

## Accident investigation practices in Europe— main responses from a recent study of accidents in industry and transport

Sverre Roed-Larsen<sup>a,\*</sup>, T. Valvisto<sup>b,2</sup>, L. Harms-Ringdahl<sup>c,3</sup>, C. Kirchsteiger<sup>d,4</sup>

<sup>a</sup> Work Research Institute (AFI-WRI), P.O. Box 6954, St. Olavs Plass, NO-0130 Oslo, Norway

<sup>b</sup> Safety Technology Authority (TUKES), P.O. Box 123, FIN-00181 Helsinki, Finland

<sup>c</sup> Royal Institute of Technology (INDEK), SE-100 44 Stockholm, Sweden

<sup>d</sup> Institute of Energy—Nuclear Safety Unit (JRC), Westerduinweg 3, NL-1755 Le, Petten, The Netherlands

### Abstract

Europe has during recent years been shocked by disasters from natural events and technical breakdowns. The consequences have been comprehensive, measured by lost lives, injuries, and material and environmental damage. ESReDA wanted in 2000 – by setting up a special expert group on accident investigation – to clarify the state of art of accident investigation practices and to map the use of thoroughly accident investigation in order to learn lessons from past disasters and prevent new ones. The scope was to cover three sectors in the society: transport, production processes and storage of hazardous materials, and energy production. The main method used was a questionnaire, which was sent in 2001 to about 150 organisations. About 50 replies were analysed. The replies showed great variations but also similarities, among others in definition of accident and incident, the objectives of the investigation team, criteria used to start an investigation, the status of the investigation organisation, the flow of information, the composition of the investigation team, and the use of internal or international procedures or rules. Several methods (in total 14 different methods were mentioned) were used for carrying out accident /incident investigations. Most of the respondents were willing to co-operate in one or another way with ESReDA. Although there are important biases in the material, the results from questionnaire are important inputs to the future work of ESReDA Expert group in this field. 3 safety approaches have been identified. © 2004 Published by Elsevier B.V.

*Keywords:* Disaster; Accident; Incident; Investigation; European survey; ESReDA

### 1. Accident investigation in Europe—2003

Several disasters from natural events and technical breakdowns have during the recent years shocked Europe. The consequences have been many lost lives and severe material damage. Many—including the politicians, the safety authorities, the victims, the mass media, the public, etc.—have asked questions about the causes; some have focused on the possibilities to prevent similar accidents. They all unite in

the common belief that some disasters could have been prevented, and that the severe consequences arising from other disasters could have been reduced.

Accident investigation is the most widely used method to clarify the basic, contributing and immediate causes to such accidents as well as identifying the appropriate measures to prevent the occurrence of similar events in the future. The obligation to investigate is partly mandatory by law, partly necessary by ethical or commercial reasons. The methods vary a lot.

### 2. ESReDA— accident investigation as part of a broader safety approach

ESReDA has from its very beginning been engaged in accident prevention. One of its very first expert

\* Corresponding author. Tel.: +47-23369218; fax: +47-22568918.

*E-mail addresses:* sverre.roed-larsen@afi-wri.no (S. Roed-Larsen), tarja.valvisto@tukes.fi (T. Valvisto), Lars.Harms-Ringdahl@lector.kth.se (L. Harms-Ringdahl), christian.kirchsteiger@jrc.nl (C. Kirchsteiger).

<sup>1</sup> Expert group member, ESReDA Accident Investigation Group.

<sup>2</sup> Tel.: +358-96167415; fax: +358-96167210.

<sup>3</sup> Tel.: +46-86432080; fax: +46-86436340.

<sup>4</sup> Tel.: +31-224565118; fax: +31-224565641.

groups—the expert group on accident analyses (ESReDA AA)—examined different aspects of the problem over some years. Highlights were two seminars—accident analysis in 1994 and learning from accident investigations (1995)—the publication of an inventory of accident databases (1997) in Europe, another seminar about accident databases in Antwerp (1999) and the publication of a guidance document for design, operation and use of safety, health and environment (SHE) databases.<sup>5</sup> Both the publication of the Guidance Document and the expert group work were finalised in 2000.

As a direct follow up of the work completed by this expert group, a proposal to establish a new expert group on accident investigation (AI) was forwarded at the last AA expert group meeting in Paris September 2000 and later endorsed by the EC of ESReDA. The new ESReDA AI expert group had four objectives:

- to identify and describe the state of the art of accident investigation in Europe (European, national and company level);
- to identify and present generic recommendations for involved parties in order to obtain better knowledge of accident mechanisms through the use of investigation methods;
- to present recommendations for involved parties with regard to the implementation of findings from accident investigations with a view of improving safety management;
- to develop general guidelines for accident investigation and for the implementation of appropriate recommendations.

The overall vision was to contribute to a safer society in Europe.

### 3. The ESReDA approach to the European study

First of all, there was a need to clarify the use of accident investigation practices among public safety authorities and organisations involved in high-risk activities. No extensive study had been done so far to map the total situation in Europe. The lack of adequate information about the situation in Europe was a clear drawback to be filled.

From a legal point of view, the European Commission has during the recent years been advocating the need to investigate accidents. One example is the Seveso II directive<sup>6</sup> on the control of major accident hazards involving dangerous substances; others are sectorial approaches in the transport field.

On the national level, all EC and EEA countries have the obligation to implement such directives as the Seveso II di-

rective in their national legislation. In addition, many European countries have separate and mandatory obligations upon public and private enterprises to both notify and investigate on their own serious accidents and incidents, especially in the working environment, but also in fields such as transport, process industry and energy production.

On a company level, some firms have established, maybe as part of a safety management system, a systematic reporting system for accident and incident, and a permanent or ad hoc investigation system as a follow up. The reasons may be many: a mandatory duty, ethical or reputation considerations, the need of confidence from their customers, image aspirations, etc.

However, little or no comprehensive research studies have been done to establish the extension of accident investigation and to measure the effectiveness of such investigation systems or procedures on an European level.

As a first step, the ESReDA AI group decided to use a questionnaire in order to gather as much systematic information of the state of the art as possible and to find out if there was a need for information about “good practices” in the field. One hundred and thirty-six organisations were selected. The majority were authority or government bodies (92) and the rest mainly industrial firms or organisations, research centres, universities and consultancy firms. A few international organisations, such as OECD and Joint Aviation Authorities, were also included. The questionnaire<sup>7</sup> was sent out in April 2001, a reminder in August 2001 and to some new respondents in January 2002 to include missing countries.

### 4. The questionnaire—and the main responses

The questionnaire was structured with 16 questions, partly with given response alternatives. The questionnaire covered several aspects, such as the definition of accident/incident used, the formal investigation structure, the internal decision-makers, the selection criteria used, the objectives, the scope, the procedures/instructions, and information about the standard method (see Appendix 1 to the report<sup>8</sup>).

Altogether, 59 authorities, firms or organisations responded with a few from outside Europe. Forty-nine answers are treated in the ESReDA report, covering 15 countries in Europe. The largest number of answers came from Sweden (11), Norway (10), The Netherlands (6), Finland (5), and France (5). In other words, five countries count for 37 responses or for about 75% of the total number of answers.

One important reservation is that neither the list of selected authorities, firms and organisations nor the responses

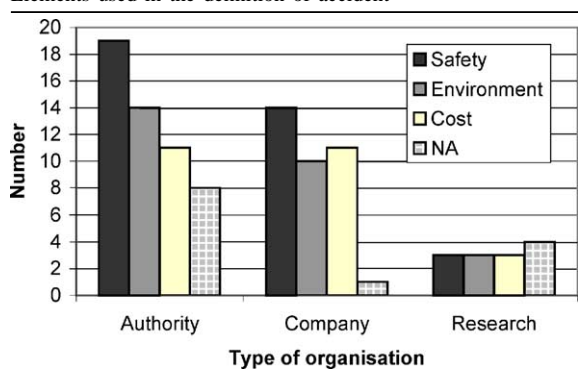
<sup>5</sup> Guidance document for design, operation and use of safety, health and environment (SHE) databases. ESReDA Safety Series, 2001. Printed and distributed by DNV, Norway.

<sup>6</sup> Seveso II directive, 96/82/EF, adopted 9 December 1996.

<sup>7</sup> The questionnaire itself is adopted as an appendix to the main report.

<sup>8</sup> Accident investigation practices—results from a European inquiry. ESReDA Safety Series, 2003. ISBN 82 515 0301 9. Printed and distributed by DNV, Norway.

Table 1  
Elements used in the definition of accident



can give us a true picture of the actual situation in Europe. Neither the selected target group nor the responses are representative, from several points of view: by country, by public safety authorities, by companies, by academic institutions, etc. The information given in the answers must therefore be looked upon as a kind of snapshot, reflecting the situation as discovered and experienced by the 49 respondents.

The respondents were divided in three main categories:

- authority (27);
- company (15);
- research (7) (consultant/research centre/university).

Regarding definitions, most of the respondents used either definitions including consequences for health, environment or property (unwanted event with significant consequences) or used definitions taken from a legal document. However, the definition of incident was more diverse, with about 40% classifying it as a near miss, 20% referred to EU or national legislation while 40% had different understandings.

When it comes to elements used in the definition of accident (see also Table 1) and incidents, there is a remarkable difference in the answers: while most of the respondents include safety/environment/costs in their definition of an accident, the majority of the respondents are uncertain regarding incidents and answered do not know—the incident definition seems to be more fuzzy than the accident definition.

## 5. More specific findings

The respondents were asked about the primary objectives of the different levels in the investigation organisation. Generally, the main objective of the investigation team (both in the public and private sector) was to collect facts and to find primary and underlying causes of an accident. Another objective was to prevent a similar accident to happen. Authority or government bodies also mentioned some other objectives:

- to make recommendations (also mentioned by a research body);
- to find a need for development of legislation;

- to find any breaches of law;
- to learn from the accident;
- to decide on information dissemination.

When the question of primary objective where directly connected to the accident investigations, the concentration on prevention of accidents or recommendation to reduce or eliminate the identified threats were even more overwhelming (60 replies). But 23 replies mentioned “just fact-finding” as a primary objective.

The answers regarding the question on the scope of investigation, focused on three main elements:

- transport (31 organisations) by:
  - road;
  - air;
  - water;
  - rail;
  - pipeline.
- reduction processes (13);
- storage (13).

The majority of organisations mentioned transport (road, rail, air, water and pipeline) as a scope. Part of the organisations mentioned production processes and storage. Several organisations had a wide scope including two or three elements from the list. Of the organisations dealing with transport accidents, most investigated railway accidents (17).

The respondents were asked if a formal investigation is carried out depending on the probability and/or the consequences of an accident. For about 33% of the responding organisations only the consequences or the consequences weighted by their probability (i.e. the accidental risks) determined whether or not an accident investigation is carried out. While authorities or government bodies concentrate more on consequences only, companies tend to also include considerations on risk. About 26% of the responses (especially authorities, but partly also companies) responded that “all accidents” are investigated.

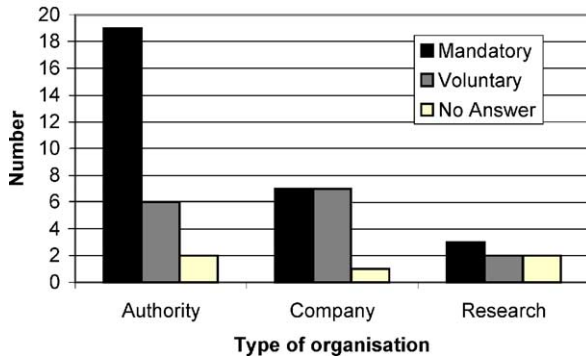
The organisations were also asked if a formal permanently established organisation is active in carrying out accident investigations within their field in their country. About 75% of the organisations replied that a formal permanent established organisation was active in carrying out accident investigations within their field in their country.

Next, the organisations were asked if it is mandatory or voluntary to provide information to an accident investigation team. For about 66% of organisations the provision of information for an accident investigation team is mandatory (the case of many organisations, and especially the case of most authorities (in some cases mandatory directly by law). Sometimes, in cases where the statement is considered very important and critical, questioning is carried out by bodies representing the law (the police, the court) (Table 2).

The respondents were asked to describe the structure of the permanent or temporary organisation responsible for accident/incident investigations. They were asked to indicate

Table 2  
Providing information to an accident investigation team

Providing information is	Authority	Company	Research
Mandatory	19	7	3
Voluntary	6	7	2
No Answer	2	1	2



the possible levels in the organisation (e.g. a board, a chamber, committees).

Accident investigation boards/bureaus usually form the accident investigation team of their own investigators. In some cases, they use also investigators employed on contract. The investigation is often managed or supervised by the head of board.

Other authorities or government bodies, research centres and universities have either permanent investigators or form a temporary investigation team of safety specialists.

Companies and consultants do not usually have a permanent organisation for accident investigation. They often form an accident investigation team/committee of their own personnel. In the team, there can be safety officer, safety technician, safety specialists, safety delegates, line organisation or eyewitnesses of the accident.

The respondents were asked who (in their organisation) appoints/nominates the members of the investigation team. Top or middle management generally appoints an investigation team or an investigator, when it is a question of a company or a research centre. Major accident investigations can be carried out in co-operation with authorities or other external experts. In minor cases someone involved with the safety or EHS matters of the company can appoint an accident investigation team. In authority and government organisations, the management of the organisation or the managers responsible for the specific domain in which an accident has occurred appoints investigation teams. In cases where a formal, permanent organisation has been established for that purpose, the appointment of an investigation team is made by a government (e.g. ministry) or the permanent body.

The respondents were also asked for the criteria for the appointment of the team members. The following were mentioned as possible criteria:

- a multi-disciplinary recognised safety specialist;
- a generally recognised specialist (e.g. in transportation safety);

- a specific specialist (e.g. in the safety of ammonia production);
- an expert on human reliability.

It was possible to mention several criteria. Most of the respondents mentioned the specific specialist as an appointment criterion. Other criteria were also mentioned but in a less amount. Authorities or government bodies mentioned also members of permanent boards or bureaus while companies and consultants mentioned line managers or foremen and people involved in the accident.

Respondents were asked to “describe the procedures/instructions that are available for carrying out accident/incident investigations”. Several organisations (45%) mentioned that they use some kind of internal procedures, instructions or rules. Five of the organisations are referring to international or national procedures, such as:

- International procedures:
  - Annex 13 (aircraft accident and incident investigation) to international civil aviation convention.
  - International Maritime Organisation (IMO): resolution A.849 (20), code for the investigation of marine casualties and incidents (27 November 1997) and resolution A.884 (21), amendments to A.849 (20) (25 November 1999).
- National procedures:
  - Swedish act (1990:712) and ordinance (1990:717) on investigation of accidents.
  - The requirements stated in Sections 70 and 70a in the Swedish rescue services ordinance.
  - Norwegian regulation concerning public prosecution (28 June 1985) and standard instructions for the maritime investigators (19 August 1998).
  - Railway safety (UK): a railway group standard GO/RT 3434/3 accident investigations and formal inquiries (1997).

In all 34 answers are referring to an instruction or procedure of some kind, representing 69% of all respondents. A few are preparing their own manuals, and the remaining organisations have not referred to any procedure.

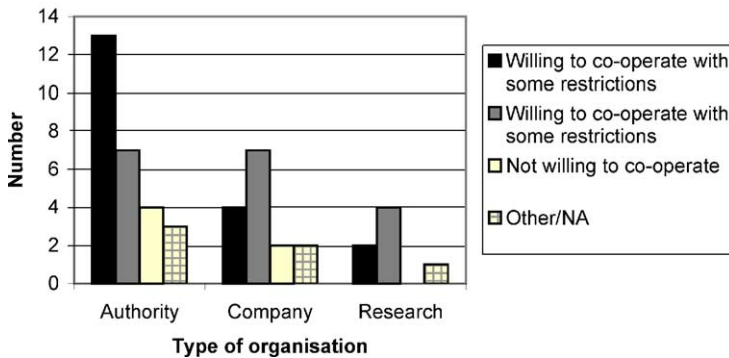
The respondents were also asked to “describe the standard method that is recommended for carrying out accident/incident investigations”. Examples are:

- TRIPOD method.
- Human error analysis.
- Cause-consequence analysis.

Eleven organisations stated that they have a recommended method. However, the largest group explicitly answered that they had no standard method. It can be noted that 12 answers were difficult to interpret, and they were classified as “unclear”. Among the 11 organisations with a recommended method, five selected Cause-consequence analysis. The rest of these organisations had all chosen different methods. These were fault tree analysis, human

Table 3  
Willingness to co-operate with ESReDA

Willingness to co-operate	Authority	Company	Research
Willing to co-operate with some restrictions	13	4	2
Willing to co-operate with som	7	7	4
Not willing to co-operate	4	2	0
Other/NA	3	2	1



error analysis, probability risk analysis, and root cause analysis. In all, there were 14 names of different methods mentioned. Of these, eight were mentioned by only one respondent.

## 6. The willingness to co-operate

The respondents were also asked if they are willing to co-operate with ESReDA and inform ESReDA more detailed about the investigations. Most of the organisations were willing to co-operate with ESReDA or to co-operate with some restrictions. The organisations also mentioned restricting issues, such as lack of resources and confidentiality with regard to accident investigations. The following forms of co-operation were mentioned:

- interview with ESReDA;
- providing information by e-mail;
- giving bookmarks to relevant web pages.

In total, 37 out of 49 were willing to co-operate in one or an other way with ESReDA (Table 3).

## 7. Discussion—some critical questions

The questionnaire was distributed to around 150 institutions/organisations within the transport and industry sectors. In total, 49 European organisations responded giving a response rate around 30%, which can be regarded as fairly low. There is also an outcome on the geographical distribution between different countries, which is not typical. There is an obvious Nordic bias in the material, and the re-

sponses from Sweden, Norway and Finland amount to 26 organisations—corresponding to 53% of all answers.

Accordingly, the material cannot be regarded as a statistically valid picture of the state of accident investigations comparing nations. However, it should be noted that the ambition was not to obtain a statistical representative sample of respondents in Europe (Table 3).

As a whole, the material gives a fairly good estimation of the situation regarding accident investigation. It gives information about methods, approaches, aims, etc., and it can give good background information for the development of guidelines.

## 8. Conclusions from the questionnaire

Responses from 49 organisations have been obtained, which gives a good estimation of the situation regarding accident investigation in Europe. However, the material does not give a statistically valid picture of the state of accident investigations comparing nations.

Most definitions of accidents are based on the extent of unwanted consequences in terms of health, environment and loss of property. There is a considerable reliance on corresponding accident definitions in national, EU or international legislation.

A clear majority (69%) of the organisations referred to a standard procedure of some kind for making the investigations. The procedure issue had a much higher priority than the choice of methods. It was a large variation on the view on methods, both considering the use and the preferred type of method. There was no clear dominance for any specific method.

A conclusion is that an important task for the ESReDA working group on accident investigation is to:

- make an overview of methods available for accident investigations;
- identify studies, which have evaluated different methods, compared with each other or with non-method approaches;
- initiate studies of evaluations.

## 9. Future work

Based on the facts given in the replies from the respondents to the ESReDA questionnaire and on commonly known facts about the accident investigation situation in Europe, some important challenges, apart from the tasks mentioned above as conclusions from the questionnaire, would be:

1. To develop, in close cooperation with key players at the European level and national levels, a joint research programme in Europe concerning different aspects of accident investigation, including several state of the

art-studies as first phase task. The European Commission should be challenged to take the initiative and the lead in the process that should involve key practitioners, public servants, consultants and research persons. A separate strategy should be developed to disseminate the results from this broad research programme in order to improve the factual use of the results.

2. To collect, analyse, and put together examples of “good practices” from three different levels of organisation: international organisations (such as EC, ICAO, IMO, UIC, etc.), national accident investigation commissions and company accident investigation commissions, and publish the recommended guidelines.
3. To stimulate both legal bodies and operational bodies to enhance more harmonised measures and tools in their work with accident investigation, including definitions, legal requirements (also requirements to objectivity, independence, competence, etc.), institutional bodies, methods and procedures, reporting systems and routines, etc.

These approaches, among others, would contribute to a safer Europe tomorrow.