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Summary of JRC/ESReDA Seminar on Safety Investigation of Accidents, 12–13 May 2003, European Commission, DG JRC-IE, Petten, The Netherlands

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1. Background: European Commission policy initiatives to protect the public and the environment from major technological accidents

The European Commission, and especially DG TREN and DG ENV, has investigated since a long time how to best protect the public from major accidents originating from industrial activities, such as operation of power plants or the various transport modes, in a way that does not compromise the competitiveness of the industry concerned. Not least due to these initiatives, there is nowadays broad consensus in Europe that it is essential to ensure the safety of the energy, transport and process industries in a cost-effective way and that the public has a rational perception of the risks posed by these industries to the environment and society at large.

Further, the awareness of the fact that a major accident in one industry sector gives no market advantage to a competitor if it leads to a general loss in confidence by the public in the industry has recently led to a healthy openness and exchange of information regarding safety issues amongst operators, regulators and the general public. Society is also seeking to ensure that man-made risks are clearly identified and assessed, so that necessary measures can be taken to reduce them to an acceptable level. Together with the knowledge that the consequences of major accidents are not confined to national boundaries, all this has resulted in a number of regulatory initiatives on both national and EU levels.

For various industry sectors in the EU, such as energy and transport, there is intensive discussion on the use of uniform 'safety standards'. Somewhat similar initiatives are going on in other industry sectors, e.g. for various transport modes, or have already succeeded in drafting an EU Directive, such as for the process industry (Seveso Directive). The current proposal by DG TREN for a framework Directive defining basic obligations and general principles in the field of the safety of nuclear facilities is one example. Further, there is a recent initiative by DG ENV in the context of its civil protection work program on discussing to propose horizontal legislation on risk mapping and to introduce an obligation to inform the Commission of natural or man-made disasters exceeding a certain magnitude. Clearly, this would concern all types of natural and man-made hazards, from forest fires to floods, and from transport modes to the energy sector.

The role of DG JRC in this context is to provide policy DGs, such as DG TREN and DG ENV, customer-driven scientific and technical support for the conception, development, implementation and monitoring of EU policies. As a service of the European Commission, the JRC functions as a reference centre of science and technology for the Union.

2. DG JRC initiative: organisation of a seminar to review status and needs of accident investigation

From 12 to 13 May 2003, DG JRC's Institute for Energy (JRC-IE) in Petten/The Netherlands hosted a seminar on safety investigation of accidents, jointly organised by DG JRC-IE and the European Safety and Reliability Data Association (ESReDA).

Although accidents will continue to occur in the future, there is hope that their consequences can be kept low. It is essential that we learn the lessons by a systematic analysis of the contributing factors, the more direct causes and the development and effects of past accidents, and that the lessons are disseminated to all stakeholders. The objective of the JRC/ESReDA seminar was to address precisely these

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issues. It provided an opportunity for cross industry sector sharing of experiences in the field including both good practice and identification of problem areas in an international perspective.

The seminar brought together more than 150 European and international participants from industry, public authorities and research from the energy sector (nuclear, non-nuclear), transport modes (aviation, road, aerospace and rail) and process industries. About 50 presentations and panel discussions were given by experts in accident investigation and risk assessment from about 25 different countries and international organisations, such as the IAEA, OECD-NEA, WANO, as well as from Commission services.

Representatives of DG TREN and DG ENV opened the seminar by discussing the need for an EU approach to accident investigation, both within specific and across different industry sectors (energy, transport, chemical), as well as its relations to existing or planned policy initiatives regarding risk regulation, risk mapping and civil protection measures.

The sessions of the workshop then split up according to the following areas:

- cross industry issues,
- energy sector,
- transport,
- process industry.

On the beginning and end of the second day of the seminar, rapporteurs presented in plenary sessions for discussion to the audience the main findings of the individual presentations and of the ensuing discussions.

3. Results: some general conclusions and recommendations from the seminar

In each session, a diversity of aspects was covered from the emerging legislative framework, investigation practice and training to risk and safe system modelling. Presentations ranged from providing a general overview of the status of issues and identifying areas for potential improvements both by legislative and scientific/technical measures through to presenting detailed information on some of the latest research and development, in particular on investigation techniques. The views of industry, regulators, research entities and various international organisations were well represented for all industry sectors and a good balance was achieved which formed the basis for constructive and effective discussions. Focus was given not only to the relevant issues where common understanding exists but also to identified problem areas which need further research and development and which can benefit from international co-operation.

From the industry-specific presentations and the common panel discussions, the following general conclusions and recommendations emerged:

- *Objectives and scope of accident investigations*: These can be quite different (search for the ‘root cause’, determine extent of damage, etc.) and the size of an investigation usually simply depends on the severity of an accident. Therefore, different methodologies that are appropriate to the specific objective and accident severity should be applied. A number of methodologies were presented and compared at the seminar. The diversity of approaches was surprising to most participants and previously unknown to them. Event investigation approaches currently used are very much based on well known methodologies and techniques, e.g. HPES, MTO or ASSET. In those industry sectors where probabilistic safety assessment (PSA) methods are well developed and applied, as is the case with nuclear energy, the safety significance of events and their rating can effectively be assessed also by using plant-specific risk assessments.
- *Causes of accidents*: The evolution of accident investigations over time seems to show a shift from the consideration of technical factors to human factors and today organisational factors. Several examples of accidents in the three different areas (energy, transport and process industry) illustrated that a multitude of factors and combinations between them lead to the occurrence of major accidents many of which relate to the organisation and management of a company.
- *Near misses*: As the same deficiencies in system safety can often be revealed by events without accident consequences, it was recognised that particularly important lessons can be learned from near misses. Investigation of incidents and near misses or the use of models to identify safety lessons can avoid problems encountered with accident investigation. However these alternatives are not without drawbacks and in any event do not replace the imperative for thorough safety investigation of accidents. They can provide a useful complement in identifying deficiencies and promoting changes to the actual safety system being modelled or investigated. The ultimate aim being to avoid the accidents before they occur and thus remove the need for accident investigation.
- *Investigation by different stakeholders*: Accident investigations are not only carried out by industrial operators but also by public authorities or independent third parties. They can either be ‘institutionalised’ or they can be performed by ‘ad hoc’ committees or inquiry boards. As an example, there were five different investigations of the September 2001 ammonium nitrate explosion in Toulouse/France without any co-operation or cross-fertilisation between the different investigation teams. This reflects the general problem that the different accident investigation methods and the corresponding theoretical frameworks are often not widely known outside specialised institutions or the research world.
- *Judicial or technical investigation*: Accidents with serious consequences, particularly those involving fatalities, are often followed by more than one type of investigation. Broadly investigations may be grouped into two general types: judicial investigations and technical (or safety)

investigations. The purpose of these two types is quite different and the presence of the former can have a harmful effect on the latter. The judicial investigation seeks to identify breaches of laws and by extension people to blame, whilst the technical investigation's sole purpose is to reveal the safety lessons without apportioning blame or liability. Therefore it is essential that the technical investigation is perceived by all parties as being a safety investigation only and that it is allowed to proceed with free access to all relevant information but with no obligation to disclose witness statements to those conducting a judicial (or police) investigation.

- *Credibility of investigators*: Although organisational independence of the safety investigation body is generally seen as a sound basis, success in identifying immediate and underlying causes of accidents will largely be dependent on its credibility. It must demonstrate through the behaviours of investigators that it impartially identifies the safety lessons with understanding and empathy for those affected by the accidents but without being seen as having any part in any judicial investigations. The competence of investigators will determine the way that people see safety investigations and the quality of their reports. Developments such as system models, training modules and handbooks, can all help to support investigators in meeting expectations that underlying causes are identified following accidents. Fundamental to successful safety investigations is trust. The safety investigators must secure the trust of those who were involved in the accident to encourage their co-operation in providing all relevant information. The trust of those affected by the accident (such as the victims and their families) as well as that of the involved parties is crucial to the acceptance of the safety investigation report findings and recommendations. The subsequent achievement of real safety improvements through actions in response to investigators' recommendations will build trust in the investigation process for the future.
- *Long term use of knowledge resulting from investigations*: Safety investigations of accidents should be considered as part of the safety culture of an enterprise. Examples of different industries showed that incident reporting is very common in all industry sectors but a classification system is needed to make the right choice of events that should be investigated in order to be able to learn lessons from them. The transfer of knowledge gathered through accident investigations into prevention and preparedness measures seems to be a particular challenge as this necessitates the creation of a 'corporate memory'. The understanding as to what constitutes an accident, incident, near miss etc. is quite different across different industry sectors. Similarly, the degree of harmonisation within a specific sector differs significantly, mainly depending on the perceived 'extent of the hazard'. As an example, in the nuclear industry the national systems in place ensure the collection, reporting, investigation and dissemination of lessons learnt from operational events within the interested organisations in a country. The most significant feedback is also shared internationally, through, for example, the joint IAEA/OECD Incident Reporting System or the event information exchange of the World Association of Nuclear Operators (WANO).
- *Continuous need for international exchange of information*: There is a continuous need for international exchange of information on the important lessons learnt from accidents and incidents in the energy sector. The benefits of international co-operation are clearly recognised and considered to be vital in furthering the cause of safety at energy installations world-wide. The International Nuclear Event Scale (INES) is widely used to facilitate communication and understanding between the nuclear community, the media and the public on the safety significance of events occurring at nuclear installations. Information reported under INES is not adequate in itself, nor was it meant for, comparisons between installations or countries. However, the usefulness of systems like INES is very much dependent on the participating countries' contributions and their openness and readiness to provide national data. All of the nuclear safety regulators that have reported at the seminar have a national system for reporting, analysing and rating operational events. The contribution of an effective operational experience feedback process is recognised as a valuable element in the continuous drive to reduce incidents and accidents and the associated costs these bring in both human and financial terms. The experience gained in the nuclear industry with regard to reporting systems and international sharing of information could provide a good example for the rest of the energy sector and possibly beyond (e.g. transport modes and process industries).
- *Comparative risk assessment*: An analysis of databases containing consistent information on accidents can prove very useful for comparative purposes, identification of trends and setting of priorities for accident prevention. In this context, as the quality of data strongly depends on legal requirements and useful feedback, mandatory accident reporting such as for the EU process industries under the Seveso Directive was considered indispensable also for other industry sectors. A recent study performed in Switzerland on the comparative assessment of environmental and health impacts of different energy systems (nuclear and non-nuclear) shows that—without favouring any energy option in particular—the accidental risks due to severe accidents in the energy sector are small in comparison with natural disasters and also when compared with the impacts of air pollution originating from the energy sector. Operational experience feedback proved to be a valuable means for improving safety in any part of the energy sector. Therefore, it was found that there would certainly be significant European added value in developing a consistent and continuously updated European information system on accidental risks from different energy systems, for the purposes of both informing all

stakeholders on specific risks and benchmarking the risks from new technologies, such as hydrogen technologies in the energy sector, against existing ones (e.g. fossil).

4. Future challenges and further steps

The following areas for future research and development which could prove fruitful have been identified in the course of the seminar:

- *Improved exchange of information on event investigation methods and techniques*: The experience gained in the nuclear industry with regard to reporting systems and international sharing of information could be transferred to other sectors. In particular, there is a need to foster the exchange of experience between the nuclear industry and the rest of the energy sector which might further help to harmonise the various approaches used across the industry. This includes consistent event classification schemes, accident data collections and possibly even continuously updated, 'living' risks monitors of different energy technologies.
- *Address properly the different stakeholders on the different levels of risk related decision-making*: For example, what is the proper level of condensation and generalisation of findings when addressing different stakeholders? What are the proper ways to address the general public with regard to content of information and ways of addressing their need to ask questions?
- *Last but not the least, moving towards comparative risk assessment*: As risk impacts of technology should not be judged in isolation from the benefits to society, balancing risks and benefits is fundamental to any consistent decision making process. Further, resources spent to reduce risk to individuals and society vary significantly across technological divides. As resources are limited, their proper allocation is essential. Risk-based methods provide measures that can significantly support consistent decision-making and enhance public understanding. With consistent data collections on accidents in specific, well-defined sectors, such as the energy sector, comparative assessment of accidental risks within a sector (e.g. nuclear and non-nuclear energies) can be performed on a consistent basis. This could also have high priority in the light of the mentioned recent EC initiative on discussing horizontal legislation on risk mapping and to introduce an obligation to inform the Commission of natural or man-made disasters exceeding a certain magnitude. In one way or another, the information reported on different risk sources in a consistent format would be looked at in a comparative way. As mentioned, within a clearly defined area such as the energy sector, such comparative studies could effectively be used:
  - for informing all stakeholders on specific risks in a consistent way and,
  - for benchmarking the risks related to new technologies, e.g. hydrogen technologies in the energy sector, against existing ones (e.g. fossil).

It was suggested by participants of the seminar that support for any initiatives in this regard is sought under the auspices of the EC's 6th Framework Research Program.