Executive Summary

2017 Chemical Accident Risks Seminar and Training

On 14-16 June 2017, the European Commission's Joint Research Centre (JRC) organized a landmark event at the JRC site in Ispra, Italy site to support exchange on emerging risks in chemical accident and Natech risk reduction between European Union (EU) and EU affiliated countries, that is, EFTA and EEA countries, EU Enlargement countries and EU Neighbour Policy Initiative (ENPI) Countries.

A landmark networking initiative

The 2017 Chemical Accident Risks Seminar and Training event marks the first time that EU and EU-affiliated competent authorities met together to share perspectives on implementation of the Seveso Directive, and equivalent national efforts in non-Seveso countries, to identify areas of common concern and to seek opportunities for mutual support. The event was jointly funded by the DG-ECHO-JRC project, Seveso Capacity Building in EU Neighbourhood Countries, under the EU Civil Protection Mechanism, and the JRC Enlargement and Integration activity.

The main purpose of the event was to exchange on common challenges in chemical accident risk reduction and to give training to competent authorities on newly available JRC tools for assessing consequences and risks associated with chemical and Natech accidents. It also aimed to welcome EU affiliated countries, many of whom are on the path towards Seveso implementation, into the network of Seveso competent authorities to participate in these exchanges. A critical outcome was the identification of emerging risks and ongoing priorities that could be the focus of future collaborations in the Seveso community to improve risk management and enforcement. **This Executive Summary highlights these emerging risks and summarizes main points and conclusions derived from the presentations and discussions in the seminar and training sessions.**

Motivated by rising industrial development and assisted by EU policy priorities, a majority of Enlargement and Neighbourhood countries are actively building towards implementing the Seveso Directive or equivalent programme. With common borders and shared industrial hazards, and in many cases, historical relationships and cultural similarities, the EU and its neighbours to the east and south have a natural interest in helping each other work more closely together on reducing chemical accident and Natech risks.

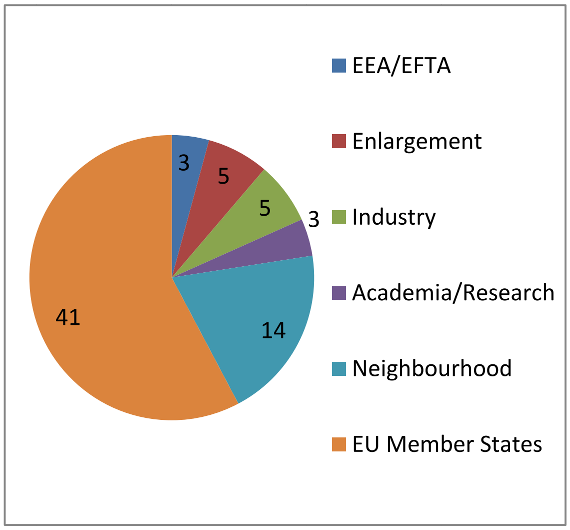

Figure 1 Number of Participants per Stakeholder Group

The so-called Chemical Accident Risks Seminar (CARS) was envisioned as a mechanism to extend the EU Seveso network to promote exchange on chemical accident risks and risk management between EU/EEA Seveso Countries and the EU Enlargement and Neighbourhood countries. In particular, the event was intended to:

- Identify the need for further work by the Seveso community on new emerging risks/new developments in the area of industrial accident prevention.
- Expand the existing EU/EEA exchange network to include all EU-affiliated countries
- Rejuvenate exchange between EU/EE countries that had diminished in recent years due to budget cuts at both EU and national level.

- Provide an opportunity for training on the JRC's flagship risk analysis products for Seveso competent authorities, the ADAM[1] (chemical accidents) and RAPID-N[2] (Natech accidents) consequence and risk assessment tools.

Event programme

The event consisted of a 1 ½ day seminar, divided into 6 sessions, and two additional half days on either side of the seminar were allocated for training on the JRC ADAM and RAPID-N consequence and risk assessment tools.

The topics of the seminar were as follows:

- **Safety performance measurement:** How should we measure and track performance in chemical accident risk reduction?
- **Integrity of installations and equipment:** How can we make more progress in reducing risks from infrastructure weaknesses, including ageing sites, high intensity processes, and small and medium size sites?
- **Safety and IT security:** What does accelerating use of IT technology on hazard sites mean to site risk managers and to the enforcement community?
- **Organizational change:** How do economic trends and changes in industry and government influencing chemical accident risk reduction and can negative impacts be mitigated?
- **Substance classification:** What are the current challenges for identifying high hazard sites that should be covered by the Seveso Directive (or equivalent national programmes) and what problems do countries face as they are working towards establishing a hazardous site inventory?

General outcomes and highlights

Outcomes and feedback from participants give evidence that the event met the four objectives with considerable success. The seminar met participation goals by attracting 71 participants from 30 different EU and EU-affiliated countries, and having different perspectives from all European regions, including industry experts,

Figure 2 Visualization in ADAM of spatial dispersion of a toxic plume on a local map

reflected in the seminar agenda. Fifty-two (52) participants received training on the ADAM (chemical accident) and RAPID-N (Natech) consequence and risk assessment tools during the event.

ADAM and RAPID-N Consequence and Risk Assessment Tools

The introductory training events proved a powerful mechanism for obtaining interest and even excitement about the tools from many countries. In feedback from the training, both from personal exchanges and evaluations, many participants expressed satisfaction from the introductory sessions that the tools could meet their consequence and risk assessment needs.

The interest and feedback regarding the tools generated a variety of commitments as well as potential future work programme elements for ADAM and RAPID-N tools. Based on the country's request, the JRC plans bilateral trainings in various countries. Needs of competent authority users will also trigger development of additional features and modules, such as an emergency planning module for ADAM and additional natural hazard modules for RAPID-N.

Performance Measurement

There is still a long way to go in obtaining leading indicators of performance trends in hazardous industries. The CEFIC/ICCA metrics are a positive step forward towards indicators. The current chemical industry initiative to make certain measures public is important, particularly for transparency and stimulating dialogue in the public domain.

However, many other hazardous industries have

[1] https://minerva.jrc.ec.europa.eu/en/ADAM/content

[2] http://rapidn.jrc.ec.europa.eu/

yet to take a similar commitment. Moreover, many sites still struggle with how to select and use safety performance indicators as true performance measures. Similarly, competent authorities struggle with how to evaluate these efforts on their Seveso sites.

Without leading indicators, it becomes increasingly difficult to justify government resources aimed at chemical accident prevention and preparedness as the years go by and no major accidents occur. More varied forms of measurement are needed to reflect the government's impact. Implementation of site-based measurement by competent authorities as leading indicators for emerging risks could be further explored. Some countries (e.g., Norway, the United Kingdom) are already leading the way in this regard.

For pre-Seveso countries, national hazardous site inventories and incident reporting systems are essential building blocks of national safety performance monitoring. Preliminary evaluations of known hazardous sites (through questionnaires and/or site visits) can also be a positive step towards establishing a baseline for measuring progress.

The results of these discussions indicate that some potential areas of future collaboration exchange could be:

1) **Experimentation and collaboration between governments on various types of indicators**, notably measures that provide input as to whether government programmes to reduce chemical accidents are working generally across the economy, such as loss data.

2) Exploration and testing of measurements that evaluate the impacts of inspection and other enforcement and compliance measures. Some specific feedback that would be useful regarding the effectiveness of Seveso inspections and the influence of different enforcement approaches across the EU.

3) P**re-Seveso countries could already establish a baseline to evaluate progress** as more rigorous measures are implemented. Full implementation and resourcing of the main obligations of the Seveso Directive could be relevant indicators, for example.

In conclusion, there appears to be a need for focused government exchange and collaboration on collection of data to support macro and micro-safety performance measurement of chemical accident risk governance. This topic could be taken up in the various forums where governments meet and discuss how to address challenges in monitoring and oversight of hazardous industries.

Mechanical integrity

Mechanical integrity is still a main cause of concern on hazardous sites in Europe and neighbouring countries. For example, the UK programme measuring performance of ageing plants revealed that > 70% of sites are managing their asset risks adequately. Italy appeared to have considerable findings from inspections related to mechanical integrity as well. Small and medium-size enterprises (SMEs) seem to have particular difficulties (e.g., due to lack of specific competence, lack of resources, and heavy reliance on external technical organizations.)

Risk assessments and risk-based decisions are often constructed on false assumptions about mechanical integrity, as evidenced by recurring accidents involving mechanical failures on sites with supposedly robust risk management programmes. Age, changes in ownership, profitability loss of corporate history can sometimes obscure mechanical weaknesses. Sometimes sites will be accustomed to working with insufficient knowledge or inadequate conditions leading to complacency about the risks.

Failure to recognise mechanical vulnerabilities has an enormous impact on the safety of the entire process. Mechanical failures can initiate or accelerate the accident sequence. Potential vulnerabilities in critical systems can include containment equipment (e.g., pipes and vessels), control measures and instrumentation (safety valves, alarms, etc.), and common services (e.g., generators). Moreover a proactive mechanical integrity programme can often be a selling point in risk communication. The costs of critical equipment failure, especially potential collateral damage, create a clear business case for a mechanical integrity programme as a key component of a loss prevention strategy.

In conclusion, many accident scenarios feature mechanical integrity as the critical factor, or "weak link" in process safety. For this reason, it is difficult to justify making broad assumptions about system integrity of safety-critical processes when parts of the system have not been evaluated or degraded conditions of some parts are ignored. Risk assessments should be based on realistic and informed evaluations of system integrity.

The impacts of systematic approaches to assessing site mechanical integrity should be evaluated over time. The technique works on the assumptions that measurement motivates better performance. Tangible results could motivate more competent authorities and operators to adopt this approach.

Mechanical integrity is also assumed to be a leading indicator for safety performance. Systematic assessment of site mechanical integrity could become also be used as a performance trend measurement for government and industry alike.

IT security and safety challenges

Awareness and identification of risks associated with advanced industrial control systems is lagging behind its implementation. There will need to be close and ongoing collaboration directed at incorporating process risk management in industrial controlling systems. IT specialists generally speak a different language than process engineers and industrial control designers. Overcoming professional and cultural barriers are likely to remain a significant challenge in this regard for years to come.

In the EU, knowledge and tools to support inspections and oversight of cyber safety and security at EU Seveso sites are not widely available. It is still somewhat early to understand the full implications of cyber security and automation with process safety for Seveso inspections. The possibility was mentioned that some competent authorities may require support from an IT expert resource in future to support Seveso enforcement and oversight at sites with advanced industrial controls systems. Security clearance could also be a requirement for inspectors at some sites.

The number of remotely operated sites should be expected to increase in future. Lack of a strategy and criteria in the face of a rapid increase would result in an ad hoc approach to risk management creating potentially serious risk management gaps on individual sites. Also, without any precedents or standard models to follow, competent authorities may be very vulnerable to legal challenges should they choose to confront operators on risk management issues. More varied forms of measurement are needed to reflect the government's impact.

In conclusion, there needs to be more discussion among competent authorities and industry on cyber safety and security risks and practical exchange of good practice and experience. Whether competent authorities need to address cyber security interfaces with process safety remains an open question. Exchange between authorities overseeing safety and those overseeing security matters could also be explored as a way of monitoring these interfaces.

Competent authorities needs some basic rules and criteria as a starting point for addressing cyber safety and security in inspections and when reviewing sites and installations for permits or commissioning. A simple set of principles will be particularly helpful to small countries and pre-Seveso countries. Eventually, more comprehensive guidance may emerge in national authorities as they gain knowledge and experience.

EU authorities will likely have to develop consistent approaches to overseeing industrial control systems and remotely operated sites. Issues such as minimum safety requirements and inspection strategies and tools may benefit from agreement on common approaches at EU level. Collaboration on monitoring and enforcement may require standardization and international collaboration. Criteria may need to be developed for acceptance of remotely operated sites. Bilateral and multilateral agreements between countries may need to be established as already exists for other cross-national hazards such as pipelines.

Organizational change

The OECD upcoming guidance on ownership change of hazardous sites provides an important new practical tool for operators and government. It also represents the first time that the expert community has examined mergers and acquisitions in the chemical industries as a site risk management issue and provided concrete evidence and guidance in this regard. Notably, the EU chemical industry has expressly recommended the use of this tool by companies involved in site acquisition and divestiture. Every effort should be made to disseminate the guidance as broadly as possible in the coming years.

Industrial parks are a particular organizational structure that has long been considered as an important mechanism for catalyzing economic growth in emerging economies. The concentration of activities lowers infrastructure costs and transaction costs may also be lowered when business partners are located on the same site. Nonetheless, these conglomerations also pose particular challenges for risk management in terms of assigning accountability and ensuring appropriate oversight of common services that can affect safety. Some industrial parks, with a high presence of hazardous sites may be vulnerable to domino effects once an accident sequence is triggered.

Work outsourced to contractors continues to be a risk factor on many hazardous sites, in particular, since outsourcing of many functions plays a fundamental role in the business models of many hazardous industries. In 2012 a JRC study revealed that subcontractors were a factor in nearly 6% of incidents in the eMARS database. The study also showed that EU major accidents involving contractors had increased dramatically in recent years, rising from a yearly average of 1.1 between 1991-2000 to 3.4 per year from 2000-2010.[3] The accident at the BASF site in Ludwigshafen, Germany of October 2016 gives evidence that contractor management requires constant attention.

Organizational change is not just an issue for industry. The ability of government to oversee and enforce effective risk management on hazardous sites can also be compromised by organizational changes and reduced staff resources in government institutions.

Capacity building to achieve high standard of risk governance requires significant changes in government and industry. Meaningful progress usually requires gaining access or investing in new competencies, launching or augmenting of support services, often accompanied by structural re-organization. There is a question as to how much stakeholders in pre-Seveso countries, as well as their external partners, take account of these factors in planning capacity building activities, developing legislation, and establishing timelines for implementation.

In conclusion, the OECD Guidance on Ownership Change at Hazardous Sites should be disseminated widely and its implementation should be closely followed. It may be important to assess the impacts of the guidance and whether there are new lessons learned from implementation.

Further exchange on risk management of industrial parks and joint ventures may be particularly valuable for Enlargement and Neighbourhood Countries. Tools such as ADAM and RAPID-N can also support consequence and risk assessment for aggregated risks from hazardous sites in industrial parks.

Changes in government organizations, or in government requirements, also merit preparatory analysis of impacts prior to implementation. Re-organization of government services, loss of staff competence, and modifications to legal requirements, are changes whose impact on both government and industry performance may need to be assessed and addressed as appropriate. Capacity building for pending alignment with the Seveso Directive in Enlargement and Neighbourhood country are changes that have greater chance of success if planned and calibrated over time in consideration of individual country strengths and limitations.

Part of change management is also managing expectations. Gathering information on the current situation can aid management and staff to develop a common in understanding of what could change. From here, they can map a common strategy to avoid that certain changes do not become accident triggers.

There are a wide range of other types of organizational changes that can influence site risk, such as the impacts of staff reductions, joint ventures, and major structural reorganization on risk management of hazardous sites. The seminar did not include presentations on all the relevant topics simply because they were not proposed. Indeed, the topic has become quite large and it is likely that much more exchange on organizational change is necessary to give attention to all the issues and identify innovations in monitoring and management that help to mitigate their disadvantages.

[3] From the Lessons Learned Bulletin on major accidents involving contractors, listed under "References" in this section.

Substance classification

Effective governance of chemical accident risks requires knowing the degree and type of hazard, and where the hazard is located. Hence, implementation of every government programme starts with the establishment of a national inventory of major hazard sites. Countries establishing new chemical accident preparedness and prevention programmes have the challenge of getting adequate information to identify their hazardous sites as far in advance of implementation, so that it can be planned with adequate resources and interventions are targeted appropriately with realistic timelines. Countries with mature programmes have the challenge of making sure their site inventory matches reality.

Substance classification matters. For good reason, authorities and operators are particularly sensitive to the costs, not just in Euros but in lives, of making wrong judgments about which sites are hazardous and why. Keeping up with new substances and new information affecting classification of known substances is essential to maintaining an up-to-date risk management strategy that uses available resources in the best way possible.

Classification of dangerous substances has always been problematic for some substances for a variety of reasons, e.g., insufficient data, conflicting data interpretations, influence of processing conditions, non-normative behavior, etc. The EU CLP Regulation and the GHS are not immune but are relatively new, such that the processes for making improvements are still in development.

The application of generic criteria, an approach taken by the UN GHS Classification System, EU CLP Directive and adapted further by the Seveso III Directive, is a standard and well-accepted approach to regulation of dangerous substances. It is also true that these instruments, perhaps deliberately to an extent, do not fully address the challenge of making generic rules fit the infinite possibilities associated with certain categories of substances, notably mixtures (and particularly waste), and substances such as organic peroxides and ammonia nitrate, all of whose dangerous properties vary substantially with different formulations.

In conclusion, the EU CLP Regulation has introduced some significant improvements, in particular, self-classification by manufacturers, that encourage transparency and are self-maintaining. The new openness afforded by the EU CLP regulation may eventually reduce uncertainties associated with classification of certain substances, but at the moment, there are not enough mechanisms for dialogue that can make the system not only open but dynamic. There is room for initiative among industry and government stakeholders to help close this gap.

For some types of substances, it is likely that ongoing dialogue is always necessary. Finding the right classification for specific substances may to some degree always be an iterative process. Some cases may also benefit from clarifications in future revisions to Seveso legislation, but this is likely to be far in the future.

Countries working towards higher levels of governance of chemical accident risks, such as alignment with the Seveso Directive, correctly prioritize establishment of a national inventory of hazardous sites even prior to adopting the enabling legislation. Capacity building should include fostering exchange and collaboration to support countries in developing strategies to identify and qualify hazardous sites. Standardized training tools on applying the Seveso substance criteria within the context of the EU CLP Regulation could also be useful.

Summary of observations and conclusions

Competent authorities need comprehensive consequence analysis tools that are cheaper, easier-to use, more versatile and transparent than what is available currently in the marketplace. Competent authorities can face a vast range of situations from site to site, with variation in type substance, size of site, level of competency, risk assessment methods used, and geographic location. There are no comparable applications in the marketplace for Natech risk analysis nor that allow the wide range of flexibility and customization of analysis design as ADAM. These applications are tailor-made for authorities but are also used by industry and practitioners.

There is overwhelming evidence from competent authorities that the ADAM and RAPID-N applications fill an enormous gap in the arsenal of tools available for countries to help protect citizens from negative aspects of industrial development. The eagerness with which competent authorities embrace these tools was not only confirmed by this training event but also past training events, as well as by feedback from stakeholder tests during development, and by actual users. RAPID-N has already been applied for earthquake-triggered Natech risk assessment for some years.

While safety performance indicators (SPIs) have been in use in many companies for more than two decades, industry is only now developing a common understanding on their design and functionality. Nonetheless, confusion and skepticism surrounding their use have not entirely disappeared. Skepticism often is generated in large part from the confusion. While no one disputes the concept of SPIs as an ideal, interpretation of what they actually should be and how they should be applied appears to vary widely.

Guidance is emerging in industry and more consensus and models of good practice are likely to evolve from these efforts. The major industry associations are making reporting certain measures a condition of membership. While much more development needs to take place, these outcomes represent significant progress, requiring many years of dedicated effort to achieve.

Government authorities in many cases either ignore safety performance indicators or struggle with how to use them in a compliance context, although a few countries have embraced them. Even when both sides are enthusiastic about the concept, there may still be disagreement on what should be measured and interpretation of results. The discussions at the seminar indicated that in both industry and government, there is a lot of work to do to understand whether and how safety performance indicators can be a relevant and even vital component of chemical accident risk management.

Context is important. In some companies, SPIs provided considerable value as a communication tool within the organization and the metrics selected have no operational value except to communicate. However, if they are intended to be an integral part of site safety performance monitoring, they must give meaningful and timely feedback on safety performance. In the latter role, the SPI must be designed to give feedback on aspects of operations that affect safety.

Mechanical integrity may be an old issue, but it remains possibly the most fundamental principle of chemical process risk management. It is never more relevant than today, even considering that the industrial age is now arguably two centuries old. At this stage, every country in the world is exposed to industrial risk from its operations to some extent and some to a very large extent.

Considerable industrial expansion took place throughout the world in the latter half of the 20th century. There are a lot of sites more than 20 and even 40 years old that are still operating. Mechanical integrity requires unyielding attention on older sites. Notably, many of these sites are oil and gas operations, such as refineries, where a high volume of dangerous substances is common and the infrastructure is vast.

New technologies need to take lessons from the old ones, even virtual technologies. Right now they seem unbreakable, but in 20 years they will suffer from degradation and obsolescence, just like the older industries. It remains important for industry and government to use all means available, data collection, risk-based approaches, development new tools, etc. in order to reduce risks from infrastructure and equipment failures.

If mechanical integrity is the old-timer, cyber safety and security is the newcomer. Awareness of potential impacts of automation and network-linked functions has been growing and some organizations have already been working to understand the main issues and define new standards to address them. From the work underway, it appears that significant improvements to assure reliability and integrity of equipment and infrastructure are already implemented or well progressed. Moreover, there is a question as to whether cyber security threats in any way are nearly as high a concern as threats to plant physical integrity.

On the other hand, while increased connectivity and automation can greatly reduce some process risks, they also can sometimes raise new questions for process risk management and regulatory enforcement. Incidents have already arisen with connectivity as a common cause and continuously unmanned sites operated from long distances, even other countries, represent a new permutation of an old model (the unmanned site) that has never made regulators very comfortable.

Moreover, the vast majority of regulators and many operators are just at the beginning of the information gathering stage on how IT technology can change a process risk profile, what standards are in place to assist risk management, and where the gaps in understanding and guidance remain.

Safety management systems remains an important and dynamic mechanism for addressing the management rather than the technical factors affecting chemical accident risk. In the past decade or so, there has been widespread emphasis on the role of organizational factors on the functionality of the safety management system. That is, the structures and processes within an organization are now considered to have a tremendous influence on the effectiveness of safety management on major hazard sites.

It has taken an accumulation of serious accidents and disasters to focus attention in this direction. It also seems that as awareness about organizational factors has grown, causal evidence can be found everywhere, even in analysis of accidents occurring decades before. The proliferation of multinational companies across the globe, the industrialization of countries in all parts of the world, the transformative role of automation in industrial processes, and many other developments have the potential to have both positive and negative impacts on how organizations see their risks. Moreover, technology will continue to revolutionize the workplace and the ups and downs of the economy will continue to produce dramatic shifts of ownership and employment as well as new management strategies in hazardous industries.

Both government and industry have endorsed the notion that management of organizational change is part of chemical accident risk management. Some steps forward such as the OECD guidance on corporate leadership and on ownership change have already been taken. There is a lot more work to do.

Proper identification of dangerous substances on site is vitally important to making the right decision about prioritizing and managing chemical accident hazards. To manage risks much there is of it, and what it can do if planned controls of the danger fail. Nonetheless, effectively, sites have to know each dangerous substances on site, how dangerous it is, how obtaining clear and definitive data to classify every substance and mixture of substances with certainty is a never-ending process. The rules developed over time and enshrined in such instruments as the UN GHS, the EU CLP Regulation and the Seveso Directive, provide more clarity than ever before. In particular, they allow more debate and transparency over how classification decisions are reached. But these instruments are never as clever as nature, so the way forward is to continue to work together to fill the gaps through creating and using mechanisms to promote dialogue and consensus. The instruments themselves may also in time be improved as experience brings more understanding.

Considerable work in future lies ahead in finding ways to share and make decisions together on the basis of new information and in adapting the instruments to incorporate new knowledge.

Final observations

Just like the technologies that produce them, chemical accident risks are complex, making heavy demands on engineering, natural sciences, the psychological fields of human and organizational behavior, and the science of business management, to name a few of the disciplines that need to be regularly consulted. With so many factors, and so many analytical specialties needed to understand them, managing and overseeing chemical accident risks cannot be successful in isolation. Operators and authorities have an awesome responsibility shared by counterparts around the world, and they need to be able to get help from each other. Hopefully, in various ways, these types of events can continue to be held as long as our social well-being and economic survival depend on goods generated through industrial production and technologies.

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The full report can be found at: https://minerva.jrc.ec.europa.eu/en/shorturl/minerva/publications

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