-professional organisations, associations of victims of a disaster, representatives of hygiene, security, environment (HSE) organisations, legal and insurance companies, etc. It will also be of interest to the academic community and students.

This document concerns the following industry sectors: energy, chemistry, oil, health, transport of material, processing, etc.

In the case of a major technological accident, the multiplicity of investigations conducted by separate teams which have different objectives, can be a source of conflict during fact-finding. This situation may also lead to conclusions that are unclear and even contradictory.

The following list gives an overview of this diversity:

- ▷ Judicial investigation: police, gendarmerie, justice;
- ▷ Administrative investigations: environment inspectorate or equivalent, labour inspectorate, rescue services;
- ▷ Parliamentary inquiry;
- ▷ Investigations of private stakeholders: insurer/victims/customers, joint-contractors, owners;
- ▷ Internal investigations: hygiene, safety and working conditions committees (CHSCT), trade unions, operating company.

The tasks assigned to the safety investigations (among which figure in particular the internal investigation of the operating company) and the judicial investigation are each of general interest, but they fall into two distinct classes. The first favours the search for the causes and the analysis of the consequences to understand the problem and propose solutions in order to prevent similar accidents; the second searches for who is responsible so that they can be punished if appropriate.

This multiplicity of approaches, even among the safety investigations, results in explanations which are sometimes divergent and leave all the stakeholders dissatisfied and with little confidence that the root causes that led to the accident have been identified.

French industries concerned by major accident hazards are not the only ones to be confronted with this situation, and there are in other activities or in other countries, good practices which could be adopted. The first part of the document is largely devoted to identifying these existing practices.

In a fairly conventional manner, the presentations of an approach for conducting an investigation after an accident (Sklet, 2004) retains the following three steps:

- ▷ The collection of factual data (what happened? where? when?);
- ▷ The search for direct causes and the determination of the root causes (why?);
- ▷ The development of recommendations to prevent a repeat of the accident or the occurrence of similar accidents.

On the basis of such a sequence, it would seem desirable:

- ▷ To organise a system which allows access to and sharing of the factual information (material and other) relating to the accident. In particular, it should be possible to organise a first step in working jointly with the teams of the judicial investigation;
- ▷ To set up a group of experts to conduct a technical investigation of common safety.

It is on these basic principles, which are likely to be modified (they have already been discussed several times), that the Discussion Group that originated this document has worked.

The document consists of four parts:

- ▷ Part 1: '**Approach followed**' presents the general context of the discussions;
- ▷ Part 2: '**State of play**' describes the work done by the discussion group and presents the information collected through the studies previously carried out and identifies the lessons that can be learned;
- ▷ Part 3: '**The connection with the legal world**';
- ▷ Part 4: '**Areas for improvement**' presents improvement actions, their timescales, their principles and associated methods of implementation.

The list of abbreviations at the end of the document defines the acronyms and abbreviations used.

Approach followed

The work of the discussion group took place over a period of a little more than two years, mainly during 15 meetings which were each attended by some 20 participants. Each of these meetings consisted of two parts:

- ▷ A presentation made by a guest or a participant in the discussion group on the practices and experiences from different environments;
- ▷ Discussion between the participants on the lessons learned from the presentation, and then on the evolution of the thinking of the members of the group.

During these discussions, the participants were asked to answer the following questions:

- ▷ What is expected of the technical safety investigation committees (today), of the investigation committee (tomorrow): an explanation of the accident, some recommendations?
- ▷ How can 'confidence', and therefore 'credibility' be obtained? What is 'independence'?
- ▷ How should the team be constituted (permanent nucleus and additional people contacted on an ad-hoc basis)?
- ▷ How should skills be maintained: in what field of investigations (especially to gain experience)?
- ▷ Mode of response, readiness to investigate 'at the drop of a hat' (go team);
- ▷ Legal powers, the need for top level legal coverage (French law, European regulation);
- ▷ What financial means should be available? What would be the origin of these means? What impact on independence?;
- ▷ Connection with the judicial investigation;
- ▷ Should/can the legal authority be given a management function (prosecution)?
- ▷ Is industry ready to invest in supporting the structure of the safety investigation (like the Airbus go team)?

A sequel to this *Cahier de la sécurité industrielle* will present the main elements of the different presentations as well as the lessons learned by the group.

State of play

2.1 Benchmark in the ESReDA framework

ESReDA (European Safety, Reliability & Data Association) is a European association which was founded in 1992 to promote research, practice and training in the field of safety (industrial safety), the experience feedback and reliability data. In 2017 it has nearly forty members (industrial undertakings, administrations, universities, research centres, consultancies) located throughout the whole of Europe. It includes several working groups of which one was allocated, from 2001 to 2008, to investigations after accidents (WGAI) [*Working Group on Accident Investigation*].

The WGAI was given four major objectives when it was set up:

- ▷ To identify and describe the state of the art of the investigations in Europe after accidents (accident investigation) or after events (event investigation);
- ▷ **Identify and present, to all the industrial sectors combined, generic recommendations to stakeholders in order to obtain a better knowledge of the mechanisms of accidents** by the use of methods of investigation;
- ▷ To present recommendations to stakeholders for the application of lessons learned from the accident investigation and event investigation in order to improve the management of safety;
- ▷ To develop general guides on the accident investigation and event investigation, as well as on the formulation of appropriate recommendations.

A few of the results of this work, are presented in the following paragraphs. These summarise of the article by Dechy & Dien (2008) and the INERIS report (2009) (cf. Bibliography).

2.1.1. State of the art of investigation practices after accidents in Europe in 2002 - 2003

This study is based on a questionnaire to which 49 replies were received and analysed in 2002. While it may not be entirely representative, this sample nonetheless provides qualitative information that is reasonably valid for the industries at risk and large organisations. The organisations which responded were predominantly administrations (27) then undertakings (15) and finally, research centres and consultants (7). More than 50% of these organisations fall within the field of transport.

The first lesson is that the regulation has a decisive impact on the triggering of investigations as well as their organisation and their conduct. Most organisations consider an accident to be an event having consequences (HSE and/or property damage) on the basis of a regulatory definition. In contrast, incidents or events, have definitions that are more varied, depending on the appreciation of the organisations. These definitions are also often linked to the obligation to declare to the authorities (cf. Annex VI of the Seveso Directive). For the triggering of an investigation, the authorities select events on the basis of the severity of their consequences while undertakings select investigations on the criteria of risks and learning opportunities. In two thirds of the cases, the organisations report that it is compulsory to provide information to investigators (quasi-systematic for the authorities and especially for legal reasons).

The existence of a permanent office for investigations like the *French Bureau d'enquêtes et d'analyses* (BEA) [Investigations and analysis board] in their industrial sector was reported by three-quarters of the respondents and confirms the trend observed in the development of these organisations. These investigation boards operate either with permanent investigators, or by service contracts with supervision provided by the Directorate of the BEA. The authorities and research centres basically create ad-hoc committees with safety specialists. The undertakings and the consultants essentially form temporary teams of safety specialists and field teams. The main criteria for appointment as a member of an investigation team are to be a multidisciplinary specialist of safety, a recognised specialist in safety in general (ex: transport), a specialised expert (ex: ammonia plants), or an expert in human performance. A member of the board, one of the managers and the witnesses of the accident, are also part of the teams of investigators. The absence of an investigator and/or specialist in the experience feedback should be noted.

The organisations surveyed indicate that:

- ▷ The main objective of the accident investigation (public, private) is to collect the facts, identify the consequences and identify the direct and indirect causes;
- ▷ The secondary objective is to prevent the repetition of a similar event;
- ▷ Other objectives are sometimes present such as the formulation of recommendations, the development of new procedures and regulations, the compliance with the Act, the interest of the information collected as feedback and the conditions for the dissemination of such information.

On the use of investigation procedures after an accident (accident investigation), approximately 70% of the organisations surveyed indicated the use of an internal procedure, a directive or a rule. Only 10% reported an international or national procedure.

The majority of the organisations indicated they did not have a specific investigation method. A method is recommended by 20% of the organisations and half of them cite the method called 'cause-consequence'.

The Working Group (WGAI) had indicated as early as 2002 that the future work for a safer and more secure Europe should focus on a European research programme on the accident investigations, on the sharing of good practices and on the need for the harmonisation of measures and tools of investigations: definitions, legal requirements (objectivity, independence, competence), institutions, notifications and routine procedures and methods.

Following this work, an ESReDA seminar was organised on the subject of safety accident investigations while distinguishing it from legal investigations. It was held in May 2003 (ESReDA 2003). It was opened by representatives of the European Commission who recalled the approach of the EU to the accident investigations and their relation to the management of risks and crises.

The main debates dealt with:

- ▷ The fields of the accident investigations;
- ▷ The nature of their direct causes and furthermore;
- ▷ The interest of considering the near-misses in the feedback;
- ▷ The management of accident investigation by multiple stakeholders;
- ▷ **The necessary distinction between the accident investigation of judicial and safety investigations;**
- ▷ The credibility of the investigators, the long-term use of the knowledge acquired by the accident investigations;
- ▷ The continual need for the exchange of information internationally;
- ▷ The comparative assessment of the risks from different technologies.

It showed a need for exchange of information on the methods and techniques of investigations after an accident and on the way to adapt the recommendations to different levels of risk management and decision.

2.1.2. Public investigations after accidents in 2005, progress in various sectors

The work of the WGAI continued and resulted in a book published in 2005 (ESReDA 2005) devoted to public investigations after accidents in Europe. The following information is extracted.

From a global point of view, and on the institutional and regulatory level, there are many variations between countries and sectors and according to the period. Many national regulations (work, transport, technological and natural risks) specify requirements on the accident investigations and the feedback. Looking back, the development of public inquiries after accidents can be seen in addition to those set up by undertakings, the progress from *ad hoc* investigating committees to the offices of investigations and analysis (BEA) with the enlargement of their field of investigation on several sectors. In addition, there is growing public interest in major accidents and the development of national and European regulations, the number of which is increasing, as well as the use of more and more current procedures and European or even international standards. European Agencies have been created in some sectors, with the objective of improving safety.

For European Civil Aviation, which is a relatively new industry, the tradition of accident investigation is well established. The corrective actions proposed by the accident investigation, including on the design, are often adopted and most of the countries have permanent investigating committees. The first permanent commission of accident investigation was established as early as 1915 in England for military aviation (Accident Investigation Branch, AIB). At the end of the First World War, the AIB was attached to the Air Ministry and extended its activities to accidents in civil aviation. In 1944, Annex 13 of the Chicago Convention of Civil Aviation described a procedure and a method of integrated accident investigation harmonised in 1951 by the International Civil Aviation Organization (ICAO). Thus in France, the BEA (Bureau of Investigations and Analysis for the Safety of Civil Aviation) was created in 1946. The European Directive 94/56/EC of 21 November 1994 contains the legal requirements for the accident investigations and explicitly requests the creation of an investigation board that is independent of the control of authorities.

In the maritime field, despite an experience of several centuries and many disasters, there is not a long tradition of investigation. Often, these focused on the issues of guilt. However, the International Maritime Organization (IMO) has passed resolutions for the establishment of accident investigations and the consideration of human factors. A few countries have an investigation board in this area of activity, or investigating commissions, including France since 1997.

In the rail sector, the accident investigations have long been managed internally including within the public companies. In the 90s, the International Union of Railways (UIC) campaigned without success for a database of accidents. The sector has been marked by many accidents in the UK rail sector, including the accident at Paddington in 1999. The Directive 2004/49/EC of 29 April 2004 on rail safety contains the legal requirements for the accident investigations and requests the creation of an investigation board. They must be independent in their organisation and their legal structure, their decision-making process and not responsible for infrastructure, operation, authorities of railway control, or safety authorities. In France, the Accident Investigation Board - ground transportation (BEA-TT) has the responsibility for the accident investigations since its inception in early 2004.

In the road sector, with the exception of Finland, which since 1968 has a permanent commission of investigation funded by the insurers, the sector did not have (in 2005) a specific Accident Investigation Board. It should be mentioned, however, that several countries have multimodal Accident Investigation Boards which cover these accidents, such as France with the BEA-TT. Yet, it is the mode of transportation that causes the most human consequences. As well, a white paper and a European program (COM(2003)311) for road safety have been established and mention the feedback.

For tunnels, the fires in the Mont Blanc tunnel (France and Italy) and Tauern tunnel (Austria) in 1999, as well as in the Gotthard Tunnel (Switzerland) in 2001, have illustrated the consequences that these accidents can have in human and economic terms: dozens of dead and wounded, major European routes interrupted for months and even years. Certain tunnels that have been in service for a long time were designed at a time when the technical possibilities and transport conditions were very different. Thus, the Directive 2004/54/EC of 29 April 2004 defines the minimum safety requirements for tunnels in the trans-European road network,

including the deadlines for submission of the accident investigations by the operators. In France, the BEA-TT is responsible for public investigations after accidents.

The sector of pipelines for the transportation of hazardous materials has suffered several accidents, including the disaster at Ghislenghien in Belgium in 2004. In France, the decree of 4 August 2006 established the requirement to notify the authorities and carry out investigations after accidents. The Dutch Safety Board, a multimodal investigation board, is responsible for carrying out investigations after accidents in pipelines.

The process industries and those involving hazardous materials have suffered numerous disasters in Europe (Feyzin in 1966, Flixborough in 1974, Seveso in 1976, Basel in 1986, Enschede in 2000, Toulouse in 2001, Buncefield in 2005) and rules and regulations for the control of major hazards have been introduced and then revised as a result of new disasters (Act 76-663, Act 2003-699, Seveso Directive). These texts define requirements regarding the carrying out of investigations after accidents (Articles 37 and 38 of Decree 77-1133), the organization of the feedback from top-tier Seveso sites (item 6 of Annex III of the Decree of 10 May 2000) and of the notification to the authorities and Member States of major accidents (according to the criteria defined in Annex VI of Directive 2012/18/EU). There is no requirement as to a public enquiry after accidents. The accident investigations are carried out by companies, third-party experts and *ad hoc* commissions. A report is sent by the authorities (in France the BARPI) to the Major Accident Hazards Bureau of the European Commission, which manages the MARS database (Major Accident Reporting System). In Europe, some countries (Netherlands, Sweden) have multimodal accidents investigation boards or commissions which conduct investigations into the major accidents in their field.

The offshore oil and gas industry of the European Union has suffered disasters on the platforms Alexander L. Kielland in Norway in 1980 and Piper Alpha in 1988. The Deepwater Horizon accident in the United States in 2010 served to remind people of the permanence of this risk. Strict regulations exist in the HSE field. The accidents are analysed by companies and where applicable by the control authorities and commissions of inquiry, in particular for disasters. In Europe, there is no permanent commission of inquiry, nor Accident Investigation Bureau. In contrast, there is the Chemical Safety and Hazard Investigation Board (CSB) in the United States. In the electrical energy production and transportation sector, several sources need to be considered (fossil, nuclear, hydraulic, renewables). At the same time, several European countries, as well as the USA, have suffered black-outs. Lessons have been learned from these events.

The nuclear energy sector has suffered accidents such as at Three Mile Island in 1979, Chernobyl in 1986 and Fukushima in 2011. An international scale INES (International Nuclear Event Scale), a classification of accidents defines the criteria for notification and therefore of the accident investigation by the operators and the control authorities. There is no requirement for a public enquiry after accidents. In France, with the TSN law (Transparency and Nuclear Safety) of 2006 and the INB Order (Base nuclear facilities) of 2012, there are criteria for notification and therefore of the analysis of events by the operators and the control authorities. EDF prepares and transmits to the Nuclear Safety Authority (ASN) and the Institute of Radiation Protection and Nuclear Safety (IRSN) more than 600 event reports per year.

In the field of space, the European Space Agency (ESA) is responsible for the accident investigations with the National Centre for Space Studies (CNES) and the French authorities if applicable. The sector was especially affected by the disasters of the American shuttle Challenger in 1986, and Columbia in 2003, the investigations of which were conducted by independent *ad-hoc* commissions (Presidential for Challenger and specific for Columbia).

2.1.3. Evolution of public Investigations

After a succession of major technological accidents, the public demanded policies which led to investigations being carried out that are both public and independent. In the United States, *ad-hoc* presidential commissions were thus set up after the accidents at Three-Mile Island (1979) and Challenger (1986). It was the same in England after the explosion on the Piper Alpha offshore platform (1988) and the train accident at Paddington (1999).

This trend was supported by the existence or the establishment of international or national regulations to oversee public inquiries for the purpose of safety after an accident. Until then, these regulations essentially concerned aviation.

In fact, permanent offices for investigations after accidents were set up several years ago mainly for air transport, then later for marine and rail transport. Others have been set up after sensational disasters:

- ▷ Creation in 2005 of the Railway Accident Investigation Branch (RAIB), after the accident at Paddington;
- ▷ Setting up in 1990 and activation in 1998 of the US CSB, after the accident in Bhopal in 1984.

On the basis of this finding, the WGAI is committed to better identify and define public investigations after accidents. In fact, it was not possible for it to define the determining criteria because of the diversity of the stakeholders and the multiple meanings given to the terms used. These criteria are basically:

- ▷ The nature of the authority in charge of the investigation;
- ▷ The origin and the power of the organisation responsible for the investigation;
- ▷ The composition of the investigation team with the presence of independent investigators;
- ▷ The opening to the public of the investigation in relation to the access to information throughout the inquiry;
- ▷ And finally, the focus on a commitment to learning about safety at the expense of the necessary satisfaction of social needs for the search for the people responsible and their guilt.

This last criterion is the one which constitutes a major distinction vis-a-vis the judicial investigations. This distinction is regularly included in regulations governing the coexistence of the two types of investigations, with a right of access to all elements useful to the accident investigations, even those covered by the secrecy of judicial procedure, medical secrecy or professional secrecy. An example of this is given in France by Act No. 2002-3 of 3 January 2002 relating in particular to the safety of the infrastructure and transport systems and investigations after transport accidents.

Lastly, accident investigation boards are increasingly replacing *ad hoc* investigating committees set up following disasters. This means that instead of less integrated bodies dominated by the government and the administration, permanent structures are favoured. The latter are more professional, independent and oriented towards the promotion of safety.

Although this evolution is perceived as beneficial, it nevertheless has a number of contradictions. Regardless of whether accident investigations are conducted internally or publicly, there are many dilemmas and conflicts. For public inquiries after accidents which are managed by the accident investigation boards, external factors such as the relationship with the environment, the structural, legal, political, administrative and financial arrangements influence, the degree of transparency, the reputation and the legal role of the victims can be at the origin of these conflicts. They may be due to internal factors such as the management of safety, the organisational model, the role of the independence, physical and financial resources, the competence of the teams, the school of thought or the dominant paradigm, the method used, the capacity for innovation, the contact with the victims and their families. A number of these conflicts or dilemmas can be present for investigations within a company at risk: independence of the stakeholders to the cause of the accident and dependence on witnesses, just culture, human error as well as managerial and organizational malfunctions, internal competence and external expertise, resources, collection of facts and “cleaning” or repair, period of investigation and delay in the restart of production, etc. The inevitable arbitrations may have consequences on the quality of the investigations and their results.

These questions are found in the debate arising from the comparison between the multimodal and sectoral accident investigation boards. In fact, two strategies (multimodal, multinational) are being discussed. They have the same objective: to build a legal basis, an independent position, a professional credibility and to win the confidence of the public, a high level of performance and a critical mass to ensure continuity. The two strategies coexist with other modes of operation (sectoral boards, and *ad hoc* committees).

2.1.4. Arguments for and against multimodal accident investigation boards (ESReDA 2005)

AGAINST	FOR
A loss of depth of expertise in the mode and credibility with the sector due to a dilution of the objectives by the combination of the different modes and sectors	A critical mass of knowledge is maintained to ensure a high quality performance; the know-how is transferable between the management of the investigators, the proof-reading of reports, the support by the non-modal trades (e.g. metallurgy, human factors)
An absence of learning potential due to the significant differences between the modes that exceed the apparent similarities	Sharing of administration services, the resources, the senior management, the training that can provide a critical mass and a defence against budgetary cuts and benefit from the economy of scale
A domination by external people with insufficient expertise, focusing attention on issues and solutions at generic and aggregated levels	A similar approach between sectors provides a similar quality of investigations, a harmonised policy and a single philosophy, leading to an increase in the confidence of the public in the investigations
An attitude of segregation and compartmentalisation between modes which affects the willingness to cooperate	A cooperation with synergies can emerge from the methodological and procedural similarities, leading to a harmonisation of methods
A loss of the expertise and know-how required during the collection of facts and analysis in the investigation of a single major event, especially when leadership is also required in a major investigation	The combined experience can improve the transparency of organisational and managerial issues: the role of the members of the Management Board during major accidents, training needs, the relations with the public and the press, the quality of the reporting, the preparation of the recommendations, the flexibility of allocation of resources and other general elements at the level of the Management Board

The other perspective is that of multi-nationality applied to a sector of activity. That is what has been observed for example with the Air Transport Accident Investigation Commission (ATAIC). This body is composed of 12 Member States of the former Soviet Union, and has been responsible for maintaining the level of safety in spite of the disappearance of the USSR. In this case, this modal culture is accompanied by a low interest in feedback from other sectors for the aviation industry.

As regards the EU, some European agencies with safety objectives have been set up. In these cases, one of the possibilities would be the evolution in parallel with the national accident investigation board toward a unified institution on the model of the American NTSB (Federal). A lot of resistance can be expected such as cultural resistance, or resistance from trades facing the prospect of multi-modal accident investigation board. It is also necessary to expect resistance coming from the Member States against this type of change.

Another element that is potentially conflicting is independence. It is supposed to promote impartiality, integrity, objectivity, the credibility of the investigators, and the confidence of the stakeholders.

This notion of independence is relative. Total independence in relation to the political and cultural system does not exist. Moreover, total independence vis-a-vis the sector and operational practices can jeopardise the credibility of the accident investigation board and deprive it of sources of information, knowledge and especially of skills. The proposed recommendations could be inadequate. As well several dilemmas, conflicts, paradoxes are present and require arbitration at several levels (institutional and regulatory framework, organisational, communicational and on the process of investigation).

If independence can be a factor of credibility, it is also a means of accessing essential information that might otherwise be ignored. Many countries and sectors have clearly distinguished, in their regulations between public investigations after safety accidents and judicial investigations. Thus, a protection of witnesses is included in order to enable people to speak and the conclusions of the report may not be used for prosecutions. It could be argued that judicial investigations may finally obtain the truth. However, the purposes of the technical and criminal investigations, and the timescales that are different, are opposed on some points but complement each other, in particular for accident prevention. This protection of sources of information, the absence of coercive or legal power, participates in a release of the information, in particular subjective and individual information.

Transparency obtained in this way, on the practices, perceptions and rationality, is necessary to understand the phenomenon of accidents. It must in return encourage integrity and impartiality of the investigation. These can be achieved only if the investigators have sufficient skills, ability and resources. With the development of more comprehensive approaches, the technical, human, organisational and society issues require more and more competency. Thus, the resources necessary for understanding of the accident phenomena and the provision of recommendations tailored to the system may be in danger in the face of budgetary considerations, which was experienced by the NTSB in the United States in the 1990s.

To conclude this point on independence, it is not the sole guarantor of a good quality investigation (within the meaning of the identification of root causes). On the other hand, with approaches becoming increasingly systemic and organisational, independence is a powerful supporting factor in the face of managerial, administrative and political resistance.

2.1.5. The organisation of investigations, models and methods

As has already been pointed out, there is a great diversity of practices in the implementation of investigations after accidents, due to the history of different countries and different sectors of activity. This is in addition to the cultural contexts and regulations. This diversity is reflected in the choice of approaches and methods implemented to understand and prevent accidents. In view of this situation, the WGAI, which has the objective of accompanying the different stakeholders in their approaches, reminds us that careful analysis of accidents, incidents and crisis has clearly shown that any event has immediate or direct causes (technical failure and/or 'human error') but that their occurrence or their development can also be explained by the underlying organisational conditions (complex factors) present in the socio-technical systems and in the organisational networks. This involves having to deal with causes of a different nature from technical or physical causes, up to more complex explanations (with positive and negative feedback loops) in human and social systems.

As a result, it is necessary to use multiple skills (engineering, human and social sciences) to investigate, make multiple factors (technical, cognitive, collective, organisational, financial, power, relations with the authorities, etc.) intelligible and learn from the accident in order to define preventive or corrective actions.

Above all, it should be noted that the diversity of investigations after an accident, due to different objectives (search for responsibility and guilt, safety, reliability), is not without consequences. In fact, when, as a result of an accident, several accident investigations are triggered and conducted simultaneously, some operational conflicts can arise for the access to the site of the accident, to the witnesses, for the collection of facts and the preservation of the 'evidence', for the analysis and conclusions and their communication.

Despite this diversity of objectives, if we stick to the case of technical safety accident investigations - those that are not intended to search for culprits but search for the causes to learn from them in order to define actions of prevention or protection - a number of general principles, protocols, coordination, competence, data and facts, formalisation and reporting, follow-up of the recommendations and communication can be identified. Similarly, their organisation meets the following steps: definition of the specification, definition of the investigation team, collection of data, formulation of hypotheses, analysis, evaluation, conclusions, lessons learned and recommendations. This list must not hide that the succession of steps is not a linear process but, rather, an iterative process (the specification can be redefined in the light of the data, the team of investigators can be strengthened if there is a need for more expertise, etc.). In addition, each investigator will influence the conduct of the investigation because of his experience and know-how.

Methods have been developed to facilitate the tasks of accident investigation. These use standard, qualitative or quantitative approaches, use different construction logics, use various underlying models, aim to illuminate phenomena at certain levels of the socio-technical system, and have different perspectives (define what has happened, how, why, and what are the measures to prevent this type of event, etc.). The idea to remember is that each method has been developed in a particular context and with a particular purpose, which the investigators should be aware of before making their choices *in situ*.

What is certain is that the accident investigations cannot be satisfied with an explanation confined to immediate causes. They must go back to the events which took place within the socio-technical system and take into account four different levels of phenomena: the main elements of an event (source of danger, barriers and defence controls), the individual level (unsafe action), the workplace (the conditions that caused the error) and the organisation. Examples of remarkable accident investigations illustrate these principles: the Paddington inquiry by Lord Cullen, the CAIB investigation on the Space Shuttle Columbia, the US CSB investigation on Texas City.

The Columbia Accident Investigation Board (CAIB 2003) which, when explaining its approach, could say:

Many investigations of accidents do not go far enough. They identify the technical cause of the accident, and they associate it with a variant of the “operator error”, the operator who has incorrectly placed the nut, the engineer who incorrectly calculated the forces, the manager who took the wrong decision. [...] When the resolutions of the causal chain are limited to the technical weakness and the failure of the individual, typically the actions to prevent a similar event in the future are also limited. [...] The implementation of (the) corrective measures lead to another error: the belief that the problem is resolved.

CAIB Report Vol.1, p. 97

2.1.6. The preparation before the accident

The organisations should implement a programme for the preparation of accident investigation protocols, and training of their investigators before the accident occurs, so as to be effective when the time comes. This programme should include the following points:

- ▷ Develop the capacity of the organisation and its stakeholders;
- ▷ Develop, with participants and stakeholders, a willingness to initiate investigations after events;
- ▷ Define requirements and criteria (notifications such as defined in the policy on the feedback of experience, codes of conduct and standards, etc.) as guides for an investigation;
- ▷ Prepare a plan to respond to an incident (notification of the event, preservation of the facts during the operations for the management of the consequences and relief to people, etc.);
- ▷ Identify the basic elements necessary for an investigation and prepare a plan to activate an investigation (potential participants and stakeholders, the investigator’s toolbox, establishment of an activation procedure, etc.);
- ▷ Develop this capacity and the preparation for the triggering of the investigation (for a rapid implementation of the response plan, the investigation plan, the constitution of the specification and terms of reference of the investigation, the consultation of stakeholders, the appointment of investigators, etc.);
- ▷ Develop a capacity to manage investigations (for directing the activities, the collection of data, its preservation, its analysis);
- ▷ Check the status of this organisational capacity.

2.1.7. The internal and external communication

Once the investigation after an accident is complete, and often during the course of the accident investigation, it is necessary to give stakeholders information on the progress of the accident investigation, the preliminary results and endpoints to initiate and facilitate the process of learning.

Investigation boards have developed public hearings where the information is debated and may feed back into the process of investigation or its finalisation. Emphasis should also be placed on the stage of the formulation of recommendations, which is a step that follows the analysis, conclusions and lessons established during the accident investigation, and that requires a special knowledge of the organisational network (stakeholders and politicians) and the behaviour of the socio-technical system.

Investigation boards have specific teams to formulate recommendations which are discussed in advance with the engineers of the designers and operators, to monitor the answers and the implementation of the improvements requested, whether they are urgent or medium and long term.

In addition, in the organisations where corrective actions are taken, particular monitoring must be put in place in order to check their effects in the short and long terms and observe any unexpected result, or even detect perverse features.

2.1.8. Lessons and perspectives

Six points emerge from all this work:

1. There is a very great cultural and sectoral diversity

It is a source of wealth in the approaches and in the analyses, but sometimes this also shows up how some countries and sectors are some way behind.

It will be necessary to consider this reality if it is desired to engage in a process leading to a European structure.

2. The investigation process is changing fast

This is in response to requests from the institutions, the public, the victims, the professional organisations and trade unions. This gives rise to developments in the approaches and methods used to acquire and enhance the feedback of experience.

This is also reflected in a development which tends to gradually replace *ad hoc* committees by permanent organisations like the investigation boards.

3. The dilemma of whether to set up the investigation boards organisations on a multimodal or multinational basis?

This dilemma arises from the desire to have permanent structures, which have the experience, the independence and the authority required. The need for a permanent minimum activity will have to be solved either by broadening the area of responsibility or by focusing on instructive events, which do not have any real major consequences.

4. Conflicts with the justice system: the need for more cooperation and joint investigation

The objectives are in part conflicting and cannot be reduced (search for the guilty vs the causes). For all that, they must be considered as complementary. It is necessary to be able to work together at least at the time of the collection of facts and evidence. The delicate problem of the protection of witnesses remains to be solved.

5. Investigations which take little account of the human, organisational and public issues

Such investigations, which remain focussed on the technical causes and operator errors, tend to ignore the root causes, and leads to a risk of repetition of major accidents.

It is also necessary to correct the barriers to learning from the experience (INERIS, 2009, Foncsi, 2014, IRSN, 2014, ESReDA, 2015, IMdR, 2016) and develop '*a knowledge and a culture of accidents*' (Dechy & al, 2010) to detect early symptoms.

6. Need to strengthen skills in investigation and feedback of experience

This corresponds to a request, both from undertakings and administrations. ESReDA proposes a training kit for this (ESReDA 2015).

For this it is necessary to allocate sufficient resources and time to carry out investigations in more depth (beside leaving to provide intermediate reports to meet the operational needs). It is also necessary to develop systemic and multidisciplinary approaches.

2.2 Other examples in France, abroad or international

2.2.1. The case of the aviation industry

Aviation is a recent industry which was organised from the beginning to ensure and improve safety. Actions were undertaken at the end of the XIXth century and at the beginning of the XXth. In 1920, a regulation set up the basis of investigations after an accident. During this same period, the majority of European countries set up such arrangements. Between 1945 and 1947 the Chicago Convention created the International Civil Aviation Organisation (ICAO) responsible to the United Nations. Annex 13 of this Convention prescribes to the States the regulations for the investigation of accidents to civil aircraft. The separation of the judicial investigations from the safety investigations was one of the founding principles.

Some elements of Annex 13

The annex begins by defining the subject of the investigations (accident, serious incident, etc.), stakeholders (State where the accident occurred, where the aircraft was registered, the operator, etc.), the stakeholders (investigator, counsellor, etc.).

The responsibilities were defined in a second step. It is up to the State where the accident or incident occurred, to open the investigation. It is responsible for its conduct. It may delegate all or part of this investigation to another State or to an investigative body.

The annex continues with a description of the different phases of the investigation, all standardised by procedures. The investigation board which conducts the investigation is asked to conduct its investigation in an independent manner and without restriction. This must include the collection, recording and analysis of all relevant information on the accident or incident in question. It must allow the causes and/or contributing factors to be determined and possibly lead to the formulation of some safety recommendations. It must finally be concluded by the preparation of the final report.

Concerning the collection and recording of information, it must contain, when practicable, an inspection of the scene of the accident, an examination of the wreckage and the collection of statements of witnesses. The information collected in this way, will only be disclosed if it is relevant to the analysis of the accident or incident.

The distinction of this investigation compared with other investigations is recalled several times:

Any investigation carried out in accordance with the provisions of this Annex will be separate from any judicial or administrative investigation aimed at determining the mistakes or responsibilities.

By contrast,

The state which conducts the investigation will recognise the need for coordination between the designated investigator and the judicial authorities. Special attention will be paid to the facts that must be recorded and analysed for the investigation to be carried out quickly, for example in the examination and identification of the victims and the analysis of the flight recorders.

As regards Europe, Regulation 996/2010 on investigations and prevention of accidents and incidents complements Annex 13, in particular as regards:

- ▷ The status and independence of the investigating body (Art. 4);
- ▷ The cooperation between the European bodies (Art. 6 and 7);
- ▷ The role of the EASA (European Aviation Safety Agency) and of the national agencies of aviation safety in the investigations (Art. 8);
- ▷ Relations with the judicial investigation (Art. 12);
- ▷ The protection of sensitive information (Art. 14);
- ▷ The recommendations (Art. 17 and 18).

Concerning the recommendations, the majority of them were addressed to the safety authorities. They can intervene without waiting for the final report and do not in any case constitute a presumption of blame or liability for an accident, a serious incident or an incident. Their reception and their implementation are very standardised (in particular, the time given to reply and indicate the action taken), which significantly strengthens their weight. Some regulatory amendments in progress tend to increase the visibility of their implementation. For its part, the DGAC (Directorate General of Civil Aviation) in France publishes the follow-up of the recommendations which concern it.

The French civil aviation accident investigation board (BEA)

The Office of Investigations and Analysis (BEA) for the Safety of Civil Aviation is the French authority responsible for investigations of safety in civil aviation. Set up in 1946, the BEA is responsible to the Ministry of Transport. Today it is placed directly under the authority of the Minister. In order to ensure the independence of the investigation, the BEA cannot receive or ask for any instruction as to the conduct of investigations. Its investigations have the sole objective of improving air safety.

The BEA does not have its own budget. Its staff costs are carried by the DGAC. This budget is approximately EUR 2.30 million per year for the operation and investment. In case of need, there may be exceptional financing. This was, for example, the case in the investigation concerning the flight AF 447 Rio-Paris, in particular due to the search for the plane at sea. Some of the costs of expertise are supported by industry as, for example, flight tests or hours on simulators.

In 2014, the BEA opened 139 new investigations as a result of accidents or incidents in public transport (commercial aviation), in general aviation (recreational aviation, flying schools, private travel, etc.) and aerial work which occurred in all the French departments and territories. Still in 2014, the BEA represented the French State in 216 new investigations led by a foreign State.

While it routinely intervenes in cases of accidents occurring within its perimeter, the BEA can launch an investigation in the event of an incident, if it believes that lessons can be learned.

Resources of the BEA

Key Point

To carry out its work, the BEA has (in 2014) a workforce of 96 people, including approximately 50 investigators. It may in addition be assisted by 160 EPI (investigators who carry out the initial investigation) mainly from the DGAC.

The organisation of the BEA is as follows:

- ▷ A Director, appointed by inter-ministerial decree for a period of five years;
- ▷ The General Secretary;
- ▷ An 'Investigations' department;
- ▷ A Technical department ("lab");
- ▷ A communication department;
- ▷ A permanent operations department.

The BEA therefore has its own resources, but it may also use outside laboratories.

The permanent investigator H24 is responsible for coordinating the dispatch of an EPI and possibly a *go team*. In general, in France, the first people to arrive on the site are the gendarmes and the emergency services, then the local EPI. The investigation begins immediately, a designated investigator is chosen and he goes to the site as soon as possible.

In 2014, 38 events required the sending of a *go team* including 7 abroad. Among the investigations giving rise to a report that meets the requirements of the ICAO, 5 have been closed. On average it takes two years to complete such reports.

Still in 2014, there have been other investigations which have been subject to simplified reporting: 10 concerned incidents of public transport and 89 general aviation accidents or aerial work. All these investigations are now closed.

As far as the investigations abroad are concerned, there is a large variability of closure times.

The BEA is an investigative body which is recognised internationally. Its activity is made up of a large diversity of investigations and contexts. This led it to have a big international reputation and, in particular, access to an important European network, and membership of a number of international committees. It is flexible and needs to be organised to cope with a high and regular case load.

The status of the investigative bodies

The investigative bodies must meet the requirements of Annex 13 to the Convention creating the ICAO. To those above, the ICAO adds recommendations in terms of independence, in a text that is not prescriptive:

Many States have achieved this objective (independence) by setting up their accident investigation authority as an independent statutory body or by establishing an accident investigation organisation that is separate from the civil aviation administration. In these States, the accident investigation authority reports directly to Congress, Parliament or a ministerial level of government.¹

ICAO also recognises that not all States have the resources to set up a permanent body and that some then create *ad hoc* committees of inquiry based on the resources of the civil aviation administration.

The European requirements are more stringent. Each Member State must ensure that the safety investigations are conducted or supervised, without external intervention, by a permanent national authority responsible for safety investigations in civil aviation. When it carries out the safety investigation, this authority must not seek or accept instructions from anyone, and it must exercise control without restrictions on the conduct of its investigations.

The authority responsible for safety investigations is functionally independent, in particular of the aeronautical authorities responsible for airworthiness, certification, air operations, maintenance, the issue of licences, the control of air navigation or the operation of airports. It must also be independent of any other party or entity whose interests or missions might come into conflict with its mission or influence its objectivity.

Taking into account European requirements, in Europe there are two types of permanent bodies:

- ▷ The offices of aeronautical investigation responsible to a minister (France, Germany, UK, etc.) sometimes controlled by a supervisory board (Spain);
- ▷ Multimodal authorities of independent investigations (Netherlands, Sweden, etc.) which enable certain resources to be pooled.

1. Many States have achieved this objective (of independence) by setting up their authority responsible for the investigation of accidents as an independent legislative body or by creating an organisation responsible for the investigation of accidents distinct from that of civil aviation. In these States, the authority responsible for the investigation of accidents reports directly to the Congress, Parliament or to a ministerial level.

Outside Europe, we find the same models:

- ▷ Authorities of multimodal independent investigations (USA, Australia, New Zealand, Indonesia, etc.), whose activity is mainly aeronautical;
- ▷ Offices of aeronautical investigation that report to a minister.

These offices are often limited to a very small number of investigators and sometimes controlled by an investigating committee for major accidents. Sometimes, there is no permanent structure.

Actual independence - formal independence

All the organisations which are said to be formally independent are not necessarily independent in practice. Others, though free of any influence, may be wrongly suspected of being influenced.

In fact, independence cannot be decreed, it must be demonstrated:

- ▷ By competency and therefore intellectual autonomy;
- ▷ By the rigour with which the investigation process is conducted;
- ▷ By the drafting of recommendations;
- ▷ By the recognition of peers.

Communication will always remain a delicate point, because external interventions (politics, builders, unions, etc.) can interfere with it.

Recruitment and training of investigators

All countries refer to the framework of Circular 298 of the ICAO (Guidelines for the training of investigators for aviation accidents), but can adapt it to their own situation.

Thus, this circular presupposes that the staff who will train in the field of aeronautics will have had previous experience in the positions of pilot or engineer. However, the BEA method of recruitment also attracts young graduates for which supplementary training in aeronautics will be necessary.

Training should allow knowledge in the field of aeronautics and in methods of investigation to be acquired, to which a lot of experience should be added. The investigator must also meet the requirements in terms of know-how and experience. This training and its implementation will lead to a progressive taking of responsibility. To this day, there is no formal licence validating these skills. The prospect of having such a qualification at the European level still seems distant.

Circular 298 distinguishes four steps in the training:

1. Initial training. Its goal is to acquire basic knowledge allowing a trainee investigator to participate in an investigation (legal framework and organisation, procedures of inquiry, site management and safety). This training lasts for approximately one month.
2. Practical training. This is the phase of learning in the field under the supervision of experienced investigators. This is reflected by participation in the various types of investigations (general aviation, transport aviation, foreign investigations, etc.) and by the progressive taking of responsibility up to the function of director of a major investigation.
3. The basic training is done in parallel during the first year. It addresses the regulatory aspects (responsibility of States), technical (examination of the wreckage, recorders, metallurgical analysis, etc.), the conduct of interviews with witnesses, the drafting of reports.
4. Advanced training is further training oriented towards major investigations. It includes additional training on human factors, design, construction and aircraft maintenance, air navigation and piloting.

The final stage is the level of director of major investigations, requiring an experience of at least 10 or 12 years of practice. There are 4 or 5 within the French BEA.

The skills expected of a director of investigation are:

- ▷ A thorough knowledge of the legal framework of investigation in the country where it takes place;
- ▷ The mastery of techniques of investigation;
- ▷ The understanding of air operations;
- ▷ The ability to obtain the resources necessary to conduct the investigation;
- ▷ The ability to collect information and evidence and to save it;
- ▷ The ability to identify and analyse the facts in order to determine the causes and, if necessary, make safety recommendations;
- ▷ The ability to write the final report;
- ▷ The ability to explain the investigation to the public and to families.

The training of the BEA investigators is essentially done internally. BEA participates in ad-hoc measures for the training of foreign opposite numbers.

There is an organisation for private training in France, the French Institute of Aviation Safety (IFSA), used by industry and the army.

Abroad, there is an offer from the academic world (Cranfield, California) or of opposite numbers to the BEA (NTSB, Singapore).

The role of the participants in the investigation

As prescribed in Annex 13 of the Convention creating the ICAO, the different authorities associated with the investigation (basically States other than the State where the accident took place) designate investigators 'Accredited representatives'. These representatives are assisted by their advisers: manufacturer (see box), operator, or other experts. They participate in the working groups and are consulted before the publication of the final report. Their comments are included in the final report or put in an annex in case of disagreement.

Organisation of the accident/incident investigation centre at Airbus

Example

This centre is directly attached to the CEO to allow action to be taken at all levels of the undertaking quickly. Each year, approximately 3 000 events are logged which will be analysed and classified. Some will be the subject of a specific analysis.

The investigation is managed as a project. All points of view must be considered: it is detailed, time consuming and energy intensive work.

There are 1 or 2 major events per year.

Within this centre, there are a dozen investigation *leaders*. They are engineers by training with good capacity in terms of communication and academic qualifications. They must show evidence of curiosity and openness of mind. They are trained both internally (at Airbus) and externally (at IFSA/France, Cranfield University (UK), NTSB and University of Los Angeles (US)).

Each investigator leader leads 10 investigations per year. A *go team* composed of 70 people, can be mobilised in support of the investigation *leaders*. It can be deployed on the scene in less than 24 hours.

For their investigations, the members of the *go team* have a complete store of equipment enabling them to work in all types of environment. Specialists from the design offices can be deployed to assist them.

In addition to these authorities associated with the investigation, the director of the investigation has the ability to call on any expertise useful to the investigation, such as:

- ▷ Other investigation or civil aviation authorities, such as the DGAC or the EFSA;
- ▷ Specialists in human factors;
- ▷ Forensic doctors;
- ▷ Metallurgical laboratories;
- ▷ Translators;
- ▷ Etc.

Relations with the main partners who are outside the investigation

These key partners in France are the DGAC, the EASA (European Aviation Safety Agency), the police and the GTA (Gendarmerie of Air Transport), justice ministry, foreign affairs ministry, the government and the victims.

The relations between the DGAC and the BEA are the subject of a protocol guaranteeing the independence of the latter. In fact, the EPI are DGAC staff but acting under the authority of the BEA. In addition, the BEA is attached to the budget of the DGAC, without this causing a functional dependency which is prohibited by the European regulation. In the course of the investigation, the DGAC may be invited as an expert in piloting (agency of the control in flight) and regulations. It may be consulted for recommendations which concern it. Outside of the investigations, there are numerous discussions between the DGAC and the BEA on the subject of safety. Thus, the BEA is a stakeholder in the 'strategic programme of the safety of the State'.

As the European authority of aviation safety, the EASA can be associated with a safety investigation to bring its expertise and give its opinion on a draft recommendation. In addition, the EASA is associated with the work of the European Network of investigative authorities.

The police and the gendarmes are the guardians of the accident site. In the first place, they participate in the organisation of first aid to the victims. They must control access to the site, so that it is strictly limited to identifiable individuals, in order to ensure the preservation of evidence. All these matters are the subject of a protocol with the Ministry of the Interior.

All fatal accidents give rise to a judicial inquiry. Since the beginning of 2015, the major investigations fall under two centres specialising in collective accidents (Paris and Marseille). The coordination between the investigation of the BEA and the judicial investigation has been the subject of a protocol in accordance with European Regulation (prior agreement concerning investigations of aviation safety of 16 September 2014).

In the past, the relations between the BEA and the justice ministry have sometimes been difficult. Currently, the BEA no longer encounters obstacles when carrying out its investigations, but the coordination of communication sometimes remains delicate. This is based in particular on the support of the examining magistrate for the spirit of the European regulation.

The examining magistrate relies on the GTA (Gendarmerie of Air Transport), the IRCGN (Research Institute of Criminal Cases of the National Gendarmerie), and judicial experts. There are sometimes a few difficulties with these, which may lead to different conclusions from those of the BEA, causing confusion.

The French foreign ministry activates the crisis committee when there are French victims in an accident abroad, or when there are foreign victims in an accident on the French territory. An ambassador coordinator is then appointed. There is no particular protocol between the BEA and Foreign Affairs department, each remaining in its role.

The Director of the BEA shall inform the Minister of the progress of the investigation to the extent that it is publicised. This introduces a risk of leaks which are difficult to control. There are sometimes attempts by

the authorities to take ownership of the communication of the investigation, which can cast doubt on the independence of the BEA.

The BEA must inform the victims, first, of the progress of the investigation. On the other hand, it does not associate them with the investigation, despite some requests.

The victims are sometimes approached by self-proclaimed experts who defend other causes (for example: the defence of the pilots) or by lawyers seeking to obtain maximum compensation. Fortunately, in this context, the BEA has established a relationship of trust with the Fenvac (National Federation of Victims of Collective Attacks and Accidents), which is an essential mediator in relations with the victims.

Management of communications

The BEA often communicates when there is a crisis:

- ▷ At the time of the accident;
- ▷ At key stages of the investigation;
- ▷ At the publication of the final report.

The considerable challenges of a major accident result in consequences for stakeholders in the field of communication, directly or interposed with the media. It is therefore essential to observe the exclusive right of the BEA to report the investigation.

The communication is done exclusively by the Director of the BEA, his spokesperson or the investigator. Information is communicated by means of press releases and conferences, progress reports and the final report. Great care needs to be taken in making the translations.

2.2.2. The US Chemical Safety and Hazard Investigation Board (US CSB)

The CSB is an independent American federal organisation, which investigates major chemical accidents and prepares safety recommendations to prevent a reoccurrence.

This agency, whose independence is ensured by the federal act, was created in 1990 by the 'Clean Air Act Amendments' (Law on the preservation of the quality of the air). It was set up as a result of the accident at Bhopal (2 December 1984). The desire of the legislator was to set up for the chemical sector the equivalent of the National Transportation Safety Board (NTSB, created 30 years earlier) for the transport sector. This organization has been fully operational since 1998. In 2014, it had an annual budget of \$11 million and approximately 38 employees. The appointment of the President of the CSB is done after interviews held by the legislator. The members of the board of directors are appointed for five years by the President of the United States and confirmed by the Senate.

The mission of the CSB is therefore '*to conduct investigations of accidents to determine the conditions and circumstances that led to the event and to identify the cause or causes to allow the prevention of a similar event*'. For this, the investigations go beyond the search for regulatory offences.

There is a Memorandum of Understanding (MOU) for collaboration previously signed with other agencies at the level of States and at the local level (eg.: Occupational Safety and Health Administration (OSHA), Environmental Protection Agency (EPA)). Unfortunately, these agreements are not a guarantee of satisfactory collaboration. There may be friction with the local representatives of these agencies, due to a leadership of federal agencies which has evolved over time, or to ignorance by the local agents of the existence of these agreements.

There is no signed agreement between the CSB and the Federal Bureau of Investigation (FBI). It should be noted that the only case cited regarding an agreement signed by the FBI is the one put in place between the FBI and the National Transportation Safety Board (NTSB) for the air accident TWA 800 New York-Rome 1996. It seems that this was more a source of conflict than an assistance to a smooth shared workload.

The Department of Justice may investigate in partnership with the agencies Occupational Safety and Health Administration (OSHA) or Environmental Protection Agency (EPA), which both have missions related to the compliance and enforcement of the laws.

Annual number of investigations and resources of the CSB

Key Point

The US CSB carries out 5 to 10 investigations per year with a workforce of some 40 people. To carry out high quality investigations, which have an educational interest for the whole of the industry, requires significant human resources.

In addition to investigations, safety studies and recommendations, the CSB has many programmes to raise the awareness of businesses and other organisations in order to disseminate all the information from the investigations. Many companies in the United States and the world use the reports, online videos and recommendations prepared by the CSB to improve the level of safety of their activities.

The recommendations of the CSB as well as explanatory videos are available online and are accessible to the general public.

The Work of the CSB: the investigation after the BP accident at Texas City

Example

On March 23, 2005, an explosion took place, followed by a fire in an isomerisation unit of the BP Refinery at Texas City. There were 15 dead, all sub-contractors, and 180 wounded. The explosion caused damage to the inside and outside of the site of the refinery. The financial losses exceeded \$1.5 billion, to which must be added \$1.6 billion paid to the victims of the accident and a fine of \$21 million imposed by the OSHA (settlement agreement in September 2005).

48 hours after the accident, 8 CSB investigators were on site. At the end of a week, they were 13 including 4 specialised contractors. The group of investigators remained on site for 3 months. The first team was strengthened by experts with skills in damage assessment, in explosions, in modelling of clouds of steam, in human factors, etc.

This investigation necessitated 370 interviews. More than 30 000 documents were analysed. There have been many tests of equipment and instrumentation, assessments of damage on site and in the surrounding area.

The investigation followed an established methodology (AcciMap of Professor Rasmussen) which is a systemic approach integrating the socio-technical factors. In this scenario, the accident is considered as a result of the loss of control of the process of work.

The investigation was coordinated with other investigations or inspections and, in particular, that of the OSHA, the internal investigation of BP and that of the US EPA.

The final report was issued 2 years after the accident.

2.3 Existing approaches in French organisations

Several presentations have been made to the discussion group, providing different and complementary insights. In the short term, there was the presentation of the results of a discussion conducted by a working group on the same subject of the investigations after an accident.

Then there were two presentations by French organisations, BARPI and INERIS.

The Total group, the BEA-TT and the SNCF have described their investigation practice.

2.3.1. Conclusions of the working group 'Strategy of the analysis and control of technological risks'

This working group was created by a decision of 15 April 2009, to assist the Director General of the DGPR (Directorate General of the Prevention of Risks), which is an entity, positioned within the French Department of the Environment.

The Working Group also dealt with the following question:

6 *Accidents and some incidents of civil aviation are the subject of very detailed safety investigations. Are there any lessons to be learned for dealing with accidents and incidents affecting Seveso facilities and other facilities or works at risk that are relevant to the DGPR?* 9

To answer this question, work was carried out in 2012 and 2013. There have been submissions to introduce the activity of the BEA and that of the BARPI (Office of Risk Analysis and Industrial Pollution), and debates to assess the possibilities of transposition from the field of civil aviation to that of Seveso facilities.

The first step was the finding of the differences and similarities:

- ▷ The two areas are both complicated technical systems implemented by human systems and complex organisations;
- ▷ The timescale is different, with on the one hand for aviation the intermittent very structured succession of flights (duration of approximately 3 hours on average) separated by safe stops, and on the other hand for the ICPE an operation that is generally continuous for the facilities and structures;
- ▷ In both cases, the need for a very high level of safety requires, among other things, the drawing of all the lessons from experience for which the understanding is the key to progress in safety. For this reason, the experience feedback required by systems of the type 'Annex 13' of the ICAO which prescribes the investigations in the aviation environment, is highly productive, if the considerable improvement in aviation safety since its creation is anything to go on.

The continuation of the discussions in the group led to 6 important characteristics being identified:

1. The existence and the position given to the organisation carrying out the safety investigation constitutes an objective and concrete sign of the priority given to the policy of improvement of safety.
2. The organisation that investigates safety is a place with specialised competence for both major accidents and incidents:
 - the competence in the various technical issues in play;
 - but also the competence in the field of investigation for 'understanding what happened' in a highly technical area.
3. The statutory and concrete independence of the organisation which carries out safety investigations and the rigorous identification of facts and initiators of technical causes together with stable methods and skills, give a high degree of credibility to the reports and conclusions.
4. The 'tempo' of the safety investigation is based solely on the technical possibilities and the urgency to 'know' to take the relevant measures for safety in the future, in the short or long term, whereas the judicial investigation follows a tempo of its own.
5. **The detailed processing and in-depth review of the significant incidents is necessary to get experience** beyond the few accidents, which are, fortunately, very rare. So there is a set of very strong obligations to account for incidents as soon as safety 'can' be put into play. The investigation of incidents which must be the subject of a treatment comparable to that provided for accidents is difficult and must take into account the concrete situations of the area examined.
6. The safety investigation authority has real powers of investigation and its relationship with the other investigations are the subject to a minimum of consensus.

The Group concluded with the following recommendations:

- ▷ That a better structuring of the investigative function for safety should be considered (preformed teams, procedures, powers of investigation and independence), upstream of the aggregation function and global analysis carried out effectively by BARPI;
- ▷ That there should be a discussion with the industrialists concerned to learn how to define and identify the incidents which appear to be sufficiently significant for safety to be subject to an in-depth analysis with the same methods as for the accidents;
- ▷ That the example provided by the US CSB should be considered.

2.3.2. Presentation of the completion of the lessons learned database of the BARPI

The BARPI (Office of risk analysis and industrial pollution) was created in 1992. It continued and amplified an activity which had existed for a dozen years within the Department of Industrial Environment. This office is dedicated to the feedback of experience from technological accidents. In the current organisation, BARPI depends on the Department of Technological Risks, within the General Directorate of the prevention of risks of the Ministry of the Environment, Energy and the Sea.

The regulatory framework

The need for experience feedback as an essential element of a policy to improve safety was recognised in the decree of application of 21 September 1977 of the Act of 19 July 1976 relating to Seveso facilities. This obligation was then set out in Article 38, now Article R. 512-69 of the Code of the Environment:

The operator of an installation subject to authorisation, registration or declaration is required to declare, in the shortest possible time, to the inspectorate of classified facilities, accidents or incidents that occurred as a result of the operation of this installation, which are of such a nature as to infringe the interests referred to in Article L. 511-1. An accident report or, at the request of the inspectorate of classified facilities, an incident report is transmitted to the operator at the inspectorate of classified installations. It shall give details of the circumstances and the causes of the accident or the incident, the effects on staff and the environment, the measures taken or envisaged to avoid a similar accident or incident and to compensate for the effects in the medium or long term.

These obligations are strengthened for Seveso sites. In the directive of 4 July 2012 (the so-called Seveso 3) it is stated in Article 18:

Information to be provided by the Member States after a major accident:

- 1 - *For the purposes of the prevention and mitigation of the consequences of major accidents, Member States shall inform the Commission of major accidents occurring on their territory which meet the criteria of Annex VI. They shall provide the following details:*
 - a) *The Member State, the name and address of the authority responsible for the report*
 - b) *The date, time and place of the accident, with the full name of the operator and the address of the establishment in question*
 - c) *A brief description of the circumstances of the accident, with indication of any dangerous substances in question and the immediate effects on human health and the environment*
 - d) *A brief description of the emergency and precautionary measures taken immediately that were necessary to avoid the accident recurring*
 - e) *The results of their analysis and recommendations.*

[...]

Note that in Appendix VI, beyond the events which meet the criteria that justify notification, it is envisaged that there should be interest in other events:

Accidents and 'near-misses', which, in the opinion of Member States, are of particular technical interest for the prevention of major accidents and the limitation of their consequences but which do not meet the quantitative criteria above, should be notified to the Commission..

The implementation, on French territory, of this obligation is reflected by the Decree of 26 May 2014, Annex I of which stipulates:

6. The system of management is proportionate to the risks, to industrial activities and to the complexity of the organisation in the establishment and is based on the assessment of the risks.
It incorporates the part of the system of general management including the organisational structure, the responsibilities, practices, procedures, processes and resources that enable the policy of prevention of major accidents to be determined and implemented.
The Safety Management System specifies, by specific provisions, the situations or aspects following the activity:[...]
6. Monitoring performance
Procedures are introduced with a view to a permanent evaluation of compliance with the objectives set by the operator as part of his policy of prevention of major accidents and of his safety management system. Mechanisms for investigation and correction in the event of non-compliance are put in place.
The procedures include the system of notification of major accidents or near-misses, particularly when there have been failures of the preventative measures, the investigations made on this subject and the follow-up, drawing on the experiences of the past. The procedures may also include performance indicators, such as the performance indicators in the field of safety and other useful indicators.

The previous version, in the order of 10 May 2000 amended, Annex III, was more explicit:

6. The Safety Management System [...] defines the organisation, the functions of the staff, the procedures and resources which enable the policy of prevention of major accidents to be determined and implemented. The Safety Management System specifies, by specific provisions, the situations or the following aspects of the activity:[...]
6. Management of how feedback is given
Procedures are introduced to detect accidents and near misses, particularly when there have been failures of preventative measures, to organise investigations and analyses necessary to remedy the deficiencies detected and to ensure the follow-up of corrective actions. Regular reviews are carried out.

Presentation of the BARPI and its activity

The BARPI was created to respond to these obligations for notifications. It is located in Lyon. Its workforce consisted initially of five members of staff during the period from 1992 to 2001. This was doubled after the explosion in the AZF factory on 21 September 2001 in Toulouse. It has 10 members of staff to this day.

Structures exist in the world (in UK, Germany and Japan) the missions of which are close to those of the BARPI, but their field of activities is often much narrower. Access to their databases is generally on a chargeable basis and sometimes reserved for professionals of the sector concerned.

The mission of the BARPI is to produce and disseminate the lessons learned from technological accidents. For this, it is necessary to:

- ▷ Collect, process and validate the information and write a summary for each accident (recorded in the ARIA database: Analyse and Research Information on Accidents);
- ▷ Analyse and use this information;
- ▷ Produce documents for the experience feedback;
- ▷ Distribute this information, analysis and documents.

The collection and recording of information on accidents is a process which consists of 4 steps:

1. Daily selection of technological accidents and incidents occurring in France (+ significant accidents abroad or carriers of feedback of experience);
2. Further research of information and drafting of the summary of an accident in the Aria database;
3. Consultations with the inspectorate, the offices of the regulatory and professional organisations on the abstracts;
4. Publishing summaries of accidents on the Aria internet site.

On average, this information appears on-line in the 6 months following the occurrence of the accident or incident. The amendment of the description of the accident is possible at any time if additional information is transmitted to BARPI.

The information thus collected and processed is widely disseminated:

- ▷ To the public at large and in particular to the operators and the offices of studies;
- ▷ To inspectors of the environment;
- ▷ To the regulating offices of the ministry.

This is done by different channels:

- ▷ Access to information in the Aria database and to the various publications of the BARPI on its internet site;
- ▷ Interventions in DREAL and participation in the training of inspectors;
- ▷ Meetings of professional organisations;
- ▷ The Biennial Seminar IMPEL (Network of the authorities of the Member States responsible for the application and compliance with the law of the Environment);
- ▷ Exchanges with the offices of the regulation of the DGPR (The Directorate General for the Prevention of Risks).

The current organisation of the analysis of accidents in Seveso facilities

Two stakeholders are essential in this framework: the inspectorate and the operating company.

The role of the Inspectorate is as follows:

- ▷ Investigate to check the application of the regulation;
- ▷ Look for possible offences and transmit the findings to the Prosecutor with the information needed for an assessment;
- ▷ Propose to the Prefect, if necessary, the procedure of sanction appropriate;
- ▷ Assess the adequacy of the requirements already imposed on the operating company having regard to the facts that occurred;
- ▷ Propose to the Prefect, if necessary, as a matter of urgency, suitable requirements.

In addition, the inspectorate assists the Prefect and the emergency services to inform them of any information available to it which would enable him to assist a person in danger or to facilitate the control of the incident. Once all the consequences of this disaster are finally understood the operating company must adopt preventive measures in order to reduce the likelihood of re-occurrence and the seriousness of this type of event.

As such, the operating company must submit to the Inspectorate an accident report and, upon their request, an incident report (notice form).

The preparation of this report (see the expected content in the box) should be an opportunity for an analysis of the accident. It is the responsibility of the operating company who may be assisted by an expert organisation. On the proposal of the inspectorate, the prefect may call for an analysis by an expert organisation, usually at the expense of the operating company.

The interest of the approach is to compare the technical competence of the operating company and/or of the expert, with the external inspection of the inspectorate.

The possible limitations of the approach are:

- ▷ The lack of transparency due to the desire not to reveal anything to the competition, for fear that it might have an impact on the brand image or in terms of sanctions, etc.;
- ▷ The reluctance of internal stakeholders to play the game (fear of the management and of sanctions);
- ▷ The supplier-customer relationship between the operating company and the expert body which may create bias in the analysis;
- ▷ The lack of financial and/or human resources, both for the operating company and for the inspectorate.

When it has access to these reports, BARPI frequently notes a lack of deeper analysis of the causes and lessons learned.

The typical content of an accident report

Example

Description of the event:

- ▷ Type of event;
- ▷ History;
- ▷ Substances involved;
- ▷ The consequences;
- ▷ Action taken.

Analysis:

- ▷ Circumstances and direct causes (disturbances);
- ▷ Root causes.

Actions taken:

- ▷ Safety improvements;
- ▷ Lessons learned.

The report must include in the Annex all useful the information, including:

- ▷ Diagrams/plans;
- ▷ Photos;
- ▷ Tree of the causes;
- ▷ Press release.

In this framework, the BARPI has the task of compiling and analysing the information received. It is faced with a number of difficulties, among which are:

- ▷ Those related to passing information upwards:
 - absence of regulatory obligation concerning the passing of information toward the BARPI (transmission on the basis of the voluntary work of the environmental or industrial inspectors);
 - difficulty in retrieving detailed information on accidents (omission of transmission of additional information or fear of 'saturating' the BARPI with information on accidents or minor incidents);
 - lack of legitimacy in the search for causes (BARPI has no clear role in the investigation or the analysis of the accident);
 - a long process of collecting and recording (by the time the BARPI raises questions on the accident, the inspectors are already working on other cases).

- ▷ Those related to the conditions of carrying out the job:
 - the need to identify the types of accidents that ‘deserve’ to be prioritised (to avoid the saturation of the resources while allowing the achievement of relevant analysis) thus the preparation of selection rules which nevertheless are always subject to interpretation in the light of the variety of accidents encountered;
 - the possible dissatisfaction of an operating company as a result of publication of information on an accident that concerns him (despite the anonymity);
 - risk of a remoteness from the realities on the ground and of poor understanding of the situations given that their only role is the collection and analysis of information.

The BARPI has a ‘credibility’ that is globally recognised by all the stakeholders of the risk, a credibility enhanced by the durability of the organisation (24 years of history and practice). However, its current function and organisation does not make it suitable to be an accident investigation body.

The number of accidents in France that were the subject of an investigation

Key Point

Over 3 years, the BARPI has identified 21 events corresponding to those which must be notified in accordance with Annex VI of the Seveso Directive.

2.3.3. Presentation of the INERIS technical investigation report after an accident

The INERIS is a public institution with an industrial and commercial character under the supervision of the French Ministry of Ecology. It was created in 1990 by the restructuring of the Coal Research Centre (CERCHAR) and the Institute of Applied Chemical Research (IRCHA). It can claim a legacy of more than 60 years of research and expertise.

Its mission is to carry out or sponsor studies and research to prevent the risks that economic activities pose to health, the safety of people and property, as well as the environment, and to provide any services intended to facilitate the adaptation of companies to this objective.

Its activity is divided into three parts:

- ▷ Upstream research and partnership;
- ▷ Support for public policies;
- ▷ Consulting and regulatory expertise.

As part of its activity to support public policies, INERIS has prepared a technical guide on investigation after accidents. The purpose of this document is to give the investigator or the analyst, reference information (or information on good practice without aiming to be prescriptive).

This guide (INERIS 2011) covers the technical and the organisational fields of the investigation process. It is aimed at environmental inspectors in charge of Seveso facilities as well as industrial investigators. INERIS provides training to accompany its deployment within the various agencies.

The guide is organised in the following manner

Example

Chapter 1: Introduction
Chapter 2: Preparatory actions
Chapter 3: The initial actions (first visit)
Chapter 4: The steps and general principles of the investigation after accident
Chapter 5: The basis of the investigation in practice (8 thematic or basic principles):

1. Analysis of the damage and effects;
2. History;
3. Analysis of direct causes (technology);
4. Analysis of measures for limiting risks (barriers and checks in prevention, mitigation, protection, intervention, communication);
5. Analysis of situations in relation to the available literature: standards, professional rules, SMS, regulations, instructions;
6. Analysis of the root causes (human factors, organisation);
7. Analysis of the technical and organisational improvements proposed by the operator with a view to formulating administrative follow up;
8. Prepare an investigation report and summary report.

Practical information sheets have been prepared by INERIS for the implementation of each of these steps.

The key elements of this guide serve as a basis for:

- ▷ Analysis of the technical and organisational improvements proposed by the operator with a view to formulating administrative follow up;
- ▷ The preparation of the analysis and summary report.

The different types of activities that an investigator, for whom this guide is intended, must be able to carry out, are:

- ▷ The analysis of an accident investigation report by an operating company;
- ▷ The preparation of an assessment after an accident;
- ▷ The ability to ask laboratories and experts for additional investigations;
- ▷ Or the possibility of conducting a technical and administrative investigation.

Over the course of this guide, a few key elements are indicated:

- ▷ An investigation is strongly dependent on the way it is carried out and the conditions under which the investigator is involved;
- ▷ Two main objectives are pursued at each stage of the investigation:
 - set out what is known of the event at a given time in the investigation;
 - set out the research and the collection of what we do not yet know.
- ▷ One of the traps of the investigation is to look for what you think has happened rather than what actually happened. The rigorous use of structured methods and approaches helps avoid this trap.

A number of tools facilitate communication within the investigation team and enable a seamless sharing of results which must be supported by facts. Nevertheless, an accident, as an object of study, calls upon the capacity of the stakeholders to collect a number of facts after the event. As a result, their analysis is dependent on their knowledge before the event. In other words, the conclusions of an investigation always have the risk of being different and dependent on investigators even when they use the same methods.

2.3.4. Presentation of the investigation conducted by an industrial engineer: the case of Total

General organisation of investigations after the event

To ensure the safety of its facilities, Total encourages the systematic reporting of every event, whether it is an accident, incident, a near-miss or an anomaly. Each event is the subject of an assessment of its severity level, real or potential. This is done on a scale with 6 levels. It is up to management to discuss and validate the assessment. The resources put into the analysis and the level of management involved (branch, group), will be a function of the degree of severity estimated.

Every event is analysed, and the actions decided at the end of the investigation, are the responsibility of the management.

Major accidents or potential major accidents, i.e. having a severity level greater than or equal to 5 (or having had fatal consequences), are also the subject of a safety investigation.

Organisation of the investigation teams in the event of a major accident

In this case, there are two levels of teams involved:

- ▷ An initial team of local investigation is formed for:
 - the collection of the initial information (facts and interviews);
 - the search for the immediate causes;
 - the review of measures to minimise the consequences;
 - the review of the immediate measures to prevent a new accident;
 - the quick alert of the company.
- ▷ An investigation team for major accidents is formed to:
 - to identify the direct and underlying causes in the technical, human and organisational areas;
 - to identify actions to prevent a new accident;
 - to put forward recommendations for the prevention and mitigation.

This second team is composed of participants who come from outside the site and are not involved in the operations of the site.

The major steps of the investigation carried out by the operator Total

This internal safety investigation should include the following steps:

- ▷ The collection of the basic facts;
- ▷ The preliminary investigation;
- ▷ The issue of an interim report;
- ▷ The search for the root causes;
- ▷ The definitive internal report;
- ▷ The feedback of experience.

The investigation, therefore, begins with the collection of basic facts. This first step must be carried out as soon as possible. It must be as exhaustive as possible, that is to say that it is necessary both to assess the damage but also the areas that remain unharmed, what has worked well and what has not worked, etc.

This fact-finding work must take account of the interference with the other detailed investigations. It is obviously necessary to give priority to operations to secure the site and give first aid to the victims.

At the same time as the collection of the basic facts, the interviews with the witnesses (staff and contractors) must be done as soon as possible, taking into account the imperatives arising from the local legislation.

This step requires:

- ▷ Multidisciplinary skills and a variety of experience;
- ▷ Participants not directly involved in the event (not emotionally involved, living some distance away, etc.)

The preliminary investigation corresponds to the beginning of the search for lines of enquiry on the explanatory causes. It must be conducted by a multidisciplinary team, involving, if possible, the contractors concerned and systematically offering to representatives of the local safety at work committee (CHSCT) the opportunity to participate. This phase allows the first hypotheses and assumptions to be put forward based on the stages of the collection of the basic facts and interviews.

At this stage, an interim report is issued which presents the state of the research of the immediate causes and results of the checks of the removal of the residual risks. It takes stock of the established facts and the elements to be investigated further.

The work continues with the search for root causes. This part of the job, which takes longer, requires expert knowledge, analysis, benchmarking, knowledge of the background (feedback), design data, expert opinions and additional interviews. It leads to the drafting of the final internal report which must present the root causes identified as well as the recommendations in terms of preventive and mitigating actions.

Then comes the phase of experience feedback which consists of sharing 'lessons' learned from the accident, and using them to deploy the actions arising and integrating them into the standards of construction or operating-maintenance of the group and in the guides to the internal know-how.

This information must be shared within the group, with contractors and with the industry.

It is necessary to stress the fact that the quality of the whole of this process depends to a large part on the quality of the collection of the basic facts:

- ▷ The photographic coverage of the damage and non-damage, including the projectiles;
- ▷ The topographic surveys, the measurements of travel, of deformations;
- ▷ The records of the installation parameters (before, during and after);
- ▷ The weather data on site and some distance away;
- ▷ The acoustic and seismic recordings;
- ▷ The metallurgical and chemical analyses.

The initial and collective review of the factual information is easier if there are pre-defined protocols to quickly mobilise stakeholders depending on the event together with investigation managers designated in advance.

2.3.5. Presentation of the investigation after an accident as part of the land transport procedure of the BEA-TT

Scope and tasks of the BEA-TT

The BEA-TT was established on 26 January 2004 in application of the French law of 3 January 2002 relating, in particular, to the safety of the infrastructure and transport systems. This Act gave a legal foundation for technical investigations in the field of land transport.

Two objectives are pursued:

- ▷ Fulfil the political and social expectations following the tragic accident in the Mont Blanc tunnel which occurred in 1999;
- ▷ Anticipate the adoption of the European Directive on railway safety.

Its field of application covers all modes of land transport including ski-lifts and inland navigation.

All European countries have an organisation which carries out the technical investigation of rail transport accidents, some of which have had their responsibilities widened to include other modes of land transport. But few cover the whole spectrum.

The mission of the BEA-TT is:

- ▷ To prevent future accidents by independently analysing the circumstances and causes of the more serious or more critical events, and preparing safety recommendations likely to avoid a recurrence;
- ▷ To carry out studies and research in the field of experience feedback.

Its vocation is purely technical, based on feedback. It is not to search for who is responsible for events, or to conduct safety audits. The BEA-TT investigations, therefore, are not a substitute for those that the operators and the safety authorities are required to carry out.

Presentation of the legislative and regulatory framework that applies to the BEA-TT

The powers of investigation and the obligations of the BEA-TT are fixed by Act No. 2002-3 of 3 January 2002 which:

- ▷ Are based on the principle of its independence in the conduct of investigations and the establishment of its findings;
- ▷ Give it access to the place of the accident, the vehicles involved as well as their on board recorders;
- ▷ Allow it, with the agreement of the Prosecutor, to examine any parts placed under seal, submit them to analysis that can alter them, to attend the expertise carried out by the judicial authority and gain access to the whole of the file of the judicial investigation.

This Act also authorises the BEA-TT to carry out any interview, to collect all the information and to consult any document useful to an investigation, even covered by the obligation of professional secrecy or medical secrecy.

In return, the BEA-TT is required:

- ▷ Not to state any opinion on the responsibilities of the stakeholders concerned;
- ▷ To act transparently in making its reports public;
- ▷ To respect the confidentiality of the investigation, medical secrecy and professional secrecy.

The operation and the conditions of independence of the BEA-TT are organised by Decree No 2004-85 of 26 January 2004 (since codified in the Code of Transport):

- ▷ This confers on it the status of service with national responsibility placed by the vice-president of the General Council of the environment and sustainable development;

- ▷ It gives its Director full and complete authority (delegation of competence), inter alia, to decide on the opening of an investigation, designate the investigators who will be in charge, set fields and methods of investigation, commission non-permanent investigators and organise relations with equivalent foreign agencies.

The Director of the BEA-TT is appointed for a term of 5 years. He is the secondary authorising officer for the expenditures of his body. These provisions ensure the functional independence of the BEA-TT.

This notion of independence remains nevertheless relative. It cannot be done by decree, but it must be achieved by:

- ▷ Competence and therefore intellectual autonomy;
- ▷ Rigour in the conduct of the investigation process;
- ▷ Clarity of the analysis and recommendations;
- ▷ Recognition of the stakeholders concerned.

Organisation and resources of the BEA-TT

Key Point

The BEA-TT carries out some twenty technical investigations per year, of which statistically:

- ▷ A third, are railway accidents (including those occurring on the approach to level crossings);
- ▷ A second third, are accidents involving only road vehicles;
- ▷ The last third, are accidents affecting other modes of transport such as guided urban transport, ski lifts and inland navigation.

The BEA-TT does not have its own budget. Its expenditure on staff and its operating costs are funded by the French General Directorate of Infrastructure, Transport and the Sea. Its total workforce is 14 members of staff including 9 technical investigators divided into two divisions. There is a doctor of the General Inspectorate of Work who is attached on a part-time basis.

Its annual operating budget amounts to EUR 100,000. It is supplemented, as necessary, by exceptional financing.

Although modest, these resources are sufficient because:

- ▷ The BEA-TT is not subject to any administrative requirement in terms of keeping files on accidents and justification of its decisions of whether, or not, to open an investigation or not;
- ▷ It can resort to the use of temporary investigators and experts;
- ▷ It can rely on any competent service of the State in its field.

The investigators are recruited from seasoned executives with a thorough knowledge of the transport sector on which they will be called upon to work. They are selected on the basis of the suitability of their skills. Training in the methods of investigation is done internally, by learning on the job.

The organisation of the investigations and the criteria for the selection of the accidents investigated

Three sources of information allow the BEA-TT to know the events affecting the safety of the land transport:

- ▷ The reports that are directly addressed by the operators or the public authorities with which it has concluded agreements (SNCF, RATP, the National Gendarmerie, technical departments of ski-lifts and guided transport);
- ▷ The daily bulletins prepared and disseminated by different centres, including those of the Department of Transport (CMVOA), the Interior (COGIC and CNIR), and also that of the SNCF;
- ▷ Digital editions of the regional daily press.

The European Directive on railway safety requires that an investigation be opened on any collision of trains or any derailment causing at least one death or five serious injuries or damage estimated at more than EUR 2 million.

In other cases, investigations are opened in the light of the toll of human life and damage caused by accidents, but also because:

- ▷ Of their potential consequences in circumstances that might have been a little different;
- ▷ Of the new lessons likely to be learned;
- ▷ Of the complexity of the factors involved;
- ▷ Of the singularity or of the repetitiveness of the situation.

The conduct of an investigation

Each investigation is carried out by one or two technical investigators under the supervision of a manager (head of division or director). It is, in general, opened in the 24 hours following the accident and, except for road traffic accidents, the designated investigators go to the scene in the following 24 hours. For road traffic accidents, the BEA-TT bases its investigation on the findings immediately after the accident by the gendarmerie or the police.

It takes about a year to complete an investigation. The investigation includes five main components:

- ▷ The precise reconstruction of the sequence of events which led to the accident, from the analysis of all the observations made and the data collected;
- ▷ The identification and analysis in a systemic approach, of all the technical, organisational and human factors, as well as the regulatory requirements that have contributed to the accident;
- ▷ The preparation of the safety recommendations which may concern any aspect of safety and be addressed to both operators, industrial organisations and public authorities, as well as control bodies;
- ▷ The drafting of the report in academic terms as far as possible;
- ▷ The consultation of the recipients of the recommendations.

Each important step of the investigation, the determination of the recommendations and the finalisation of the report, is the subject of a collegial validation within the BEA-TT.

It should be noted that the BEA-TT may issue recommendations during the course of the investigation if their immediate implementation is likely to prevent accidents.

For road traffic accidents the BEA-TT bases the report directly on the judicial report that it may complete. For safety events affecting other modes of transport, it conducts its own investigations in coordination with those carried out in the judicial framework.

Relations with the judiciary in practice

The coordination between the investigation of BEA-TT and the judicial investigation is the subject of an inter-ministerial circular.

The BEA-TT shall systematically inform the responsible Prosecutor of the opening of any investigation, even if the accident concerned had no human consequences. It consults him on its report before making it public and it warns him that it is about to publish.

When a judicial investigation is open, the relationships that are established with the investigating judge, do not, in general, pose difficulties. Some reluctance can appear when the examining magistrate is not very familiar

with the texts governing the BEA-TT. The BEA-TT is therefore committed, each year, to submit its mission and its modes of operation to any new commissioners and new judges as part of their training.

In addition, not all prosecutors are suitably equipped to deal with unpublished and very serious traffic accidents. This situation, as for other collective accidents, has led the Department of Justice to create two specialised judicial centres. This evolution should in the long term facilitate relations between the BEA-TT and the representatives of the judicial administration.

It should be noted that magistrates and prosecutors frequently refer to the reports of the BEA-TT, which in fact are public.

The relations with the Department of Transport in practice

The BEA-TT has to inform the Minister of the opening of investigations and their findings before making them public. This information may be accompanied by a note of warning on issues of safety that are particularly critical.

For accidents that have a major media interest, it can convey to the Minister the main findings reached during its first visit to the site. It warns him of its actions of communication to the national press. On the other hand, it does not keep him informed of the progress of its investigations.

The BEA-TT never has difficulties in obtaining the services of the minister or the legal or technical support which it needs in the course of its investigations. Friction can sometimes arise with the departments in charge of safety checks when their methods are questioned.

Besides investigations, the BEA-TT participates in the safety committees and commissions in land transport placed under the authority of the department (the rail safety committee), [*comité de sécurité ferroviaire*], cable car commission, [*commission des téléphériques*] CNESTG National Commission for the assessment of safety of guided transport [*Commission nationale d'évaluation de la sécurité des transports guidés*].

Relations with victims

In a general way, the BEA-TT tries not to use terms in its reports that are likely to offend the victims, and to inform them of its analysis and conclusions before making them public.

The BEA-TT does not systematically meet the victims, even if they are formed into an association. On the other hand, it always meets them when they request it.

The [*Fédération nationale des victimes d'attentats et d'accidents collectifs*] National Federation of the victims of attacks and accidents (Fenvac) plays an essential role in these relations. It is a confident and constructive partner in the discussions.

Relations with staff and their representatives

The relationships with the staff of the transport organisations depend very largely on the nature of the investigations conducted. They may be expanded to include other persons than those directly affected by the accident.

The BEA-TT ensures that the management does not participate in the meetings that it holds with members of the staff and it always offers them the possibility of being accompanied by a person of their choice.

It receives the representatives of the staff who made the request and sends them the report of the CHSCT on the accident concerned.

The management of communication

Together with the recruitment of investigators, the management of communication is one of the major concerns of the BEA-TT.

The first method of communication with the media is the report, regardless of whether it is an interim or final report. Particular care is therefore taken with the rigour and the quality of its drafting. It must be precise, clear and academic while allowing several levels of reading.

For the most complex situations, it may be accompanied by a video animation illustrating the sequence of the accident.

In the majority of cases, communication with the media is limited to the dissemination of the report to the specialised press and to the regional daily press, supplemented by telephone interviews with any journalists who request them.

For accidents where there is a strong media interest, more communication is required such as the issuing of news releases and the holding of a press conference.

The BEA-TT is then confronted with two main concerns:

- ▷ How to control the flow of information without being accused of lack of transparency;
- ▷ How to inform the victims, the Minister and the operators in advance while avoiding leaks.

The exclusive right of the BEA-TT to communicate the results of its investigations has never been questioned by politicians.

The arrangements for monitoring the recommendations

The recipients of the recommendations must advise the BEA-TT, within the 3 months following their notification, of the action they intend to take. These replies are made public.

The monitoring of the effective implementation of these recommendations is not the responsibility of the BEA-TT. It is carried out by:

- ▷ EPSF [Établissement public de sécurité ferroviaire] (Public Establishment for Rail Safety) for recommendations concerning railway safety, which reports to the Railway Safety Follow-up Committee chaired by the Minister of Transport;
- ▷ DGITM [Direction générale des infrastructures, des transports et de la mer] (General Directorate of Infrastructure, Transport and the Sea) and the STRMTG (Technical Service for Ski Lifts and Guided Transport) for the others.

This follow-up is the subject of an annual progress report which is published in the BEA-TT activity report.

These procedures do not guarantee that the recommendations are considered and implemented. The BEA-TT is therefore committed to bringing the most sensitive recommendations to the attention of the public authorities, particularly those relating to regulations, to the capacity of the inspection services or to the management of safety policies.

It also organises, in conjunction with the safety authorities, meetings with operators in the same sector of activity to discuss the lessons learnt from the different investigations that it has carried out.

2.3.6. Presentation of the investigation undertaken by company experts: the case of SNCF (French railways operator)

SNCF is organised to take charge of the investigations after an accident (or event). This begins with the process of immediate reporting of safety events which stems from regulatory obligations (Articles 12 and 15 of Decree No 2006-1279, as amended, Article 22 of the Decree of 19 March 2012 as amended). These articles specify the different levels within the SNCF, which must be informed as well as the external agencies: The EPSF (Public Establishment for Rail Safety), the Minister responsible for transport and the BEA-TT depending on the severity of the events.

When an event occurs, several actions must be carried out. They are intended to:

- ▷ Take any emergency measures necessary to limit any risk of worsening of the event on the site of the accident;
- ▷ Disseminate the knowledge of this event as soon as possible to the operators concerned;
- ▷ Take steps to allow for the safe access of the emergency services;
- ▷ Notify authorities and entities;
- ▷ Initiate an investigation to identify the causes and allow, if necessary, the lifting of the provisional measures.

For the needs of the investigation, precautionary measures are necessary. The objective of these is:

- ▷ The freezing of the situation to examine the vehicles that have derailed, damaged vehicles, the position of the track appliances, the position of the shunting devices, the aspects shown by the signals;
- ▷ The backup of the different recordings (graphic chart, record of driving events, video monitoring of stations, etc.);
- ▷ The provisional withdrawal from commercial service of a vehicle for the purposes of expertise;
- ▷ The keeping of the staff who were present at the time of the accident available to give their statements, etc.

At the time of occurrence of a safety event that can involve the activity of the SNCF, each entity concerned performs a thorough investigation and determines the direct and indirect causes of the event in order to draw useful information for the experience feedback. At the start of this investigation, each entity concerned confirms or adapts, possibly with the support of the national branches of the profession, the first measures taken and decides, if it considers it relevant, to extend them to other facilities or vehicles likely to present a similar risk.

The investigation is set in motion when a safety event has occurred, and as soon as possible after its occurrence. The knowledge of the event constitutes the point of departure for the investigation. It is carried out by the local operations manager.

The investigation is independent of the investigations conducted by external entities or by each railway operator involved.

An investigation manager leads or gets someone else to carry out the investigations on the local level. He collects the information and writes the statement of immediate findings (SIF) within a period of 7 days.

An SIF is established which gives both points of view, that of the operator of the facilities (or his delegate) and that of the user (or his delegate). This document is co-signed.

At this stage, the object of the investigation is:

- ▷ To identify the scenario of the event;
- ▷ To identify the conditions in which the facts were products;

- ▷ To identify the factors which were the direct cause;
- ▷ To contribute to the lifting of the provisional measures.

Then, the investigation continues to:

- ▷ Understand the root causes;
- ▷ Define corrective actions.

The investigation manager, who is the addressee of the statement of immediate findings (SIF), performs the final assembly of the parts of investigation and the drafting of the report on causal factors. In accordance with Article 12 of Decree 2006-1279, he can ask the railway undertakings to supply the documents and items necessary.

The causal factors report is retained by the investigation manager and, after validation, is also sent just to the operators concerned by the event. No element of the report transmitted must be of a confidential nature.

Other SNCF authorities can conduct investigations in parallel. In addition, the EPSF may ask the SNCF for a report on any accident or incident of its choice.

The other possible investigations can be:

- ▷ A national assessment triggered when:
 - the investigation conducted locally is not, or may not be conclusive at this level;
 - the conclusions are contested by one of the operators;
 - the seriousness of the event or its media dimension requires it;
 - the technical complexity requires specialist skills to be called on;
 - some actions need to be involved on the national level.
- ▷ An investigation of the Directorate of Safety Audits (DAS): In the case where the President sponsors the Directorate of Safety Audits to conduct an investigation on a particular accident, the report is provided in the following seven days. This investigation concerns only the elements for which SNCF is responsible. The DAS investigation does not replace in any way other investigations conducted within the undertaking.

In addition to the internal investigations, other agencies have powers of investigation on the national rail network: an investigation may be conducted by bodies or external entities such as the BEA-TT, the Public Establishment of Rail Safety (EPSF), judicial authorities, etc. These investigations do not in any way replace the SNCF investigation.

The connection with the legal world

3.1. The regulatory context of the safety investigation carried out by the operating company

There are two types of investigation after an accident

Key Point

As indicated previously, there are two types of investigation after an accident:

- ▷ Safety investigations which seek to determine the causes of the accident and then propose solutions in order to avoid similar events;
- ▷ Judicial investigations which seek to establish who is responsible to punish those who are found guilty, if appropriate.

The tasks assigned to the safety investigations (among which figure in particular the internal investigation of the operator) and the judicial investigations are each of general interest, but they fall into two distinct classes.

The first is directed toward the explanation of the causes of the accident. It aims to promote “socio-technical innovation” and has no moral connotation. The action aims at the transformation of the whole socio-technical situation. In this capacity, it is driven by a dynamic notion of search for progress in the field of safety (Dodier, 1994). It involves the implementation of actions designed to allow the understanding of the technical and organisational causes and physical phenomena at the origin of the accident or incident. It is not motivated by the search for an offence.

The second is concerned with finding who is responsible. It analyses and prepares the examination of the reality of the offence and the demonstration of the causal link, which can lead, where appropriate, to a punishment. From this point of view, the approach on which the judicial investigation is based is clearly distinct from that which drives the operating company. It is specifically oriented towards punishment.

But these two types of investigation must coexist. In addition, safety investigations are subject to a number of regulatory obligations.

3.1.1. A legitimacy arising from practice

The search for the causes of a malfunction, regardless of the magnitude of its effects or its consequences, is intimately linked to the scientific and industrial approach where the operation of complex tools requires constant attention. In order to optimise such a search, the industry has defined a series of methodological tools intended to structure the investigations aimed at the search and the explanation of the causes of malfunctions.

3.1.2. The beginning of the XIXth century: the first fruits of the approach

Since the beginning of the nineteenth century, the company DuPont de Nemours has conducted investigations following explosions in its gunpowder factory, founded in 1802 in the vicinity of Wilmington (Delaware). Much later, industrial disasters (Feyzin in 1966, Flixborough in 1974, Seveso in 1976, Three Mile Island in 1979, etc.) have been the subject of investigations using specific methodologies and helping to identify lessons

learned based on the main points of the analysis of the accident. In parallel, the oil and chemical industry uses lessons learned from accidents to define preventive measures.

The “tree of causes”, commonly used in industry in France, is a method which aims to determine the combination of events that led to the accident. This method, which is based on the analysis of malfunctions, aims to develop a plan of preventive actions by drawing up a list that is as comprehensive as possible of the causes affecting the whole of the components of the situation studied. It is a root cause analysis whose results are presented graphically as the left-hand side of a bow-tie diagram (similar to a fault tree).

The analysis is made up of several phases: the gathering of the facts, the construction of the tree, the search for factors that might have affected the accident and the development of a list of actions. The presentation must be factual and objective. The aim is therefore not to identify the existence of any offence and, even less, to designate a guilty person, but to consider all the explanations - even very remote ones - of the incident or accident. It is to draw the wider lessons learned and thus broaden the field of understanding to the maximum. The method of the tree of causes consists, therefore, of assembling the mechanisms that produced the accident from facts that can be checked, without ever implicating the subject or victim (Terssac and Mignard, 2011). It involves answering the following question: ‘*What facts have played a role in the occurrence of this accident and in what way were they combined?*’ (Mortureux, 2002). Such an approach is a source of progress and innovation.

The authorities in France have recognized the interest that there is in this approach by the industry and have generalised this practice to the whole of the classified installations for the protection of the environment by registering it in the administrative requirements, both at the national and at the European level².

3.1.3. A practice laid down in the texts

European law

Article 16 of Directive No 2012/18/EU, called the “Seveso III Directive” provides that the operating company, under the control of the Member States, contributes to the search for the ‘circumstances of the accident’. Article 17 of the same directive imposes the requirement to ‘collect, by means of an inspection, an investigation, or any other appropriate means, the information necessary for a full analysis of the major accident from the technical, organization and management point of view’.

National law in France

In French law, such as Article 38, paragraph 2 of Decree No 77-1133 of 21 September 1977 (today codified in Article R.512-69 of the Environment Code) the report of an incident or accident that the operating company must send to the inspectorate of classified installations in the event of an incident or accident ‘*specifies in particular the circumstances and causes of the accident or incident, the effects on people and the environment, the measures taken or envisaged to prevent a similar accident or incident and to alleviate the effects in the medium or long term.*’

3.1.4. A practice of coordinated investigation by the operating company: the example of Belgian law

Other legislation in Europe confers the role of investigation on the operating company by organising the procedures of collaboration with other private persons likely to be affected by the analysis of the accident. In Belgium it is the law itself which provides a mechanism for investigation of collaboration on safety matters.

Thus, Article 94 ter of the Law of 4 August 1996 relating to the well-being of workers during the execution of their work requires the organisation of an internal investigation following a serious accident at the work.

2. Note that there are many other methods (e.g. Sklet, 2003, CICH, 2013) and that it is appropriate that the investigators use the relevant methods to tackle different issues (technical, human and organisational aspects). In France, for the mapping of the direct and immediate causes, the bow tie method has been developed in risk analysis over the last 15 years. It shows the interest in promoting the use of safety barriers. Other methods can be used for the representation of root causes such as the Accimap (cf. INERIS, 2011).

A report must be prepared within the ten days after the accident by the employer of the victim and sent to the Social Inspector (§ 1).

This text, which is placed in Chapter XI bis entitled 'Measures to prevent the repetition of serious accidents in the workplace,' provides, in addition, that in the event of a serious accident that occurred during the work carried out by external companies or by temporary workers:

§2. (...) *The employers, the users, the firms employing temporary workers, the project managers responsible for the work, contractors, sub-contractors and independent workers concerned by the accident, depending on the case, collaborate to ensure that the accident be immediately reviewed by one or several competent prevention services and that a detailed report should be provided to all the people concerned covered above and to the officials referred to in the preceding article in the ten days after the accident.*

In this second case, Article 94 ter specifies that the practical conventions concerning this collaboration, the responsible prevention services which will examine any serious accidents at work and the arrangement of the costs that may arise from these reviews, are given in the specific clauses of the contracts concluded with the employer in the establishment where workers of external, independent or agency undertakings come to do their work.

In all cases, social inspectors can accept an interim report within the same time frame. If there is no detailed or provisional report within ten days, an expert will be designated. The Royal Decree of 28 May 2003 concerning the implementation of Chapter XI bis defines other situations in which these officials may designate an expert (faulty collaboration, complex circumstances outside the relationships between private persons mentioned above, illegal situations and particularly serious accidents at work).

3.1.5. A practice that is not coordinated with the judicial process

A well conducted investigation of the accident done by the operating company is an important method for the prevention of accidents. At present, in France, there is no coordination between this type of investigation and the judicial or administrative procedures. Some cases even reveal a complete ignorance of regulatory approaches of analysis post-accident (outside of the investigations conducted by the public agencies similar to BEA).

The fact of conferring a legal status on the operating company's safety investigation is a solution to promote because this is a legitimate investigation. In this hypothesis, this new system should then offer all the safeguards to enable the doubts of the public regarding the confrontation of the two logical requirements that are the major analysis of the technological accident and the preparation of the defence, to be reduced as far as possible.

The definition of a perimeter of cooperation circumscribed by the collection and sharing of factual information on accidents in a timely manner and to the extent that their investigations are progressing in parallel, would also be an important step forward.

3.2 The organisation of the judiciary when faced with a major accident

3.2.1. The legal framework for the procedure applicable to a major accident

In France, an organisation has recently been put in place to deal with the specific situation arising from a major accident. Its main objective is to guarantee the best reactivity for the assignment of the cases to be prepared.

Article 23 of Act No. 2011-1862 of 13 December 2011 relating to the distribution of the litigation and to the reduction of judicial responsibilities creates centres and courts that specialise in matters of major accidents.

Article L. 706-176 of the Code of Criminal Procedure provides that the territorial jurisdiction of a high court can be extended to the investigation, the prosecution, the preparation of a case and the judgement for some unintentional offences (manslaughter and unintentional injuries) in the affairs which include several victims and are, or appear to be, of great complexity.

The decree 2014-1634 fixes the jurisdiction of the specialised courts:

- ▷ The south-east quarter: Marseille;
- ▷ The rest of the territory: Paris

The centres and the courts of Paris and Marseille may be designated to manage major accidents from other jurisdictions.

These jurisdictions are not *ipso facto* responsible authorities. They have joint responsibility with the court which has competent jurisdiction. The Act provides for a process of arbitration by the Attorney General if two jurisdictions claim the referral.

The circular of the Ministry of Justice of 30 December 2014 specifies the notion of a major accident and the conditions in which a choice can be made between the specialised jurisdiction in matters of a major accident and the court with competent jurisdiction (situation of joint legal responsibilities).

As an example of arbitration made by the Attorney General, for the railway accident at Brétigny, the question was raised in 2015, after the Act came into force in January 2015, and the file was kept in Evry.

Major accident

Definition

The concept of a major accident specified in the circular of 30 December 2014, is defined as:

- ▷ An accident with several victims and a complex character:
 - major accidents of passenger transport;
 - disasters related to technological risks.
- ▷ Choice to make on a case by case basis depending on the different criteria considered:
 - domicile of victims: if victims are locally domiciled a local jurisdiction is favoured;
 - capacity of the court with competent jurisdiction to deal with the cases before it: the resources of the jurisdiction (number of magistrates, financial resources) must be proportionate to the issues of the case;
 - technology of the investigations to be carried out: opportunities for magistrates to benefit from international mutual assistance, to have available the specific skills required (techniques, conduct of investigation, communication).

The collective accident centre is inspired by the centre for public health and the environment with its specialised prosecution service and its judges of the specialised departments.

3.2.2. Organisation of relations between the judiciary and the BEA (France)

A prior agreement concerning investigations of aviation safety was established on 16 September 2014. This Agreement stems from European Regulation No 996/2010 of 20 October 2010. It complies with the principles that are set out in its foreword. These requirements are:

- ▷ The independence of the safety investigation;
- ▷ The free access of the authority responsible for the safety investigation to all the information necessary for its investigation;
- ▷ The preservation of evidence;
- ▷ The respect of the objectives and the independence of the judicial inquiry;

- ▷ The search for a fair balance between the prevention of future accidents and the proper administration of justice in order to ensure the general public interest.

A letter of 13 June 2016 was sent to the prosecution. It defines the implementation procedures regarding this agreement. This letter (non-public) analysed potentially conflicting situations and proposed operational solutions (problem for the collection and sharing of evidence, communication, etc.).

It should be noted that the investigating judge, due to the fact of the independence of the judiciary, is not concerned, although the European regulation is addressed to all the world. In fact, thanks to the good relations between the air transport gendarmerie and the BEA, coordination can be established.

This is in addition to the training undertaken with students of the National School for the Judiciary. This is a very important way to familiarise these future magistrates with the organisational and procedural arrangements recently introduced.

The problem remains 'in getting a fair balance'. In France, unlike in the United States, there is no protected witness status. If during their investigation, the staff of the BEA discover misdemeanours, like all public servants, they have the obligation to inform the prosecutor.

3.2.3. Coexistence of the technical safety investigation and the judicial Investigation

It is a question of coexistence, working together on these investigations and not of confrontation. Both partners share a general interest.

The responsibilities of the judiciary and the BEA are different. The judiciary is, for example, responsible for specific missions, such as:

- ▷ The identification of the bodies for the judicial declaration of death by the prosecutor;
- ▷ The relations with the victims who are going to appear in the criminal procedure with the institution of civil action proceedings with rights of access to the file;
- ▷ The communication to the public on the file.

For all that, the BEA can ask for post mortems or analyses in order to determine the causes or the circumstances of the accident, a request which the judicial authority may oppose. In addition, the BEA will have its own public communication.

So there are many points to organise to coordinate concurrent responsibilities: the access to the site, access to the facts and the sharing of information, reports and seals to conduct a technical analysis, etc.

Both investigations, safety technical and judicial, will progress at different speeds. Their decoupling is therefore inevitable.

To complement this presentation focused on the relations between the BEA and the judicial authorities, it should be noted that other stakeholders may want to have access to the items in the file. This can be done, if they are set up to bring a 'civil action'. For the operating company which might be tempted by this scheme to be able to have the necessary information for his own investigation, this may cause social risks within the undertaking, which may then be faced with some of its employees.

3.3 Lessons: two complementary objectives

The work of this discussion group (WGAI) on investigations after an accident arose from the observation that during a major technological accident, the multiplicity of investigations, far from providing a better understanding of the explanatory causes and phenomena could, more often than not, be a source of confusion. As a result, this situation leaves all the stakeholders dissatisfied and liable to develop concerns and even reconsiderations which can lead to distrust. This leads to the rejection of the conclusions prepared and in the long term, it is the high-risk activities which will no longer be accepted.

At the origin of this multiplicity of investigations are two complementary objectives from the point of view of public interest, but which register in two distinct perspectives:

- ▷ The search for the causes of the accident in order to propose solutions to avoid the accident or similar facts occurring again (prevention);
- ▷ The search for those responsible to eventually start criminal penalties or to determine who must pay for the damage caused under the heading of personal liability (punishment and compensation).

These objectives can be entangled in the facts. For all stakeholders, the aspects of cause and responsibility will be represented to varying degrees. For example:

- ▷ To retain the responsibility of a person, criminal justice must first establish the direct causes explaining the accident;
- ▷ The administration verifies that the regulations in force have been complied with. If this is not the case, this can lead to administrative or criminal punishments. The experience feedback drawn from the accident is also useful to improve or complement the existing regulations;
- ▷ The undertaking wants to understand the reasons for the accident to remedy the problem and prevent it from happening again. There are also cases in which investigations result in punishments to staff. Sometimes, the undertaking seeks to collect information for its legal defence;
- ▷ The trade unions have an approach for the prevention of accidents. They are also keen to prepare the legal case to defend employees or victims and their beneficiaries;
- ▷ The associations of victims want to understand the details of the accident to help them through their mourning of the deceased and prepare the legal remedies of victims and the beneficiaries;
- ▷ Other stakeholders, environmental associations, territorial communities may also be interested in the results of the investigations as part of the interests they represent.

It is, therefore, necessary to take into account these two requirements which are to search both for the causes and the people responsible.

In practice, as a result of an accident that caused the death, there are two analyses of the causes and circumstances:

- ▷ That of the judiciary;
- ▷ That of all the other investigations done for various reasons, as mentioned above.

3.3.1. To make the different investigations compatible it is first necessary to make them possible

It is necessary to make available the joint resources to be able to establish a shared base of facts and information, which allows relevant work in a climate of confidence.

The second point is that it is necessary to have access to the facts, data, findings, statements, so that the investigations can get off to a good start. For the majority of this information and in the majority of cases, at least for the accidents that caused victims, it is the judicial enquiry that has the better access. There should, therefore, be an agreement between all or some of the stakeholders and the judicial authority to arrange access

to this information as well as the sharing of it. The information to be shared is primarily that set out in the descriptive part of the investigation conducted by an industrial organisation.

The initial and collective review of the findings and information can be facilitated if there are pre-defined protocols to quickly get in touch with pre-identified stakeholders depending on the event, with investigation managers designated in advance.

From the point of view of the organisation of investigations, this agreement is possible because it does not create a particular difficulty, since the different presentations during the work of the WGAI showed that there were two distinct stages:

- ▷ The collection of information requiring a rapid intervention due to the existence of volatile information, and possibly the need to restart the service;
- ▷ The analysis of the information collected which is done over a longer duration with the assistance of other experts.

An agreement governing the collection phase does not in any way commit the parties to the organisation of the rest of the investigation.

If we take into account the French case, there is an agreement between the Department of Justice and the BEA for civil aviation accidents. It should be noted that this agreement is the result of international requirements, those laid down by ICAO, but especially those emanating from a European regulation.

This agreement Judiciary-BEA is based on:

- ▷ The existence of laws or national or possibly European regulations which enable such agreements to be set up;
- ▷ The existence of recognised and permanent organisations which, like the BEA, are authorised and able to investigate major technological accidents.

Organisations such as the BEA and the BEA-TT are set-up by politicians spurred on by international requirements or by those of society. The BEA-TT was set up as a result of the accident in the Mont Blanc tunnel. The US CSB was created as a result of the accident in Bhopal, and in Great Britain, the RAIB was set up after the railway accident at Paddington.

These organisations are given budgetary resources and staff, enabling a certain level of independence. This independence is enshrined in the law, often under the constraint of the law of the European Union or of international law.

The independence can be built up and can become permanent thanks to the professionalism and integrity of the staff which make up its teams. These organisations will benefit from the input of the companies directly concerned which are the only ones to be able to provide the resources and the necessary skills to conduct their investigations, (cf. Airbus: Its *go teams*, its simulators and testing capacity).

Some guarantees of independence

Key Point

Some formal organisations may not be a guarantee of independence. In fact, independence cannot be decreed, it must be earned:

- ▷ By competence and therefore intellectual autonomy;
- ▷ By the rigour in the conduct of the investigation process;
- ▷ By the drafting of recommendations;
- ▷ By the recognition of the pairs.

These organisations must be permanent and achieve a sufficient size to establish their credibility. The BEA for the Safety of Civil Aviation has approximately 100 staff of whom 50 are investigators. It may be assisted by 160 initial investigators who carry out the initial investigation, mainly from the DGAC. As regards the BEA-TT, its workforce is a staff of 14 including 9 technical investigators. In addition, there is a part time doctor of the General Inspectorate of Work. The US CSB has about 40 employees who can be supplemented by many contract workers if necessary.

The full time staff must be trained (initial technical skills and specific training in the conduct of investigations) and be sufficiently active at work to ensure that they retain their skills.

For the BEA, the training alternates between the theoretical parts and the practical parts, and team building occupies a central place in this training. To become a director of major investigations - there are 4 or 5 within the BEA - it is necessary to have 10 or 12 years of practical experience, which illustrates the longevity of the "hard core" of the BEA.

In terms of activity, in 2014, the BEA opened 139 new investigations as a result of accidents or incidents. In addition, it represented France in 216 new investigations led by a foreign State. The BEA-TT carries out some twenty technical investigations per year.

As regards the industries likely to experience major technical accidents, BARPI has identified 21 events in France, over 3 years, corresponding to those which must be notified in accordance with Annex VI of the Seveso Directive. This volume remains low, but it is comparable to that of the activity of the US CSB.

In view of this, two ways forward, not exclusive of one another, are possible:

- ▷ Broaden the scope of investigations to Europe, by creating a European body. It would be necessary to overcome the institutional and regulatory difficulties, then succeed in getting the teams on the ground to work together faced with linguistic and cultural diversity;
- ▷ Broaden the scope of the investigations by extending the remit to the investigation of accidents of lesser magnitude and to incidents having an educational character. This implies, among other things, that industrialists would agree to open their facilities to external investigators without fear of disclosing their know-how. This is the option that the existing investigating offices (BEA, BEA-TT, US CSB) have selected.

In order to resolve these difficulties, it is necessary to nominate staff to form these teams. There are a lot of skilled people but each one is associated with one of the stakeholders and scattered among several sectors of the administration, undertakings and certain associations. We can consider a temporary or even a permanent arrangement, to mandate one or several existing public agencies which already have a large part of the skills necessary for carrying out the investigation of major technical accidents. These organisations exist but are not currently designed or mandated to carry out these investigations. At the meetings of the Discussion Group, organisations such as BARPI, INERIS and IRSN were mentioned.

The challenge for organising a process of technical safety investigation contains three headings, there must be:

- ▷ Consolidation of various skills;
- ▷ Coordination and organisation of their actions;
- ▷ Leading to the summarising of the resulting analysis of different parts of the investigation.

As a first step, considering the number of significant events in France (about 10 per year) in the sectors of activity with technological risks, and in order to maintain a good level of competency, an estimate of the team of managers of technical safety investigations could lead to a result of approximately 5 to 10 people.

In a second step, by extending the scope of the investigations, and therefore, the amount of work, it would be possible to increase the staff of the organisation envisaged.

The creation of appropriate training for safety investigators based on the courses arranged in the field of aeronautics, also constitutes a method of improvement (initial technical training, specific training in the conduct of an investigation, work experience). The same goes for the formalisation of the reports and the reporting (use of guide or typical model of report allowing a wide dissemination of lessons learned, etc.).

Finally, only a text of the regulatory level (decree) or statutory (national or European) could change the situation and bring the legal legitimacy essential to the organisation which would be in charge of the conduct of this triple mission.

Areas for improvement

In the light of the information collected during the various meetings of the Discussion Group and the debates which followed, it became apparent that for the current situation to progress, it would be necessary to satisfy three requirements, namely:

- ▷ A joint initial collection of information;
- ▷ A European basis;
- ▷ A specific office of investigation.

These responses may be provided consecutively or more likely, in parallel.

Among the lines of reply identified to respond to these three imperatives, some have been the subject of **consensus** on the part of the participants in the discussion group and others have been the subject of **strong differences** of opinions. These different situations are identified below.

4.1 Make possible an initial joint collection and its coordination

Consensus

In the first place, it is necessary to create the conditions for sharing the facts of the case from the first moments of the investigation, with the Prosecutor or the judicial authority as the engine of the coordination.

Indicative list of items to be collected

Example

- ▷ The photographic coverage of the damage and non-damage, including the projectiles;
- ▷ The topographic surveys, the measurements of travel, of deformations;
- ▷ The records of the parameters of the installation (before, during and after the accident);
- ▷ The weather data on site and some distance away;
- ▷ The acoustic and seismic recordings;
- ▷ The metallurgical and chemical analyses.

The purpose of this coordination would be that everyone benefits from this information and industrial safety is improved. This joint initial work should facilitate the establishment of a climate of confidence between the different parties and promote the sharing of the results of various technical investigations (non-judicial).

For this, it is necessary to have:

- ▷ A structure to coordinate the technical investigation in the initial phase of collection of facts: at least a few directors of investigation pre-appointed and located in one of the existing bodies (BARPI, INERIS, IRSN) (cf. § 3.2);
- ▷ Develop a working, operational and collaborative procedure defining the arrangements for the collection and sharing of facts and hardware. The existing protocol between the judiciary and the BEA in France is an example of a protocol that works reasonably well.

Such an approach will require:

- ▷ That an interdepartmental coordination which will be associated with the various administrative services carrying out investigations (such as the inspectorate of work and DREAL) and other stakeholders, organised by the DGPR (Directorate General for the prevention of the Risks of the Department of the Environment) should be put in place to define the scope, the powers, responsibilities and resources of this structure for the joint collection of information;
- ▷ That in parallel, consideration should be given to the scope of the coordinated collection and its definition, as well as to the list of facts that must be established between the industrial undertakings and services;
- ▷ That representatives of the local communities such as Amaris should be involved;
- ▷ That the Fenvac can put forward its view.

On financial matters, the minister in charge of the joint structure should be able to have access to exceptional sums of money decided by the Prime Minister, in the case of an investigation that at first sight might be very costly. The structure of investigation should also be able to receive funds or assistance in terms of resources from the operating company associated with the collection of facts in connection with the accident.

On the basis of what has been done with the BEA and the BEA-TT, the content of the agreement could be determined between the DGPR and the Justice department.

In this situation, the signature presupposes a **political will of the executive** composed essentially of three stakeholders: the Department of Justice and the Ministries in charge of Industry and of the Ecology; in other words, the three Directors General who received delegated responsibility to sign for their respective minister in charge of the aforementioned skills, are able to sign this agreement which could have been previously worked out by their departments.

4.2 Give a European basis to this investigation process

Consensus

An essential brick in the setting up of this organisation, should be the publication of a European regulation or of a directive transposed by a French law which would transcribe at a high legal level the need to coordinate the two investigations, one judicial and the other safety, both performed in the public interest.

The regulation of the European Parliament and of the Council or the directive would also acknowledge the need to learn lessons from accidents that have occurred not only in our national space but also in other countries which are members of the European Union.

4.3 Create an office of investigation after an accident

Opinions were strongly divergent on this subject and consequently its principles and methods of implementation

It appeared advisable to some people to consider the creation of a 'Chemical' or an 'Industrial' office of investigation like the BEA or the BEA-TT or the American CSB, as the authority responsible for the conduct of standardised safety technical investigations.

This system would guarantee good technical expertise and allow various interested parties to know the facts in a perspective of progress.

The criminal process could also be strengthened by the existence of a high quality safety investigation, and both the designation and the choice of judicial experts could, for example, be facilitated.

It is observed that:

- ▷ Large companies have staff who are very knowledgeable and experienced on many subjects including the details of the tools that they operate. Following the example of the aircraft manufacturers, who cooperate in the investigations of the BEA, their contribution to the investigations should be organised. In addition, large companies and public institutions (INERIS, IRSN) are the places where the people pre-designated as directors of investigation can be found;
- ▷ On the other hand, for SMEs that do not have such resources, the assistance of such a system is indispensable.

4.3.1. Principles

Access to and the sharing of information would be guaranteed by an agreement of the type concluded by the BEA. The creation of this new office, its organisation, how it would decide its workload would in the short term be defined at the regulatory level before being covered by the texts of a higher level (French law, European Regulation).

At this stage, it would be a question of:

- ▷ Organising the investigation team (or at least a permanent structure, possibly part-time);
- ▷ Giving it the capacity to launch its investigations 'quickly' (go team and the provision of skills) and to have the resources to enlist the services of experts on a case by case basis;
- ▷ To ensuring its structural and financial independence;
- ▷ To define a scope of activity sufficient to allow a workload plan that would guarantee the acquisition and the maintenance of a good level of experience.

It should be noted that not only public opinion, but also the relatives of the victims, have serious doubts about the real independence of investigators from industry and even more so of the operating company, which appears to be at the centre of the accident. Yet the maximum expertise on any specific vehicle (and not on the principles or concepts that many more experts can bring) is found only in the industrial creators or users. Ethics and expertise should generate confidence over time.

4.3.2. Implementing the rules

There are two possibilities, which, moreover, can be two stages of a progressive rise in power.

1st possibility: structuring and creation of a kernel

A group of a few directors of investigation, generalist technicians, who know how to lead a safety investigation. For a safety investigation, the director of the investigation would be in charge of the conduct and coordination of different investigations conducted at that time. This would at least allow the sources of methodological conflicts to be reduced and would promote communication and the transfer of information.

2nd possibility: structuring and creation of three stages

- ▷ The Group of Directors of Investigation described above;
- ▷ Groups of investigators bringing together the appropriate specialists at the initiative of the director of investigations dealing with a particular accident. These groups can receive technical support from staff of expertise organisations, such as the INERIS or the IRSN and other recognised experts (university, inter-profession, etc.);
- ▷ Discussions as necessary between the two levels above and anybody who can provide information that can advance the investigation (operating company, constructor, trainers, suppliers, inter-profession, etc.).

Some procedures still need to be defined such as the logistical resources available, the method of financing, the origin of the Directors of Investigation (training, status), etc. While the examples of the BEA or of the BEA-TT can be used as a guide for some choices, it is likely that it will not be relevant to use these models exactly.

On this last point, divergent views also emerged within the discussion group. Some people like the work of the future 'BEA' to be carried out by an existing organization while others would like to create an independent structure.

In addition, some people imagine a structure that is very French, while others only consider that an inter-European structure, would have a sufficient volume of activity, to ensure a critical size and a suitably high level of skills.

Conclusion

The way in which the investigations in France, following major industrial accidents affecting installations classified to protect the environment, are organised and operated is the subject of much criticism. Indeed, besides the judicial investigation to enable the judicial authority to determine the criminal and civil responsibilities, various agencies and administrations have a need to understand the origins and circumstances of accidents, in order to be able to best deal with the follow-up to the accident, including how to propose solutions and avoid similar events. These include the operating company, the committee involving labour organisations, the labour inspectorate, the Seveso facilities inspectorate, trade unions, etc. Each one carries out, more or less, its own analysis but these investigations, which are based on different logics and are sometimes confrontational, are not coordinated while their areas overlap. In particular, access to the relevant facts is often blocked by the judicial investigation at the beginning of the investigation.

Thus, the members of the Institute for an Industrial Safety Culture (ICSI) wanted a discussion group to be set up, with a mandate that:

*is not to search for the convergence of the objectives of the different stakeholders involved in the conduct of these separate processes but to **consider the conditions to be met in order that a single investigation should be carried out** studying all of the observed phenomena and all the context and this, without any preconceived ideas. This comprehensive analysis would thus allow different parties to conduct their actions, which would determine responsibilities, prepare recommendations to improve safety. Improving the practice of investigation would also be an important element in the adoption of a different culture to take account of the risks and the evaluation of the measures taken to control them. This would also contribute to **improving the level of confidence** of the speakers in a public debate about a Seveso facility³.*

The response by all the participants in the discussion group to these expectations was positive and agreement was reached on certain points, but there were strong differences of opinion on the possibilities of implementation of the actions of progress:

1. In the first place, the group thought it was necessary to **predefine the list of information to be collected** to achieve a safety investigation (*consensus*).
2. The group thought it necessary to agree a **protocol of cooperation** (*consensus*) between the authorities in charge of the judicial investigation and the various organisations which today conduct safety investigations, to facilitate access to the factual findings at the beginning of the investigation. The current protocol in France for civil aviation accidents constitutes a solid reference that demonstrates, in particular, the compatibility of this kind of protocol with the judicial procedures that exist.
3. The group thought it necessary to **set up a high level legislative base** (*consensus*) which should transcribe a freely affirmed policy recognising that the best interests of society are found both in 'do justice' and in 'avoid similar accidents in future'. This legislative base, which is essential for the implementation of the actions for progress identified by the discussion group, would prescribe the provisions to be ensured, in law and vis-a-vis the opinion, the necessary credibility of this structure of safety investigation (independent of the investigation process, financial sources, profiles and the status of the staff, etc.). This political will could take a European dimension as is the case for civil aviation accidents, expanding the number of cases dealt with in passing from the French accidents to the European dimension, which would improve the statistical quality of investigations and deal with situations where the major accidents have cross-border effects. Europe could decide to strengthen the provisions relating to safety investigations (regulation of the Council and the Parliament) but their practical implementation could remain at national level or raise a single structure of investigation.
4. **With regard to the organisation of the investigation itself, two different options have emerged but have been the subject of strong differences of opinion as to their choice and consequently on the principles and methods of implementation:**

3. Extract from the group's mandate.

- ▷ Like the practices in the French air and land transport sectors, set up a **permanent structure** for carrying out safety technical investigations. The existence of this structure does not alter the responsibilities of various bodies to carry out their own investigations today but would bring them the results of a credible investigation leaving each of them to draw the conclusions which fall within their area. The experience accumulated over nearly seven decades by the BEA civil aviation and land transportation indicates an overall positive response with respect to the expectations of confidence expressed by the public, with the conclusions of the safety investigations generally taken into account in the judicial procedure. This configuration of the structure, with expanded functions for important incidents justifying the same treatment as the accidents dealt with under the Seveso Directive, could analyse six to eight French events per year.
- ▷ Another possibility, is to set up **a structure of investigation, where the staff would be designated in advance and able to start** the investigation within hours following the accident. These people would come from industry and the relevant institutes and would be assigned on a part-time basis. Industry and institutes in effect have a pool of skills that are very diverse.

Concerning this pool, some participants in the discussion group have advocated an approach that does not refer to the model offered by the air and land transport and entrusts the activation of a structure of the safety investigation to INERIS.

In this latter configuration, the accumulation of public trust would be a significant challenge.

Bibliography

Concerning the State of play:

Sklet, S. (2004). Comparison of Some Selected Methods for Accident Investigation, *Journal of Hazardous Materials*, 111 (1-3), pp 29-37.

Institute of Energy (2008) Guidance on investigating and analysing human and organisational factors aspects of incidents and accidents, ISBN 978 0 85293 521 7

Concerning the studies of the ESReDA:

Dechy N. et Dien Y. (2008) *Résultats et enseignements du groupe de travail de l'ESReDA sur les enquêtes après accidents*, [Results and lessons of the Working Group of the ESReDA on investigations after accidents], Papers from the conference λμ 16 of the Institute for the Control of Risks in October 2008, Avignon, France. www.imdr.fr

ESReDA (2003), Eds, Valvisto T., Harms-Ringdahl L., Kirchsteiger C., Roed-Larsen S., Accident investigation practices, results from a European inquiry, printed by DNV, and *Journal of Hazardous Materials* 111 of 2004

ESReDA (2003), Ed. Kirchsteiger C., Proceedings of the JRC/ESReDA 24th Seminar on Safety Investigation of Accidents, 12-13 May 2003, JRC, Petten, Holland, and *Journal of Hazardous Materials* 111 of 2004

ESReDA (2005), Eds. Roed-Larsen S., Stoop J., Funnemark E., Shaping public safety investigations of accidents in Europe, Imp. DNV

ESReDA (2007), Eds. Dechy N. Cojazzi G., Proceedings of the 33rd ESReDA Seminar on Future challenges of accident investigation, 13-14 November 2007, JRC, Ispra, Italy

ESReDA (2009), Eds, ESReDA working group on accident investigation; Guidelines for safety investigation of accidents, (downloadable from <http://www.esreda.org>)

ESReDA (2015), Guidelines for Preparing a Training Toolkit in Event Investigation and Dynamic Learning, Edited by Dechy N., Tulonen T., Dien Y., Vetere Arellano A.-L., Drupsteen L., Marsden E., Van der Vorm J., Roed-Larsen S., Strucic M., Stoop J., Felicio A., Cunha C. www.esreda.org

ESReDA, Ed. (2015), Barriers to learning from incidents and accidents, Marsden E., Dechy N., Dien Y., Drupsteen L., Felicio A., Cunha C., Roed-Larsen S., Tulonen T., Stoop J., Strucic M., Vetere Arellano A.-L., Van der Vorm J. www.esreda.org

Ineris (2009) Evaluation des risques des systèmes industriels - Rapport d'opération II.D Résultats et enseignements du groupe de travail de l'ESReDA sur les enquêtes après accidents N° DRA-08-95321-15659A [*Ineris (2009) Evaluation of the risks of industrial systems - Report of Operation II.D Results and lessons of the ESReDA Working Group on investigations after accidents N° DRA-08-95321-15659A*]

Concerning the BEA:

ICAO Annex 13 to the Convention on International Civil Aviation - Investigation on accidents and incidents in aviation - 10th edition July 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

Preliminary agreement concerning investigations of aviation safety (BEA Justice agreement of 16 September 2014).

Concerning the study of the US CSB on the accident at Texas City:

US CSB(2007), Investigation Report - Refinery Explosion and Fire, Report No 2005-04-I-TX, http://www.csb.gov/assets/1/19/Baker_panel_report1.pdf

The 'Baker' report which is complementary to that of the CSB:

Baker, J., Bowman, F., Erwin, G., Gorton, S., Hendershot, D., Leveson, N., Priest, S., Rosenthal, I., Tebo, P., Wiegmann, D. & Wilson, L. (2007). *The report of the BP US refineries Independent Safety Review Panel*, available at www.bp.com

Concerning the presentation of the BARPI:

Site of the BARPI: <http://www.aria.developpement-durable.gouv.fr/>

Annex VI of the Directive No 2012/18/EU of 4 July 2012 on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC (Seveso Directive III): Criteria for the notification of a major accident to the Commission, laid down in Article 18, paragraph 1

Concerning the Ineris Guide:

Ineris (2011) *Elaboration d'un memento technique d'enquête après accident* [Development of a technical guide for investigation after an accident] – Rapport d'étude N°DRA-08-95321-15486B

Regarding the connection with the legal world

DODIER N., *Causes et mises en causes : innovation sociotechnique et jugement moral face aux accidents du travail* [Causes and questions: socio-technical innovation and moral judgement in the face of accidents at work], *Revue française de sociologie*, XXXV, 1994, p. 251.

MORTUREUX Y., *Arbre de défaillance, des causes et d'événement* [Fault tree of the causes and of events], *Techniques de l'ingénieur*, traité CD-ROM Sécurité et gestion des risques, n°SE 4050-3 du 10 octobre 2002

TERSSAC (de) G. and MIGNARD J., *Les paradoxes de la sécurité* [The paradoxes of safety], PUF, 2011, coll. Le travail humain, p. 149

Complementary Publications:

Blatter C., Dechy N., Garandel S. coordinators for the human factors group of the IMDR (2016), *Vers un retour d'expérience prenant en compte les facteurs organisationnels et humains* [Toward a feedback of experience taking into account the organisational and human factors], *IMdR - 2016/09*, www.imdr.fr

Dechy, N., Dien, Y., Llory M. (2010), *Pour une culture des accidents au service de la sécurité industrielle* [For a culture of accidents in the service of industrial safety], *Congrès λμ 17 de l'IMdR*, La Rochelle, 5-7 octobre, www.imdr.fr

Groupe d'échange Icsi "Analyse d'événement" (Discussion Group ICSI 'Analysis of the event') (2013). Numéro 2014-04 des *Cahiers de la sécurité industrielle*, Institut pour une culture de sécurité industrielle, Toulouse, France (ISSN 2100-3874). Available free of charge from the URL <http://www.icsi-eu.org>

Rapport INERIS, Dechy N., Dien Y., Llory M., (2008), No DRA-08-95321-15660A du 23/12/2008, *Les échecs organisationnels du retour d'expérience* [The organisational failures of the feedback of experience], www.ineris.fr

IRSN (2014), *Faire du REX aujourd'hui : pourquoi ? comment ? – Repères pour un retour d'expérience événementiel source d'apprentissage* [Making feedback today: Why? How? - Landmarks for a feedback of experience from events: A way of learning], rapport IRSN PSN-SRDS/2014-00019, www.irsn.fr

Marsden E. (2014), Ed. Groupe de travail REX Foncsi coordonné par E. Marsden, *Quelques bonnes questions à se poser sur son dispositif de retour d'expérience* [A few good questions to ask on its system for the feedback of experience], les *Cahiers de la sécurité industrielle*, 2014-01. www.foncsi.org

And, in addition, the following document: Vuorio, A., Stoop, J., Johnson, C., The need to establish consistent international safety investigation guidelines for the chemical industries, *Safety Science* 95 (2017) 62–74, dealing with subjects dealt with by the group has been brought to its attention but has not been the subject of debate in view of its publication after the meetings.

Abbreviations

- AIB:** Accident Investigation Branch
- Aria:** Analysis, research and information on accidents;
- ASN:** French Nuclear Safety Authority
- ATAIC:** Air Transport Accident Investigation Commission
- BARPI:** Bureau for analysis of risks and industrial pollution
- BEA:** Office of investigations and analysis for Civil Aviation Safety
- BEA-TT:** [*Bureau d'enquêtes sur les accidents de transport terrestre*] The Land Transport Accident Investigation Bureau (BEA-TT);
- CERCHAR:** [*Centre de recherche des charbonnages de France*] The French Coal Research Centre
- CHSCT:** [*Comité d'hygiène, de sécurité et des conditions de travail*] Committee of hygiene, safety and working conditions
- Cnes:** [*Centre national d'études spatiales*] National Centre for Space Studies
- CNESTG:** [*Commission nationale d'évaluation de la sécurité des transports guidés*] National commission for the evaluation of the safety of guided transport
- CSB:** Chemical Safety and Hazard Investigation Board (USA)
- DGAC:** [*Direction générale de l'aviation civile*] Civil Aviation Directorate
- DGPR:** [*Direction générale de la prévention des risques*] The Directorate General for the Prevention of Risks (Ministry of the Environment)
- DGITM:** [*Direction générale des infrastructures, des transports et de la mer*] Directorate-General for Infrastructure, Transport and the Sea
- DREAL:** [*Direction régionale de l'environnement, de l'aménagement et du logement*] Regional Office for the Environment, Planning and Housing
- EASA:** European Aviation Safety Agency
- EPA:** Environmental Protection Agency (USA)
- EPI:** [*Enquêteur de première information*] Investigator to collect initial information
- EPSF:** [*Établissement public de sécurité ferroviaire*] The French railways safety authority
- ESReDA:** European Safety, Reliability & Data Association
- FBI:** Federal Bureau of Investigation (USA)
- FENVAC:** [*Fédération nationale des victimes d'attentats et d'accidents collectifs*] National federation of victims of attacks and collective accidents
- FonCSI:** Foundation for an industrial safety culture
- GTA:** [*Gendarmerie des transports aériens*] Air Transport Gendarmerie
- HSE:** Health and Safety Executive (UK)
- ICSI:** [*Institut pour une culture de sécurité industrielle*] Institute for an industrial safety culture
- IFSA:** French Institute of Aviation Safety
- IGE:** [*Inspection générale de l'environnement*] General inspectorate of the Environment (France)
- INERIS:** [*Institut national de l'environnement industriel et des risques*] National Institute for the industrial environment and risks (France)
- IRCGN:** [*Institut de recherche criminelle de la gendarmerie nationale*] Institute of Criminal Research of the National Gendarmerie (France)
- IRCHA:** [*Institut de recherche chimique appliquée*] Institute of Applied Chemical Research (France)

- IRSN:** [*Institut de radioprotection et de sûreté nucléaire*] Institute of Radiation Protection and Nuclear Safety (France)
- MAHB:** Major Accident Hazards Bureau (EU)
- MARS:** Major Accident Reporting System
- MOU:** Memorandum of Understanding
- NTSB:** National Transportation Safety Board (USA)
- ICAO:** International Civil Aviation Organisation
- IMO:** International Maritime Organization
- OSHA:** Occupational Safety and Health Administration (USA)
- RAIB:** Railway Accident Investigation Branch (UK)
- STRMTG:** [*Service technique des remontées mécaniques et des transports guidés*] Cableways and guided transport technical service (France)
- WGAI:** [*Groupe d'échange*] Working Group

Reproduction of this document

With the exception of the ICSI logo and other logos and images it contains, this document is licensed according to the [Creative Commons Attribution-NoDerivs licence](#). You are free to share (copy, transmit and distribute) the document under the following conditions:

- ▷ **Attribution.** You must attribute the work in the manner specified by the author or licensor (but not in any way that suggests that they endorse you or your use of the work).
- ▷ **No derivative works.** You may not alter, transform or build upon this work.



You can download this document, and others in the *Cahiers de la Sécurité Industrielle* collection, from ICSI's web site. Documents are available in pdf.



Publisher: **Institut pour une culture de sécurité industrielle**
(Institute for an Industrial Safety Culture)

A French non-profit organisation (Association de loi 1901)

<http://www.icsi-eu.org/>

6 allée Emile Monso – BP 34038
31029 Toulouse Cedex 4
France

Phone: +33 (0) 534 323 200
Fax: +33 (0) 534 323 201
E-mail: contact@icsi-eu.org



6 allée Émile Monso ZAC
du Palays - BP 34038
31029 Toulouse cedex 4
FRANCE

www.icsi-eu.org