European Commission

JRC TECHNICAL REPORTS

2017 Chemical Accident Risks Seminar and Training Workshop

Summary Report of Proceedings and Outcomes

WOOD, Maureen H.

2017

This publication is a Technical report by the Joint Research Centre (JRC), the European Commission's science and knowledge service. It aims to provide evidence-based scientific support to the European policymaking process. The scientific output expressed does not imply a policy position of the European Commission. Neither the European Commission nor any person acting on behalf of the Commission is responsible for the use that might be made of this publication.

Contact information
Maureen Heraty Wood
European Commission Joint Research Centre
Via Enrico Fermi, 2749
Ispra (VA), Italy 2
Email: maureen.wood@ec.europa.eu
Tel.: +39 0332 78 9140

JRC Science Hub
https://ec.europa.eu/jrc

JRC109442

PDF	ISBN 978-92-79-76909-2	doi:10.2760/441341
Print	ISBN 978-92-79-76908-5	doi:10.2760/575015

Luxembourg: Publications Office of the European Union, 2017

How to cite this report: Wood, M. H., *2017 Chemical Accident Risks Seminar and Training Workshop: Summary Report of Proceedings and Outcomes*, Luxembourg: Publications Office of the European Union, 2017, ISBN 978-92-79-76909-2, doi:10.2760/441341, PUBSY No. JRC109442

Acknowledgements

This document benefits from the thoughtful and well-prepared contributions of numerous speakers from many countries who participated in the event. Gratitude also goes to the seminar Steering Committee and the JRC staff who organised the ADAM and RAPID-N training sessions. A special thanks to Zsuzsanna Gyenes, Orsolya Sudar and Maria Giuliani of the JRC for their considerable efforts to ensure a positive experience for all participants through their efficient management of logistics and handling of unexpected situations.

Abstract

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. This combined seminar and training event was the first time that all 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 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 report highlights these emerging risks and summarizes main points and conclusions derived from the presentations and discussions in the seminar and training sessions.

TABLE OF CONTENTS

Table of Figures

List of Tables

Executive Summary

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.

In a continuation of its long tradition of promoting networking among Member States on implementation of the Seveso Directive, and in light of recent technological advances and the EU's long term goals to strengthen its partnerships within the region, the JRC proposed to organize and host a seminar to support exchange between EU and EU-affiliated countries on topics of importance to chemical accident risks governance. In particular, a majority of Enlargement and Neighbourhood countries, motivated by rising industrial development and assisted by EU policy priorities, 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.

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 event 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 of the event

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, 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.

In total, 71 experts from 30 countries, including 3 Enlargement countries, 7 Neighbourhood Countries, 1 EEA Country and 19 Member States, participated in the event, with more than 50% coming from the 30 EU/EEA countries, and nearly 25% from the 10 Enlargement and Neighbourhood countries. Almost all countries volunteered a presentation. In addition, the agenda also included speakers from 3 industry organizations and 2 speakers from the research and consulting fields. The

---

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

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

seminar also benefited from presentations from JRC experts on cybersecurity and disaster risk management. In total, there were 44 different presentations delivered in the seminar.

Outcomes of individual sessions

1) ADAM and RAPID-N Training

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.

2) 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 chemical industry has conducted extensive research and elaborated concrete guidance in order to help their memberships. 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 yet to take a similar commitment. Moreover, a majority of 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. While the reporting of major accidents in eMARS is invaluable for recording and exchanging lessons learned, it is not adequate for performance measurement. Moreover, EU governments, with some exceptions, have not been aggressively seeking to adopt proactive safety metrics to identify trends and emerging risks for themselves. 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. 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** could be particularly useful, 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) **Pre-Seveso countries to 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.

3) 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).

Effective management of site integrity is a good story for business and for the public. Insufficient mechanical integrity leaves sites very vulnerable to losing their right to operate in the face of a serious incident or concerned citizens and politicians. Conversely, a proactive mechanical integrity programme can often be a selling point in risk communication. Moreover, 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.

<u>In conclusion,</u> 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.

4) 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. The seminar represented one of the first occasions where industry and government have exchanged good practice and experience in this regard. 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 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 an ad hoc approach to risk management creating potentially serious risk management gaps on individual sites. 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.

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.

5) 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 pose particular challenges for risk management in terms of assigning accountability and ensuring appropriate oversight of common services that can affect safety. Depending on the proportion of hazardous facilities on site, some industrial parks 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

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

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.

6) 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 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 judgements 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.

Identification of likely sites for Seveso coverage is often undertaken in pre-Seveso countries, such as many Enlargement and Neighbourhood Countries, in order to assess potential resource and competence issues that will arise once new comprehensive legislation is authorized. In the absence of a notification requirement for all hazardous sites, countries will use alternative methodologies and information gathered from existing enforcement and monitoring activities associated with chemicals management, environment and civil protection and labour safety.

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 since some years.

While safety performance indicators (SPIs) have been in use in many companies (mostly large multinationals) 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. (Although these reportable indicators represent a narrow range of measures, they serve a slightly different purpose than site-specific measures since the public is the targeted audience rather than any specific site.) 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 in this group, cyber safety and security is the newcomer. The seminar featured an interesting mix of presentations from industry, researchers, and government authorities. 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 possibly 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. Among all the information needed to make good risk management decisions, every risk assessment starts with hazard identification. Every hazard identification starts with the identification of dangerous substances on site. To manage risks effectively, sites have to know each dangerous substances on site, how dangerous it is, how much there is of it, and what it can do if planned controls of the danger fail.

Nonetheless, 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 that can be generically applied to a set of problems that affects many substances.

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.

1. Background and Description

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[4] risk reduction between European Union (EU) and EU affiliated countries, that is, EFTA and EEA countries[5], EU Enlargement countries[6] and EU Neighbour Policy Initiative (ENPI) Countries[7]. This combined seminar and training event was the first time that all 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. 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. The event was jointly funded by the DG-ECHO-JRC project, Seveso Capacity Building in EU Neighbourhood Countries[8], under the EU Civil Protection Mechanism[9], and the JRC Enlargement and Integration activity[10].

This report explains how and why the seminar was organized and summarizes outcomes of the event, including a reflection from the seminar Steering Committee on the potential implications of key arguments emerging from the seminar for risk management in future.

In the present day, the Seveso Directive is widely considered the most effective model for building a comprehensive national chemical accident prevention and preparedness (CAPP) programme. It is a performance-based measure that places

---

[4] Natech = Natural hazard events causing chemical accidents

[5] http://www.efta.int/about-efta Iceland, Liechtenstein, Norway and Switzerland

[6] https://ec.europa.eu/neighbourhood-enlargement/countries/detailed-country-information_en Albania, Bosnia Herzegovina, the former Yugoslav Republic of Macedonia (FYROM), Kosovo, Montenegro, Serbia and Turkey

[7] https://ec.europa.eu/neighbourhood-enlargement/neighbourhood/countries_en Algeria, Armenia, Azerbaijan, Belarus, Egypt, Georgia, Israel, Jordan, Lebanon, Moldova, Morocco, Palestine, Tunisia, and Ukraine. As a practical matter, the JRC Seveso work in ENPI countries does not include Libya or Syria because of the ongoing conflicts in those countries.

[8] https://minerva.jrc.ec.europa.eu/en/content/minerva/a93c18e3-b2ba-46c4-b467-3fe02773ec7e/seveso_capacity_building_in_eu_neighbourhood_countries

[9] http://ec.europa.eu/echo/files/aid/countries/factsheets/thematic/civil_protection_en.pdf

[10] https://ec.europa.eu/jrc/en/working-with-us/enlargement-and-integration

direct responsibility on operators for keeping their plants safe but imposes also rigorous requirements on government authorities to track and motivate operator progress. Implementation of the Seveso Directive poses significant challenges for all national authorities because it is a comprehensive risk management and enforcement programme covering all aspects of chemical accident disaster risk reduction.

Since the first United Nations Conference on the Human Environment in 1972, it has been acknowledged that the developed world has a shared responsibility to actively support developing countries in acquiring knowledge, tools, and regulatory frameworks that will lead to the sound management of chemicals in these countries. The EU also has considerable strategic motives for aiding its neighbours in this regard, including shared borders, shared natural resources, strong trading relationships, and shared responsibility for the sustainability of technology supporting trade. In addition, the inability to control chemical accident risks can create instability, should a major accident occur, and undermine security, particularly the control chemical weapons risks. For this reason, EU policies for disaster risk reduction and for peace and stability both include support for capacity building in chemical accident prevention and preparedness as a priority.

Within this policy framework, the JRC's Major Accident Hazards Bureau (JRC-MAHB) has led scientific and technical support to Seveso Directive implementation in the EU, in association with DG ENV since the first Seveso Directive was authorized in 1982. For almost 20 years, the JRC-MAHB has contributed to capacity building of countries currently in the accession process, as well as providing ongoing support to new countries as they move up the learning curve towards mature Seveso programme implementation. It offers unique capacity building opportunities for governments seeking to improve their chemical accident prevention programmes, associated with its long term collaboration with EU countries in promoting good practice and lessons learned, and developing tools to assist them in chemical accident risk analysis.

1.1. The purpose of the event

Since the first Seveso Directive was authorized in 1982, European Union Member States recognized that working together allows every country access to a bigger pool of expertise and expertise for a very challenging area of risk governance. These challenges stem from the diversity of industry and substances with chemical accident risks and the need for scientific competence and experience in both government and industry to oversee and manage them effectively. These conditions impose particularly high demands on small and medium size governments where even a few hazards close to populated areas can require substantial attention to maintain an acceptable risk profile. As indicated in the Text Box on the next page, information exchange has been a core contributor to EU government efforts to improve chemical accident risk reduction.

The Chemical Accident Risks Seminar (CARS) was conceived as a mechanism to extend this model to promote exchange on chemical accident risks and risk management between EU/EEA Seveso Countries and the EU Enlargement and Neighbourhood countries. In particular, it was intended:

- To expand the existing EU/EEA exchange network to include all EU-affiliated countries
- To rejuvenate exchange between EU/EE countries that had diminished in recent years due to budget cuts at both EU and national level.
- To provide an opportunity for training on the JRC's flagship risk analysis products for Seveso competent authorities, the ADAM [11] (chemical accidents) and RAPID-N [12] (Natech accidents) consequence and risk assessment tools.

It was considered that a seminar that met these three objectives would make the event attractive to countries with a diversity of interests and needs. The need for an EU event that could support EU competent authorities and bring EU affiliates into the Seveso network became particularly clear in 2015-16 when the JRC conducted a number of multilateral and bilateral workshops in which challenges in Seveso implementation with EU Neighbourhood countries were discussed. In parallel, the JRC has also been engaged in supporting capacity building for Seveso implementation in Enlargement Countries and since 2014 the JRC extended its Seveso capacity building work to EU

EU Expert Exchange on Chemical Accident Risk Reduction: A Long and Fruitful Tradition

For over three decades, the JRC-MAHB, supported by DG ENV, has facilitated a programme of ongoing exchange of good practice and experience between Seveso (EU/ EEA) countries. The exchange programme has multiple benefits for reduction of chemical accident risk in Europe:

- Accelerates the transfer of new strategies and tools for more effective oversight of high risk sites
- Conveys new lessons learned from recent incidents and helps the community to keep "old" lessons alive
- Allows small and medium-sized countries to acquire new learnings and techniques from the investments of large industrialized countries in research on strategies and tools for chemical risk oversight
- Supports free trade in the European Economic Area by promoting common practices for sustainable production across the region
- Contributes to the professional development of competent authority staff providing new learnings for managing risk in this complex field.

While the exchange itself is valuable, the events can also results in production of tools and technical briefs for implementation, such as

- Handbook of Chemical Accident Scenarios for Emergency and Land-Use Planning
- Common Inspection Criteria
- Seveso Inspection Good Practice Reports
- A study of Seveso Implementation in Lower Tier Establishments

These and more publications from EU level exchanges on chemical accident risk are available at minerva.jrc.ec.europa.eu/en/shorturl/minerva/publications.

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

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

Neighbourhood countries in the JRC/ECHO Seveso ENPI project[13]. The JRC has hosted a multilateral Seveso event for Neighbourhood (ENPI) and Enlargement countries in 2013, 2015 and 2016, administered a Seveso implementation survey to ENPI countries, and held several bilateral workshops.

A striking impression from each encounter was that each country had difficulties with the same frustrating issues that EU competent authorities have discussed over many years of exchange, such as, unknown risks of hazardous sites near urban areas (e.g., ammonia manufacturers, large storage sites), lack of co-ordination among competent authorities, building safety culture and competence in industries, convincing local populations that risk was manageable, how to gain confidence in the operator's risk assessment, etc. Moreover, many EU Enlargement and Neighbourhood Countries lack vibrant networks internally or externally where they can discuss their challenges with chemical accident risks with like-minded colleagues.

It follows that there is also an overwhelming interest from EU and EU-affiliated countries in JRC consequence and risk assessment tools for chemical and Natech accidents. From any event of the last 3 or so years, where the tools have been presented, there are numerous comments on evaluation forms emphasizing that "we need these tools", "when will they be available?", "when is the next training?" The tools are freely available to competent authorities (or will be in the near future)[14] and developed specifically with the needs of Seveso competent authorities in mind.

These observations eventually led to the conclusion that the JRC's 2017 Seveso event should be for the entire network of the EU and all its regional partners. The EU countries would benefit from the training and an additional forum for exchange on Seveso implementation, while also would gain knowledge important to chemical risk management in countries where they share borders, trade and often historical ties. For the Enlargement and Neighbourhood countries, training and exchange with EU countries would offer fast track learning on their path towards implementing comprehensive chemical accident risk legislation.

1.2. Organization and structure

The seminar was organized with the intent of maximizing participation of all countries. To this end, the JRC took a number of decisions for structuring the event and encouraging active engagement of participants with the advice of a Steering Committee of competent authority experts.

[13] JRC-MAHB/ECHO collaboration on building capacity for chemical accident prevention and preparedness in Neighbourhood countries that started in 2014.

[14] The earthquake module of the RAPID-N tool for calculating consequence and risks for Natech events is already available at http://rapidn.jrc.ec.europa.eu/. A flood module is in development and expected to be launched for testing in 2018. The ADAM tool for consequence and risk assessment of chemical accidents will be launched online in 2018.

The seminar topics would address a variety of topics on emerging issues associated with Seveso implementation and chemical accident risk management. This approach had the advantage that each country was likely to be interested in at least one topic. Feedback from the seminar could stimulate input on topics that would be attractive for a subsequent seminar.

2017 CARS Steering Committee Members

Isabelle Borgonjon, Federal Public Service Employment, Labour &Social Dialogue, Belgium
Mark Hailwood, LUBW, Germany
Miljenka Klicek, Ministry of Environment and Spatial Planning, Croatia
Ragnhild Larsen, Directorate of Civil Protection and Emergency Planning, Norway
Francisc Senzaconi, General Inspectorate for Emergency Situations, Romania
Julie Sharman, Health and Safety Executive, United Kingdom
Michael Struckl, Federal Ministry of Science, Research and Economy, Austria
Svetlana Stirbu, Danube Logistics, Moldova
Fabrizio Vazzana, National Institute for Environmental Protection and Research, Italy
Simone Wiers, Ministry of Social Affairs and Employment, The Netherlands

A seminar plus training would make a convincing argument for a country's participation in the event. It was assumed that all countries would be interested in training on consequence and risk assessment tools. Therefore, two training sessions each were scheduled on RAPID-N and ADAM, allowing more possibilities for all participants to have training on each tool.

The seminar would give more time to presentations than to discussion[15]. This strategy allowed participants to put a face to almost every country at the event (because they almost all had a presentation) and a talking point for bilateral exchange at coffee breaks and meals. The organizers accepted the risk that this strategy would limit the time available for discussion on key topics during the seminar, with the view that the more participants would benefit from the opportunity for bilateral exchanges.

[15] It was also decided that the seminar would not provide interpretation from other languages into English (and vice-versa), with the exception of speakers. The language of EU technical networks is English and providing interpretation would undermine the networking objectives, especially if many countries sent non-English speakers. Recognizing that speakers experience particular challenges, speakers were offered the opportunity to have interpretation, but no one requested it.

It was determined that the event would consist of a 1 ½ day seminar event divided into 6 sessions, and two additional half days on either side of the seminar were allocated for training.

The JRC sent out a notice to all country focal points of the seminar event in November 2016, inviting suggestions for seminar topics. Subsequently, the JRC formed an advisory team of 10 national experts who had experience in multilateral venues for chemical accident prevention and preparedness. Over a series of conference calls, the advisory team, called the Chemical Accident Risks Seminar, or CARS, Steering Committee, brainstormed on seminar topics, including suggestions offered by the various countries, and agreed on 5 topics (one would be covered in a double session).

The topics 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 (double session):** 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) and what problems do countries face as they are working towards establishing a hazardous site inventory?

The Steering Committee agreed that these topics represented the most common issues of concern in competent authorities in the European Union and its Affiliated Countries. Although the participating countries may have different regulatory regimes[16], they face many similar challenges. Trends in chemical accident risk tend to be dominated on the one hand by economic and technological developments associated with multinationals, and on the other hand, by small and medium-size enterprises that bring a different set of challenges. Despite differences industry size

[16] All enlargement countries have started preparations for transposition and implementation of the Seveso. Neighbouring countries are more varied in that some plan to transpose (or have already transposed) the Seveso Directive into national law, while others are more inclined to target alignment with the Seveso Directive rather than outright transposition.

Table 1 Chemical Accident Risks Seminar and Training – Countries/Organizations Represented

Representation	EU Relationship	No.	Role (in addition to participation)
Albania	Enlargement	2	1 Speaker
Armenia	Neighbourhood	2	1 Speaker
Austria	Member State	1	1 Chairperson, Steering Committee
Belgium	Member State	3	1 Chairperson, Steering Committee
Bulgaria	Member State	3	1 Speaker
CEFIC	Industry	2	1 Speaker
Chemical Business Association	Industry	1	Speaker in 2 sessions
Croatia	Member State	4	1 Session Chair, 1 Speaker, Steering Committee
Czech Republic	Member State	1	1 Speaker
Denmark	Member State	4	1 Speaker
DG-Environment	European Commission	1	1 Chairperson
Ergonomica	Research/Consultant	1	1 Speaker
Estonia	Member State	1	1 Speaker
Finland	Member State	2	2 Speakers
Georgia	Neighbourhood	3	1 Speaker
Germany	Member State	4	1 Chairperson, 2 Speakers, Steering Committee
Hungary	Member State	1	1 Speaker
INERIS	Research/Consultant	2	1 Speaker

Israel	Neighbourhood	3	Speaker in 3 sessions
Italy	Member State	3	2 Speakers
Kosovo	Enlargement	2	1 Speaker
Latvia	Member State	1	1 Speaker
Lebanon	Neighbourhood	1	
Malta	Member State	1	1 Speaker
Moldova	Neighbourhood	2	1 Speaker, Steering Committee
Montenegro	Enlargement	1	
Netherlands	Member State	2	1 Chairperson, Steering Committee
Nopco Paper	Industry	1	
Norway	EEA/EFTA	3	3 Speakers, Steering Committee
Palestine	Neighbourhood	2	1 Speaker
Poland	Member State	2	1 Speaker
Romania	Member State	1	1 Chairperson, Steering Committee
Slovakia	Member State	2	1 Speaker
Slovenia	Member State	1	1 Speaker
Solvay Group	Industry	1	1 Speaker
Sweden	Member State	2	1 Speaker
Ukraine	Neighbourhood	1	
United Kingdom	Member State	2	2 Speakers

and composition of each country, leading risk factors are the same, but experience in and resources for addressing these risks can vary considerably.

The seminar team deliberately chose a traditional presentation-style approach. As the first event of its type, the emphasis was on making new colleagues comfortable in the setting without trying to force interaction through breakout sessions and discussion. The seminar would offer opportunities for short presentations, in addition to several of 15-20 minute presentations, more typical for events of this type. This provision would offer more opportunities for different countries to present their experiences as well as reducing the burden of presentation.

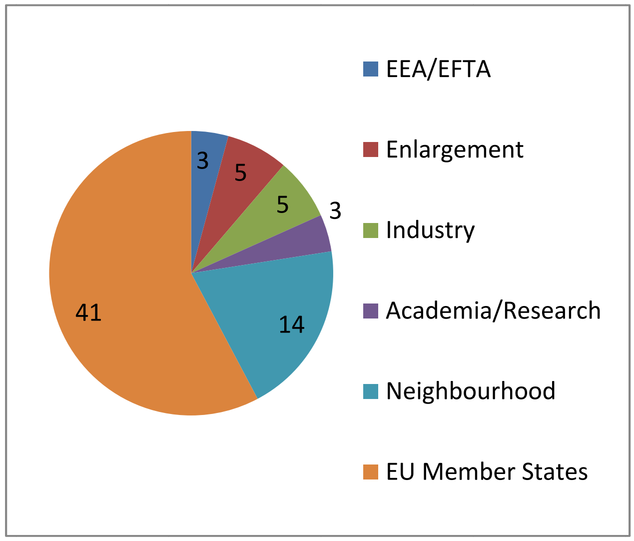

Figure 1 Number of Participants per Stakeholder Group

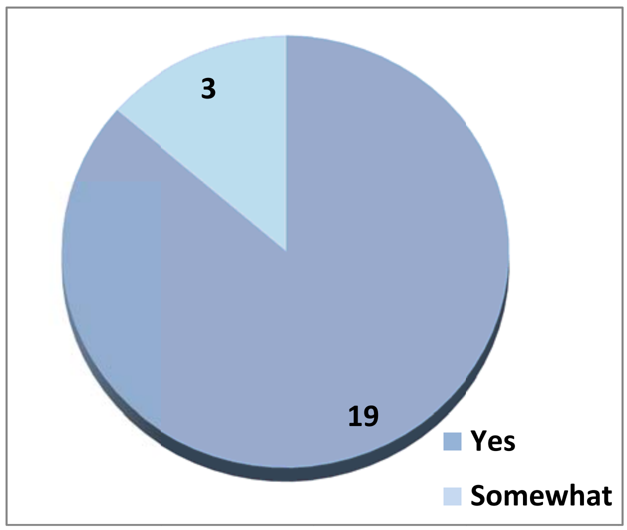

Figure 2 Participant responses to the question on whether the event met their expectations (N=22)

1.3. General outcomes and highlights

The event appeared to have met the three objectives with considerable success. The seminar met participation goals by attracting 71 participants from 30 different EU and EU-affiliated countries, and having several different perspectives 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.

Table 1 on pages 21-22 lists the countries and organizations that participated in the event and the role they played in the seminar (if any). In total, 71 experts from 30 countries, including 3 Enlargement countries, 7 Neighbourhood Countries, 1 EEA Country and 19 Member States, participated in the event, with more than 50% coming from the 30 EU/EEA countries, and nearly 25% from the 10 Enlargement and Neighbourhood countries. (See **Figure 1** above.) Almost all countries volunteered a presentation. In addition, the agenda also included speakers from 3 industry organizations and 2 speakers from the research and consulting fields. The seminar

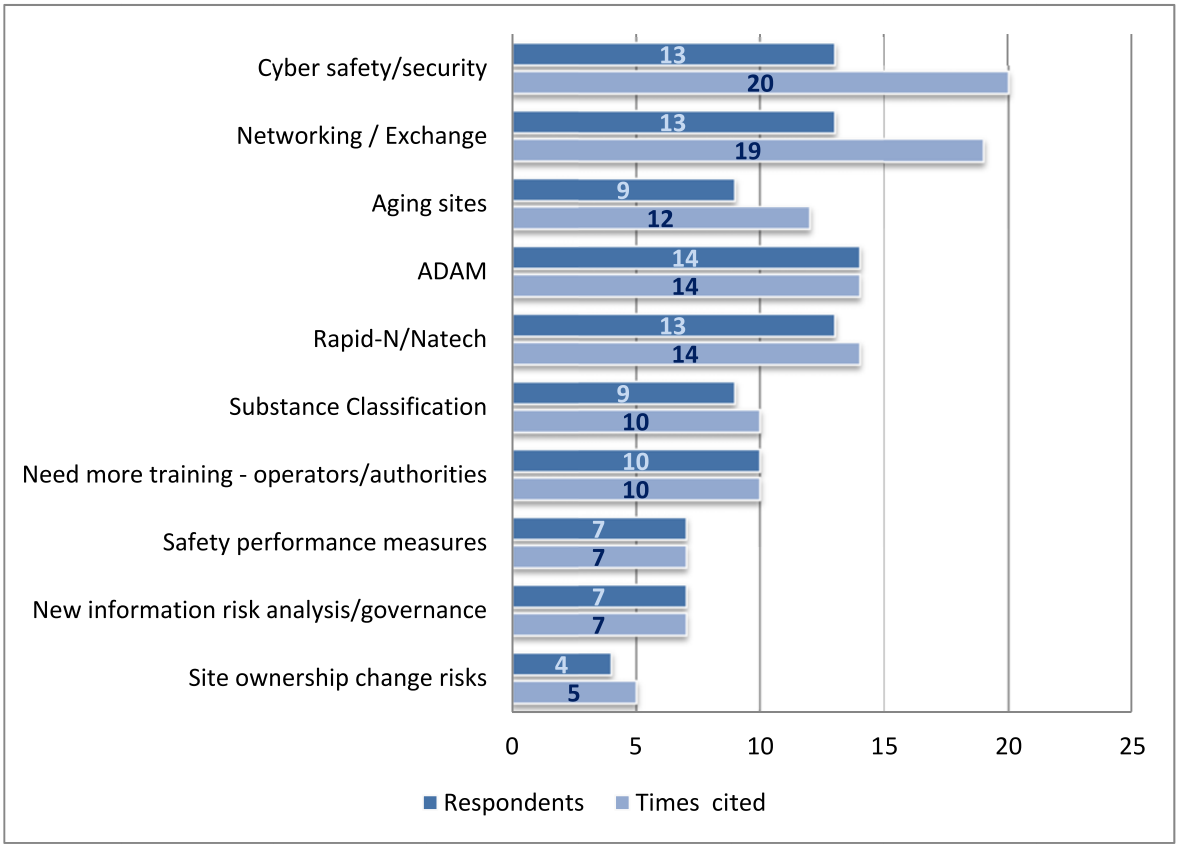

Figure 3 Top outcomes and ideas gained by participants as indicated in event feedback forms (N=25)

also benefited from presentations from JRC experts on cybersecurity and disaster risk management. In total, there were 44 different presentations delivered in seminar.

Formal feedback in the form of evaluation forms were received from 25 participants. As indicated in **Figure 2** on page 23, 19 responded that the event fully met their expectations and 3 responded that it somewhat met their expectations (3 others did not respond to this question). These three indicated that they would have preferred more time for discussion or possibly break-out groups. This comment was made by more than half of the participants in the evaluations. As noted earlier, the organizers had expected this criticism and had made a deliberate choice to take a different approach.

Figure 3 above shows the top ten most cited issues in regard to what was learned at the event and what would be taken back for use in the home country. These topics were cited in response to three different questions asking respondents to indicate what they considered the most important outcomes of the event, what they learned that they could apply in their country, and what outcomes could be taken forward in future exchanges and collaborations. The ADAM and RAPID-N tools for consequence and risk assessment were mentioned by the most respondents (14 and 13, respectively) along with cyber safety and security and networking and exchange in general (also 13 respondents each). Cyber safety and security and networking and exchange clearly made a strong impression since they were mentioned a total of 20 and 19 times, respectively, by respondents.

“The seminar provided an opportunity to take a broader look at risk assessment in other countries.”

“The “Seveso-Rules” are also interesting for other [countries that] will become [EU] members or are interested in this good regulatory framework.”

“Including authorities of other EU countries in [our] activities and research-organizations in other EU countries in [our] research projects would be interesting.”

“Including authorities of other EU countries in [our] activities and research-organizations in other EU countries in [our]research projects would be interesting.”

“In other EU-member states there are often the same problems like we have.”

“There’s a good network for Seveso-

“Problems can be solved in different ways, and all are good and practical.”

“[It was important to have] competent officials from all over Europe – a networking platform for future knowledge exchange.”

“The presentations contained a lot of important information. It was good to know what other countries are doing - ongoing projects.“

“Everyone is struggling on almost the same topics, knowing people and how they are dealing with certain problems sometimes helps to see the picture from a distance and sometimes provides you solutions.”

Figure 4 Feedback on the benefits of networking from participants

Several respondents (10) obtained ideas regarding topics for additional training for their operators and authorities. Substance classification was cited in particular as a potential topic for future networking. A number of respondents also appreciated the industry perspective on topics such as cyber safety and security and safety performance measures. A selection of participant comments on the seminar are shown in **Figure 4** above.

In addition to the topics noted in **Figure 3** (page 24), respondents also mentioned gaining important information and new ideas regarding:

- Guidance available (4)
- Land-use planning (3)
- Ammonium nitrate risks (3)
- Risks associated with remote installation (2)
- The opportunity to identify potential partners (2)
- The importance of risk communication and public awareness (2)
- Different approaches to implementation of the Seveso Directive in various countries (2)

2. Training on ADAM and RAPID-N Tools

The ADAM and RAPID-N training sessions was offered twice during the event, allowing the possibility for more than 50 participants to benefit from the training. Being only a half-day long, the training was only introductory. The workshops mainly featured an overview of the relevant risk assessment process, chemical accidents general (ADAM) or specifically Natech accidents (RAPID-N). The theoretical presentation was followed by a case study demonstration of the software tool, describing elements of the software and how they worked together to produce an estimate of the severity and extent of impacts across a geographic area.

> "Risk assessments serve many ends and the risk assessment process is used for a variety of "purposes/objectives" related to prevention, preparedness or response.
>
> They are used in practically every step of the so-called safety chain: proaction (setting policy, prioritising action, weighing alternatives, and making decisions about permitting dangerous activities or nearby developments); prevention; preparedness; response; and recovery (including health care).
>
> Governments use risk assessments, inter alia, to frame regulatory controls, for land use planning and in emergency preparedness. Management of hazardous installations use risk assessments for, e.g., setting policy, ranking risks, prioritising action, and weighing options."
>
> *Organisation for Economic Cooperation and Development (OECD). Report of the OECD Workshop on Risk Assessment and Risk Communication in the Context of Accident Prevention, Preparedness and Response. No. 1, 1997, OCDE/GD(97)31 http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?doclanguage=en&cote=ocde/gd(97)31*

2.1. Summary of the training sessions

Figure 5 Visualization in ADAM of spatial dispersion of a toxic plume on a local map
(Luciano Fabbri, EC-JRC, CARS ADAM Training

One objective of the training was to show the experts the potential for using the tools in support of their enforcement and oversight activities. In this way, experts could be encouraged to already work with the online tools whenever they wished. (RAPID-N is currently available online and ADAM will be available online in 2018.) More importantly, the training established the basis for each participating country to engage the JRC in a bilateral cooperation to provide more in-depth training. As a result, some bilateral training workshops on ADAM and Rapid-NRAPID-N have already been scheduled infor 2018. To accommodate other countries, the JRC also expects to host one or more launching workshops in 2018-

Steps in Natech risk assessment
1 Characterization of the natural hazard
2 Identification of critical equipment
3 Identification of damage severity and accident scenarios
4 Estimation of damage likelihood/probability (Equipment damage models)
5 Consequence evaluation of the accident scenario
6 Identification of credible event combinations
7 Probability/likelihood calculation for each combination
8 Consequence calculation for each event combination
9 Risk integration

Figure 6 Theoretical explanation of the Natech risk assessment process *(Elisabeth Krausmann, EC-JRC, CARS RAPID-N Training Workshop, 2017)*

2019 once ADAM is officially online. with the JRC on more in-depth training. As a result, some bilateral training workshops on ADAM and RAPID-N have already been scheduled in 2018. To accommodate other countries, the JRC also expects to host one or more launching workshops in 2018-2019 once ADAM is officially online (see **Figure 5** on page 27**)**.

The second objective was to provide basic information on the kinds of data and algorithms used in the consequence and risk assessment models. For experts who were not very familiar with consequence and risk assessment, the training gave insight into consequence and risk assessment theory, such as what is the risk assessment process (see **Figure 6** above), what is meant by a "consequence assessment", what kind of terminology used and its meaning, the kind of data needed to produce damage estimate, etc. More experienced participants would learn new information about working with advanced tools and techniques for consequence and risk assessment, such as up-to-date scientific models and data sources used by the software, as well as the software's approach to dealing with challenges associated with specific substances and accident conditions (e. g., Natech risks).

2.2. Follow-up and future implications

The high participation in the training events confirmed that consequence and risk assessment are essential competences in chemical accident risk governance. The scientific complexity of this discipline has created a high demand for tools that can predict the potential impacts of chemical accidents on neighboring communities, should they occur. The increased frequency of extreme weather events associated with global warming has created a special interest in chemical accidents generated by natural hazard impacts. Moreover, the ADAM and RAPID-N tools go beyond tools available in the marketplace to meet the specific needs of competent authorities, for example, particularly in terms of transparency of methods (algorithms are published) and manual-input for a wide diversity of fields.

"[A new idea is] the possibility of using a common system for risk analysis …"

"Hands-on trainings should be organized at home with the participation of the JRC [ADAM and RAPID-N]"

"Some quantitative risk analysis is interesting, so I will [try] to learn more about."

"[Follow-up could include] sharing experience between national experts through ADAM and RAPID–N [using] real cases and [examining] relative differences with other calculation packages"

"Natech risks [should] be better addressed in the national program, i.e., capacity building for the authorities and industry, cooperation between Seveso authorities and civil protection authorities"

"The first and obvious idea is the use of ADAM software as the main risk assessment tool. The software could be implemented at two levels: 'Light version' for rough consequences calculations on the basis of information reported by installations to authorities. Full version to give to the competent authorities an ability to calculate risks at different levels of accuracy and critically overview the reports presented by the industry and the advisors."

Figure 7 Quotes from respondent evaluations about ADAM and Rapid-N training sessions

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. (**Figure 7** on **Page 29** lists some comments that respondents provided on the training in the evaluation forms.)

The interest and feedback regarding the tools generate d a variety of commitments as well as potential future work programme elements for ADAM and RAPID-N tools. In particular:

- Based on the country's request, **the JRC plans bilateral trainings on the tools in Bulgaria, Georgia, Israel and Ukraine across 2017-2018**, and other countries as resources allow.
- **Multilateral workshops are expected to be scheduled in 2018-2019** to coincide with the launching of the ADAM tool online and the new Flood module for RAPID-N.
- A Train-the-Trainer for experts should be eventually developed to expand the trainer pool to allow the possibility of more frequent training workshops 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.
- The JRC will continue to maintain and update online Help tools with staff support as back-up as necessary.

3. Performance Measurement

This session was structured as a panel session in which each speaker had only 5 minutes to make a presentation. It consisted of a brief presentation outlining the Loss Data Initiative of the Sendai Framework for Disaster Risk Reduction, two presentations from industry, and numerous presentations by national authority experts.

Why Safety Performance Measurement is a Priority Topic

Safety performance measures to support chemical accident risk management has been an accepted part of chemical process safety management for a few decades, promoted by prominent organizations such as the OECD and the Center for Chemical Process Safety in the late 1990s and 2000s. In the aftermath of the BP Texas City accident of 2005, the concept has become mainstream process safety in both government and industry. Establishing meaningful performance measures for industrial processes can be both a complex and dynamic exercise. The data should generate relevant and timely feedback for improving safety that can be converted into recommendations for action. Increasingly, governments are also establishing performance measures, to evaluate effectiveness of regulation and their own efforts to enforce it.

What This Session Aimed to Discuss

We cannot improve what we cannot measure. How do we know if we are reducing chemical accident risks? Do we have the right tools to measure this? This is a panel session that will explore what measures are currently available for the EU, national authorities and industry to measure safety performance in reducing chemical accident risks. This session seeks to answer the following key questions: What do these measures say about industry process safety performance? What are the things they can't tell us? Is the picture clear and complete? What kind of leading indicators could be used to predict safety performance trends across industry? What are some possible options for obtaining more accurate and complete statistics on EU performance in reducing chemical accident risks?

3.1. Highlights from the session

Of the considerable information provided across presentations, the following points represent some of the main highlights.

The majority of safety performance measurement systems in use today only follow – rather than lead – safety. This situations needs to change. There is still tremendous work ahead in establishing appropriate measures and systems for collecting data to assess safety performance and drive prevention improvements. They are not proactive in identifying increased risk. Performance is often equated with accidents reported, a lagging indicator that also excludes near misses and accidents on sites and within activities outside the reporting regime (e.g., Seveso).

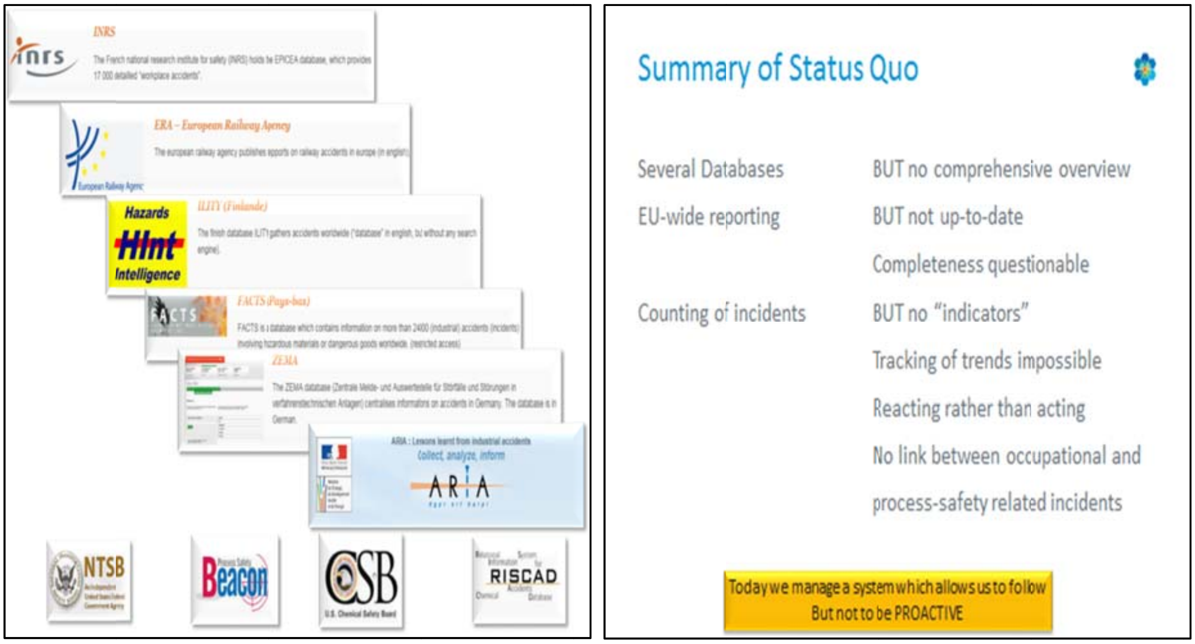

Figure 8 Status of common sources of chemical accident trends in the EU and globally *(William Garcia, CEFIC, CARS 2017)*

Lessons learned reporting systems, such as the Seveso EU eMARS database[17], are vastly useful for lessons learned, and giving evidence of why certain activities, substances and practices are ongoing risks. However, these data are questionable as sources of safety performance trends. (Examples of some sources of chemical accident data are shown in **Figure 8** above.) Their coverage (limited to certain sites, e.g., Seveso), relatively small number of accidents per year (usually only big impact accidents), the diversity of risk sources, coupled with (usually) death and injury as the only reliable severity measure can be serious limitations in obtaining statistically valid information about progress in reducing potential accident risks over time.

Multinationals, large companies and several government entities are driving efforts to progress towards more proactive safety performance measurement. OECD and the European Industry Chemistry Council have each published well-regarded guidance on process safety performance measurement.[18],[19]

---

[17] https://minerva.jrc.ec.europa.eu/en/emars/content

[18] OECD. 2003. Guidance on Safety Performance Indicators. http://www.oecd-ilibrary.org/environment/oecd-guidance-on-safety-performance-indicators_9789264019119-en

[19] CEFIC. 2011. Guidance on Process Safety Performance Indicators. http://www.cefic.org/Documents/IndustrySupport/RC%20tools%20for%20SMEs/Document%20Tool%20Box/Guidance%20on%20Process%20Safety%20Performance%20Indicators.pdf

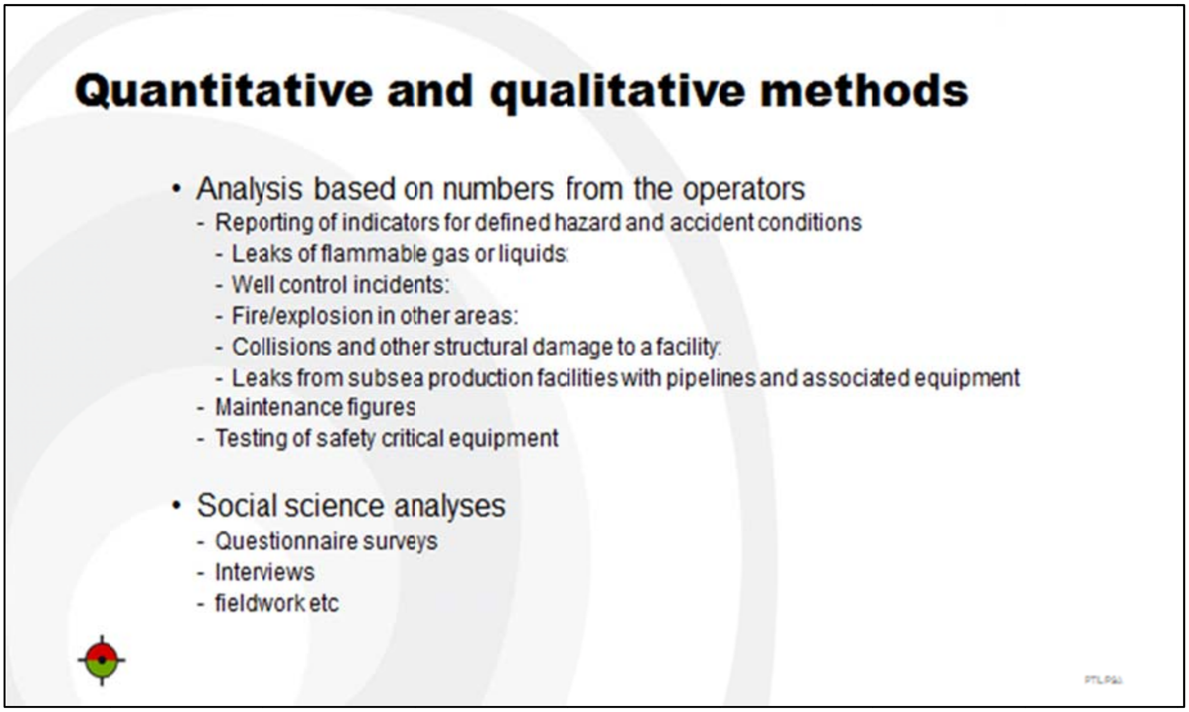

Figure 9 Methods used by Trends in Risk Level (RNNP) performance measurement tool *(Asbjorn Ueland, Norwegian Petroleum Safety Authority, CARS 2017)*

The International Council of Chemical Associations has a set a target of 2020 for its national associations to report against new process safety performance metrics that include leading indicators to identify emerging trends and increased risks. Indicators are approximations of risk, based on what are already known risks, and risk is a moving target. For this reason, even the most updated proactive measurements are imperfect, but experience indicates that the act of measurement itself creates pressure to improve.

Some EU competent authorities have also developed measures to identify weaknesses in site risk management as a mechanism for driving improvements**.** **In the United Kingdom**, a government initiative to use safety metrics to monitor aging plant risks has generated a collaborative response from industry. The UK chemical industry associations analyses its companies' to score industry performance in addressing these risks and motivate self-improvement.

The experience of the Norwegian Petroleum Safety Authority (PSA) also demonstrates the benefits of having a safety performance measurement system for industry, particularly to monitor performance as markets and economic conditions change. (**Figure 9** above shows an excerpt from the presentation from the PSA.)

The UN Loss Data Initiative is a prominent activity within the Sendai Framework for Disaster Risk Reduction and also closely followed by the EU. While the Sendai Framework supports collection and analysis of data for numerous purposes, the Loss Data Initiative emphasizes the importance of accident loss data as evidence to policy makers of disaster risk vulnerabilities. Together with other partners, including the EU, it is **working towards a uniform set of indicators for collecting loss data** from all types of natural and technological disasters.

Countries that have not implemented Seveso, or a Seveso-like programme are for the most part looking at different safety performance metrics than their EU counterparts. Pre-Seveso countries are looking at whether they are sufficiently enabled to manage their chemical accident risks. These kinds of measures include having an inventory of all major hazard sites, having a complete set of legislation in place to manage the risks, whether competent staff are available and operational systems have been established to support implementation of the legislation.

3.2. Future implications and potential follow-up

Pursuant to the meeting the CARS Steering Committee met to discuss what ideas could be taken forward from the presentations in this session. The Committee made the following observations.

- **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 chemical industry has conducted extensive research and elaborated concrete guidance in order to help their memberships. 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 yet to take a similar commitment. Moreover, a majority of 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.** While the reporting of major accidents in eMARS is invaluable for recording and exchanging lessons learned, it is not adequate for performance measurement. Moreover, EU governments, with some exceptions, have not been aggressively seeking to adopt proactive safety metrics to identify trends and emerging risks for themselves. More varied forms of measurement are needed to reflect the government's impact.

    - In particular, high-consequence, low-frequency accidents are not measures of performance.

    - Secondly, the full impacts of the accidents that are reported are not recorded, if they are even measured at all (or known).

- **Implementation of site-based measurement by competent authorities as leading indicators for emerging risks could be further explored.** 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** could be particularly useful, notably:

- Measures that provide input as to whether government programmes to reduce chemical accidents are working generally across the economy. Loss data are one type of measure that could be useful for this purpose. Taking this forward would imply that data collected may have to have lower thresholds than existing schemes and cover a wider range of impacts. There are probably some countries that are collecting these data that could be used as models.

- So-called "bottom-up" indicators that give feedback on site specific conditions. These measures would provide input to inspection strategy and could also promote constructive dialogue on improvements between government and industry, as noted the United Kingdom and Norway examples. Instruments such as safety culture surveys and other similar questionnaires used by some EU inspectorates are already going in this direction.

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 includes:

- How effective are Seveso inspections?
- How does enforcement vary across the EU in terms of approach, intensity and outcome?
- How well do other government enforcement and compliance measures work, e.g., fines , guidance, etc.?
- Does impact of inspection and other measures vary depending on the type of company, and if so, what are the key variables in this regard, e.g., the type of activity, safety culture, size?

3) In light of these observations, **it is also relevant for pre-Seveso countries to 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.[20]

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 should be taken up in the various forums where governments meet and discuss how to address challenges in monitoring and oversight of hazardous industries.

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.

3.3. Additional sources of information

- **CEFIC Guidance on Process Safety Indicators**
  http://www.cefic.org/Industry-support/Responsible-Care-tools-SMEs/3-Plant--Process-Safety/Cefic-Guidance-on-Process-Safety-Indicators/

- **OECD Guidance on Developing Process Safety Indicators**
  https://www.oecd.org/chemicalsafety/chemical-accidents/41269639.pdf

- **OECD Corporate governance for process safety: Guidance for senior leaders in high hazard industries**
  http://www.oecd.org/chemicalsafety/corporategovernanceforprocesssafety.htm

[20] The JRC Survey of Seveso Implementation in Neighbourhood Countries aimed to establish a baseline for each country within the Seveso Directive context. https://minerva.jrc.ec.europa.eu/en/shorturl/minerva/seveso_enpi_project_outputs

4. Integrity of Installations and Equipment (Mechanical Integrity)

This session consisted of 8 presentations from government experts. The topics ranged from a monitoring and performance measurement system for ageing plants (already mentioned in Session 1), analyses of accidents involving mechanical integrity failures, highlights of good practice and findings from inspections, and two case studies associated with risk management and communication of risks on ammonia storage sites.

Why Mechanical Integrity is a Priority Topic

The core principle of chemical process safety is to avoid a loss of containment, that is, an unplanned release of a dangerous substance. Mechanical integrity failures remain a prominent factor in chemical accident and near-miss occurrences, serving often as primary causes as well as contributing factors in the sequence of events. of chemical accidents and incidents. Core elements of a mechanical integrity program are monitoring, inspection, testing and maintenance at appropriate intervals and in response to system feedback of relevant equipment, including 1) pipes, vessels and tanks in order to avoid spontaneous leakage or ruptures, 2) process controls to ensure the prevalence of safe operating conditions, and 3) safety instrumentation and emergency response systems designed to contain impacts should process failures occur. Ensuring that the site's mechanical integrity programmes are sufficiently controlling process risks is an ongoing concern for operators and inspectors alike. Maintenance activities are particularly vulnerable to cost-cutting measures when profit margins are down. In addition, efforts to maintain integrity can be undermined by uncertainties associated with factors such as aging, quality of repairs and replacement, process change, and lack of equipment documentation.

What This Session Aimed to Discuss

Hazardous sites should ensure ongoing mechanical integrity for systems and their critical components, both containment of hazardous substances inside the equipment and/or critical lines and the proper functioning of critical safety systems during all phases of the plant life cycle: design, installation and start-up, operation and maintenance, shut-down, cleaning and decommissioning. This session sought answers to a number of questions to have a view of current strengths and weaknesses in mechanical integrity management on hazardous sites. What are major / typical findings from recent inspections and accident investigations and what kind of actions have been undertaken? How do integrity challenges affect small sized establishments (especially in small companies or with simple processes, like LPG storage)? How can the new requirements of the Directive be interpreted in relation to mechanical integrity of equipment and control and monitoring of plant ageing? How can Seveso competent authorities/industry groups promote better integrity management on major hazard sites? How is industry addressing planning and foresight on integrity in new design?

4.1. Highlights from the session

A main observation from this session was that it was linked strongly with Session 1, that is, **mechanical integrity is one of the most influential leading indicators for safety performance**. Notably, the HSE presentation on its ageing plant metrics was raised in both sessions. (See **Figure 10** below.)

Some key messages drawn from this session are described below:

Hazardous sites should set up an assets register of all critical equipment on site. There continue to be numerous accidents that fundamentally were caused by, or exacerbated by, wrong assumptions about the equipment involved. Companies often fail to address these significant gaps in documentation of specifications and the operational and maintenance history of critical equipment. This situation is a particular risk for older plants (> 10 years), because rules of documentation were less rigorous, or documentation was lost over time, or was never passed on to new owners.

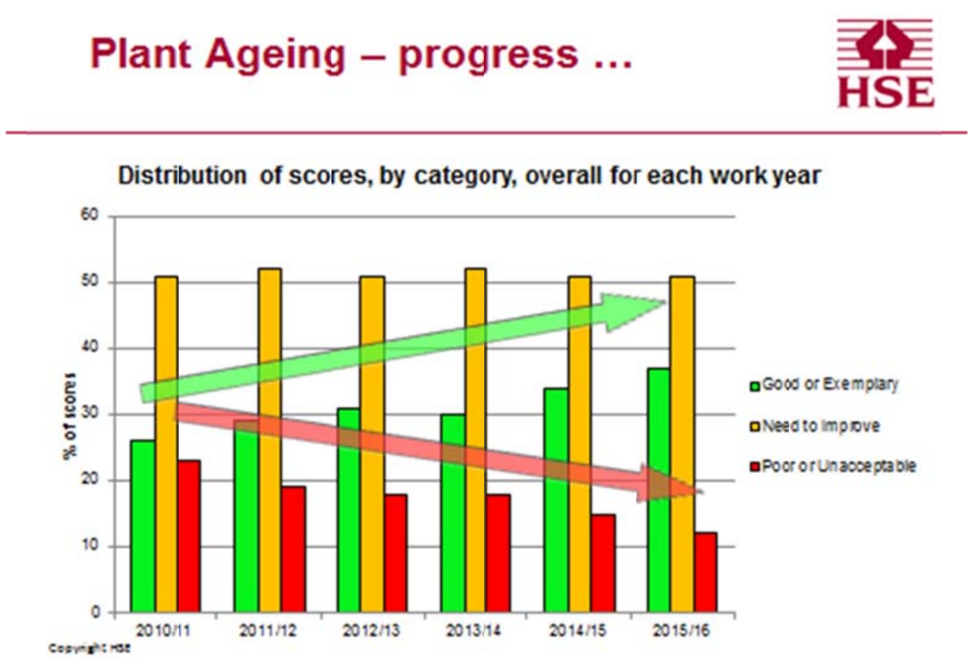

Figure 10 Results of performance measurement programme for ageing plants *(Julie Sharman United Kingdom Health and Safety Executive, CARS 2017)*

Using accurate information on equipment and process dynamics is essential to assuring appropriate use and maintenance of equipment to avoid failure. This information typically consists of age, function and specifications of critical equipment. The appropriate performance degradation rates should be incorporated into calculation of maintenance intervals for each piece or section of equipment. In addition, the kind of degradation phenomena and static/dynamic stresses that may affect material compatibility with operating conditions.

A strong mechanical integrity programme can be demonstrated to the public and politicians, and provide evidence of good risk management. For some substances, such as ammonia, Public doubts and/or political awareness about mechanical integrity of hazardous sites have surfaced with large ammonia storage tanks near urban areas in various countries (Israel, Norway, Slovakia).

Ammonia is an essential ingredient to many industrial processes and having storage sites within the country gives economic advantages in many cases. In Norway, the uncertainty surrounding the risk level associated with a very large ammonia storage tank stoked public concern. However, a structural examination of the tank produced convincing evidence that the risk of an ammonia release were very low and elevated public trust.

4.2. Future implications and potential follow-up

Pursuant to the meeting the CARS Steering Committee met to discuss what ideas could be taken forward from the presentations in this session. The Committee made the following observations.

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. It is essential that hazardous sites maintain complete asset registers for safety-critical processes.

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).

Effective management of site integrity is a good story for business and for the public. Insufficient mechanical integrity leaves sites very vulnerable to losing their right to operate in the face of a serious incident or concerned citizens and politicians. Conversely, a proactive mechanical integrity programme can often be a selling point in risk communication. Moreover, 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.

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.

4.3. Additional sources of information

- OECD Ageing of Hazardous Installations
  http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=env/jm/mono(2017)9&doclanguage=en

- UK. Health and Safety Executive (HSE) . Ageing Plant Operational Delivery Guide Ageing Plant Operational Delivery Guide. Control of Major Accident Hazards (COMAH).
  http://www.hse.gov.uk/comah/guidance/ageing-plant-core.pdf
  The UK HSE has several other ageing plant guides for operators on its site at http://www.hse.gov.uk/comah/ - Search on "ageing plants"

- INERIS. 2009. International Benchmark on regulations and practices as regards managing industrial installation ageing. Study Report N° DRA-09-102957-07985C.
  http://www.ineris.fr/centredoc/ageing-web.pdf (English)
  http://www.ineris.fr/centredoc/benchmark-vieillissement-general-web.pdf

(French)

- Mansfield, D., T. Atkinson and J. Worsley, 2012. The importance of recognising and managing ageing plants. Symposium Series No. 158 Hazards XXIII. IChemE. https://www.icheme.org/~/media/Documents/Subject%20Groups/Safety_Loss_Prevention/Hazards%20Archive/XXIII/XXIII-Paper-56.pdf

5. IT Security and Safety Challenges

This session was a double session that looked at both security and safety risks with increased integration of IT technology in hazardous site operations. It consisted of 11 presentations from a mix of industry, national authorities and the research community (represented by the JRC). The presentations were varied and complementary, with some providing problem analysis and case studies, others describing some of the solutions underway to resolve the emerging challenges.

Why Cyber Safety and Security is a Priority Topic

The use of new technologies introduces new and unforeseen risks. The significant advances in information technology in the past two decades has launched a revolution in manufacturing as process automation increasingly takes over more and more process operations. Companies are increasingly investing in internal information technology that connects their networks of sensors and actuators for data collection and monitoring to optimize production processes and automate routine process decisions. According to a recent report by McKinsey and Company on emerging and disruptive technologies*, this technology application, often referred to as the "Internet of Things" will add trillions of Euros of added value to the world economy by 2025. Many industries will increase IT dependencies in other areas, such as advanced robotics and cloud technology (computer hardware and software delivered over the Internet). It is evident that companies and entire industries will need to rethink and rewrite hazard assessments to reflect new process considerations, including large scale process interconnectivity, remote control from longer and longer distances, and software and hardware integrity.

What This Session Aimed to Discuss

The session sought to understand whether ongoing innovations in the use of IT technology for operation of major hazard sites make major hazard sites more vulnerable to cyber attacks than they were 5 or 10 years ago? Can they introduce additional risk factors affecting process safety on major hazard sites? Why or why not? What are companies doing to protect their sites from cyber attacks or increased safety risks and what are vulnerable industry groups doing to help their sites reduce these risks? What tools and approaches can the Seveso competent authority use to motivate sites to take action to reduce IT-related safety and security risks at their sites? Compared to other risks, how relevant and how serious are IT risks for a hazardous site?

*Manyika, J., M. Chui, J. Bughin, R. Dobbs, P. Bisson, and A. Marrs. 2013. Disruptive technologies: Advances that will transform life, business, and the global economy. McKinsey Global Institute.

5.1. Highlights from the session

For many participants, this session represented a basic and well overdue education in understanding the potential impacts of a new generation of production that is heavily dependent on information technology. Key messages drawn from this session are described below:

The opportunities represented by advances in information technology also bring new technological challenges. For all industries, these innovations create new types of demands on resources and introduce new security risks. (An example of how control systems may be used on chemical plants is shown in **Figure 11** on page 45.) Notable changes in the traditional business model stem in large part because:

- Industrial control systems are not isolated anymore
- Modern industrial control systems are communicating over the Internet
- Industrial control systems are running generic operating systems

These aspects have notable implications for chemical accident risks at hazardous facilities, in particular, increased potential for common cause failure as well as the possibility that hacking the system could result in a potential release of hazardous substances.

Industrial control systems introduce safety risks as well as security risks that have implications for both design and maintenance of these systems. Risk managers will have to include hazard analysis in a number of relatively new areas associated with the use of information technology, such as:

- design of interfaces between new and "old" IT systems,
- integrity of IT system components and functions,
- software and equipment life cycles, and
- risks associated with maintenance and updates to hardware and software
- risks associated with remote operation of plants

A case study of the Mongstad refinery incident (October 2016) given by the Norwegian Petroleum Safety (PSA) gave evidence that IT failure coupled with interconnectivity of process operations across a common network can launch a series of events leading to an accident.

Site safety management systems may not reflect an awareness of safety risks associated with implementation of IT innovations. Industrial control systems are a new source of common cause failure. It has also has profound implications for management of change.

As noted in the presentation from the Norwegian PSA, elements that may need to be elaborated in an SMS may include such items as:

- risk assessment of threats within the IT domain,
- IT architecture and interfaces with other IT systems,
- passive protective measures,
- monitoring, analysis and response related to cyber irregularities
- procedures for reporting cyber vulnerabilities and near-misses
- auditing of IT systems for safety risks

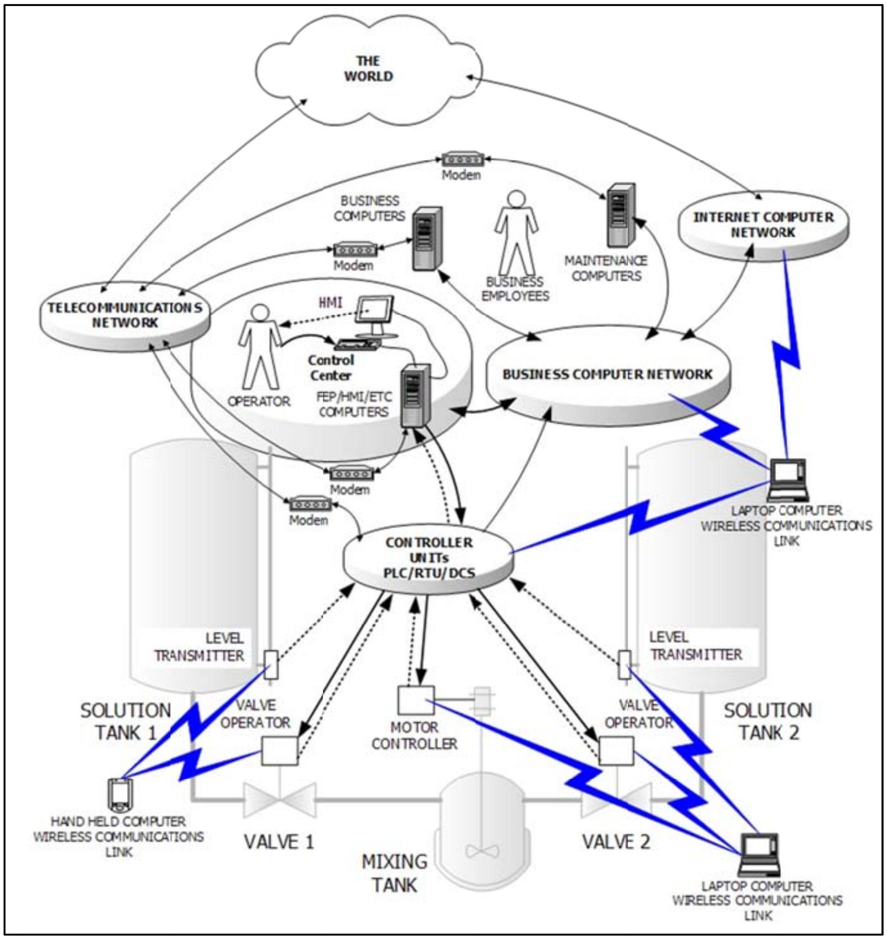

Figure 11 Communication across control systems *(US Department of Homeland Security https://ics-cert.us-cert.gov/content/overview-cyber-vulnerabilities)*

There are also many common sense measures that should become standardized, such as password protection, security procedures for contractors and guests who enter the site, etc.

Cyber security of hazardous sites merits attention as industry will continue to be incrementally exposed to cyber threats. Nonetheless, it should be emphasized that traditional security risks faced by hazardous sites are most likely still higher risks than cyber risks. For the chemical industry, the risk of information theft and/or process interruption is more relevant than the risk that a hacker will reconfigure process operations to cause an accident. Still, as companies increase their use of industrial control systems, they will need to remain vigilant in reducing their exposure and vulnerability to cyber threats. (**Figure 12** on page 46) shows an example of a security analysis performed by one company.)

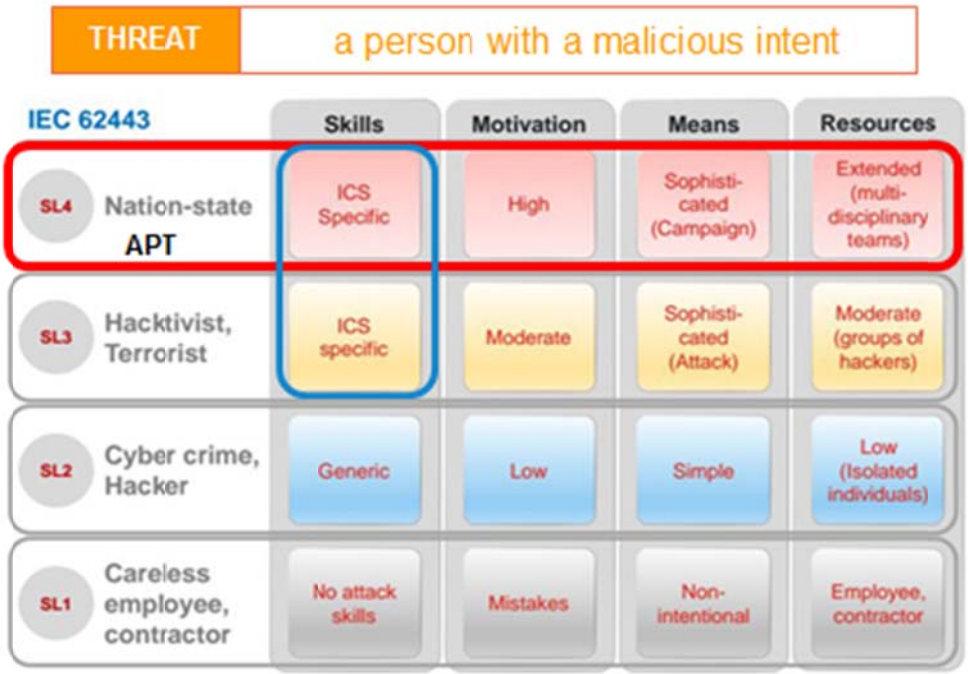

Figure 12 An evaluation of cyber security threats as classified using IEC 62433 security levels *(Werner Cooreman, Solvay Group, CARS 2017)*

The potential increase in remote operated plants because of new automation potential raises some new safety and legal issues. A case in Finland has already triggered concerns by authorities of the adequacy of emergency response provisions proposed by a new remote-operated, unmanned hydrogen plant. Several challenges emerged from this case that have serious implications for safety, such as:

- The Seveso status of the central operating units managing the remote control sites,
- How to inspect and enforce Seveso requirements when these installations are located in another country
- Identification of activities that can, and cannot, be safely managed by remote control systems and which cannot. Criteria may need to be established for making decisions in specific cases.
- Identification of major accident scenarios specific to remotely operated sites
- Minimum requirements to assure equivalent or lower risk on sites when changing from a locally operated plant to a remote operated plant
- Establishing limits to automation, e.g., list of operations that cannot be automated, criteria for accepting or rejecting automation of certain procedures
- Risks associated with increased interconnectivity and scale and other complexities, e.g., number of remote plants running on the same system,

geographic distribution, interconnectivity between plants, size of remotely operated plants, etc.

- Good risk management practice specific to remote sites, such as minimum response time; coping with loss of power; Internet access and hacking; and manual functionality and overrides necessary in the case of failures or emergencies.

There are a number of initiatives implemented or underway both in the European Union and internationally to address security vulnerabilities associated with industrial control systems. The Directive on security of network and information systems (NIS Directive) (EU 2016/1148) and the current proposal to strengthen standardization and certification activities within the EU agency for Network and Information Security (ENISA) represent significant steps forward in establishing a strong cybersecurity framework in Europe. (EU efforts to strengthen standardization and certification have subsequently become more visible within the proposal for regulation COM/2017/0477 final/2 issued on 4.10.2017.[21])

5.2. Future implications and potential follow-up

Pursuant to the meeting the CARS Steering Committee met to discuss what ideas could be taken forward from the presentations in this session. The Committee made the following observations.

Awareness and identification of risks associated with advanced industrial control systems is lagging behind its implementation. The Norwegian PSA study indicated that, while some operators understand the threat and are working towards integration of cyber risks in their risk management approach, others do not have a risk assessment approach at all.

There will need to be close and ongoing collaboration directed at incorporating process risk management in industrial controlling systems. Designers of industrial control systems speak a different language than process engineers. 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. The seminar represents one of the first occasions where industry and government have exchanged good practice and experience in this regard. It is still somewhat early to understand the full implications of cyber security and automation with process safety for Seveso inspections. For example, it was discussed that some competent authorities may require support from an IT expert resource to support Seveso enforcement and oversight at sites with advanced industrial controls systems. Security clearance could

---

[21] Proposal for a Regulation of the European Parliament and of the Council on ENISA, the "EU Cybersecurity Agency", and repealing Regulation (EU) 526/2013, and on Information and Communication Technology cybersecurity certification (''Cybersecurity Act'')

also be a requirement for inspectors at some sites. Ongoing exchanges with industry and the cyber community should help to evolve effective approaches over time.

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 an ad hoc approach to risk management creating potentially serious risk management gaps on individual sites. 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.

Conclusions: 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.

5.3. Additional sources of information

International Standards

- IEC 61511-2. Functional safety – Safety instrumented systems for the process industry sector – Part 2: Guidelines for the application of IEC 61511-1 (https://webstore.iec.ch/p-preview/info_iec61511-2%7Bed1.0%7Den.pdf)
- BS IEC 62443. Industrial Automation and Control Systems Security. (http://isa99.isa.org/Public/Information/The-62443-Series-Overview.pdf)
- EEMUA Information sheet 2. Cyber security assessment process for industrial control systems (https://www.eemua.org/EEMUAPortalSite/media/EEMUA-Flyers/EEMUA-Industry-Information-Sheet-2.pdf)

European Union

- The Directive on security of network and information systems (NIS Directive) (https://ec.europa.eu/digital-single-market/en/network-and-information-security-nis-directive)
- ENISA, the EU agency for Network and Information Security (https://www.enisa.europa.eu/)
- European IACS components Cybersecurity Certification Framework (ICCF) (https://erncip-project.jrc.ec.europa.eu/documents/introduction-european-iacs-components-cybersecurity-certification-framework-iccf)

Norway

- NOROG 104 Recommended guidelines for information security baseline requirements for process control, safety and support ICT systems, NEW REVISION 05122016 (https://www.norskoljeoggass.no/en/Publica/Guidelines/Integrated-operations/104-Recommended-guidelines-for-information-security-baseline-requirements-for-process-control-safety-and-support-ICT-systems/)
- A guideline based on ISO 27002 and adjusted for OT environment

United Kingdom

- HSE Operational Guidance. Cyber Security for Industrial Automation and Control Systems (IACS). (http://www.hse.gov.uk/foi/internalops/og/og-0086.pdf)

United States

- NIST Special Publication 800-82 Revision 2 Guide to Industrial Control Systems (ICS) (http://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.800-82r2.pdf)

- Chemical Sector Cyber Security Framework https://www.us-cert.gov/sites/default/files/c3vp/framework_guidance/chemical-framework-implementation-guide-2015-508.pdf

Industry and academia

- Charpentier, J-C. 2015. What kind of Modern « green» Chemical Engineering is required for the Design of the « Factory of Future »? Symphosium 2015. 3rd International Symposium on Innovation and Technology in the Phosphate Industry http://www.sciencedirect.com/science/article/pii/S1877705816004689#abs0005

- Charpentier, J-C. 2010. Among the trends for a modern chemical engineering, the third paradigm: The time and length multiscale approach as an efficient tool for process intensification and product design and engineering . Chemical Engineering Research and Design 88 (2010) 248-254 http://www.sciencedirect.com/science/article/pii/S0263876209000732

- Gani, R. 2008. Integrated Chemical Product-Process Design: CAPE Perspectives . Computer Aided Process Engineering (CAPE). ISBN: 3-527-30804-0. Wiley Online Library http://onlinelibrary.wiley.com/doi/10.1002/9783527619856.fmatter/pdf

- Potier, B. 2015. Air liquide digital policy/approach. Air Liquide Keynote at Financial Times Manufacturing. FT Live. https://www.youtube.com/watch?v=LC6Egjyuyug)

- C. B. Frey and M. A. Osborne. 2013. The future of employment: how many jobs are susceptible to computerisation? University of Oxford. Oxford Martin School. http://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf

6. Organizational Change and Influence of Enforcement

This session consisted of presentations aimed to identify and address challenges associated with organizational change, and in particular, change of ownership, that can have a dramatic influence on the safety of hazardous sites. This session consisted of 4 presentations from national experts, and one each from experts from industry and academia.

Why Organizational Change is a Priority Topic

Over its lifetime sites, can undergo diverse phases of organizational changes, the most common are changes stemming from economic downturn and ownership change. There is ample evidence from past accident history that failure to control ownership change risks can have long term impacts on overall site safety performance. However, there are a number of other kinds of organizational changes that elevate risks, including changes that dramatically alter work processes, such as outsourcing and digitization of operations. Multi-operator sites, such as industrial parks and joint ventures, can also create new risk management challenges where responsibility and accountability for some safety critical operations, such as emergency response and maintenance and common infrastructure, are distributed.

What This Session Aimed to Discuss

This session examined how organisational change may affect process safety risks on major hazard sites and what government and industry can do to reduce potential risk from organizational change. Key questions that were addressed include: Do site managers know that organizational changes may also affect the plant safety and must be evaluated in the SMS? What impacts do ownership change, staff reductions, re-organisation, reduction in competency requirements, joint ventures, and general drives for more efficient production affect process safety? How can competent authorities identify when sites are at risk because of organizational change? How can competent authorities influence sites to evaluate and address process safety risks due to organizational change?

6.1. Highlights from the session

The presentations on this topic had some clear links to other topics in the seminar, especially with mechanical integrity, and to some extent also cyber safety and security. Key messages drawn from this session are described below:

Challenges remain in managing the volume and pace of organizational change in our time (e.g., economically driven changes, IT systems). In industry, change is often a function of effective business management implemented through a proactive strategy. In some cases, change is forced by external factors, such as regulation or competition, in which case the strategy may be reactive.

In many countries, change of ownership of one or more hazardous sites is a common occurrence, particularly, in the chemical industries. Most, if not all, countries have experienced change of ownership associated with a hazardous site over the last several years. It is not uncommon that the change strategy overlooks the effects of organizational change on process safety. Failure to analyze these impacts in time can result in a weakened defense against major accidents. For example, industry implementation of government actions to improve safety can temporarily reduce its capacity to manage exposure to the risks in question.

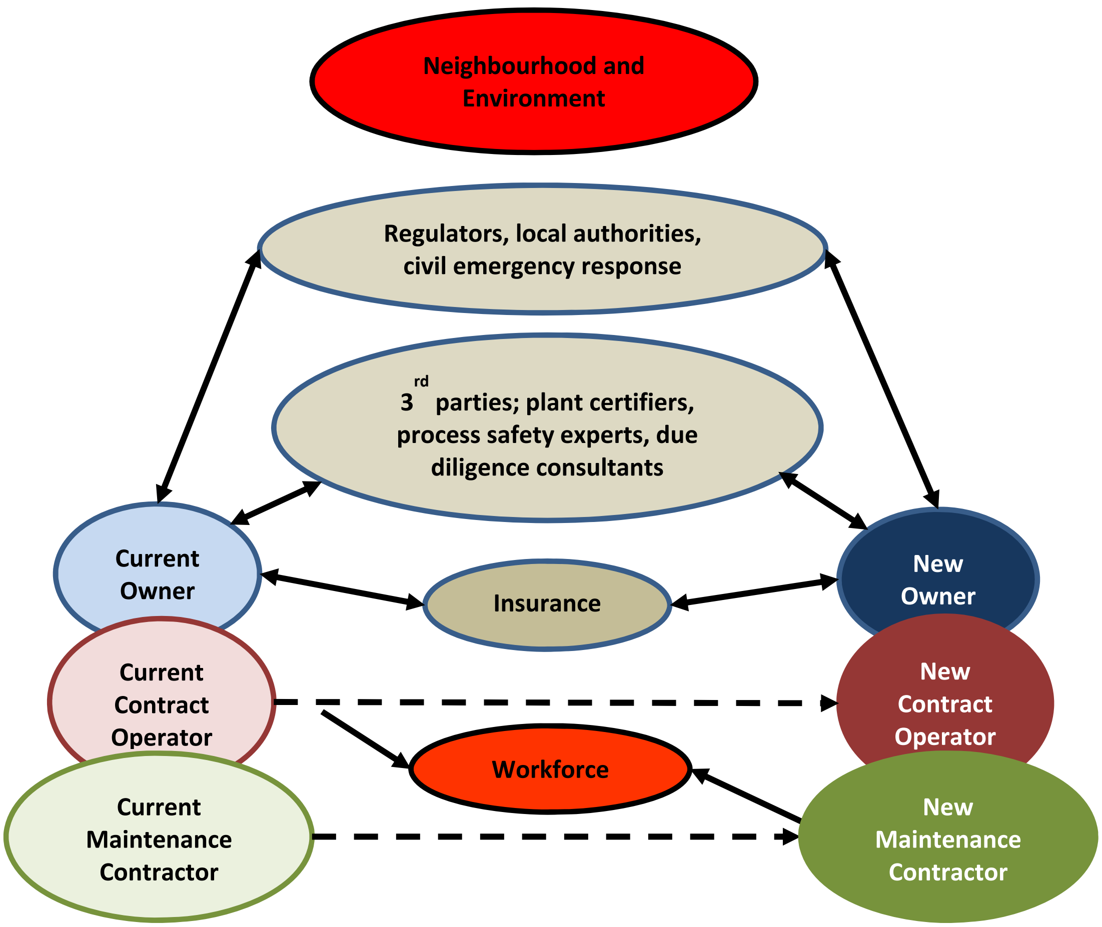

Figure 13 Relationships and responsibilities of stakeholders in change of ownership *(R. Larsen, Norwegian Directorate of Civil Protection and Emergency Planning, CARS 2017)*

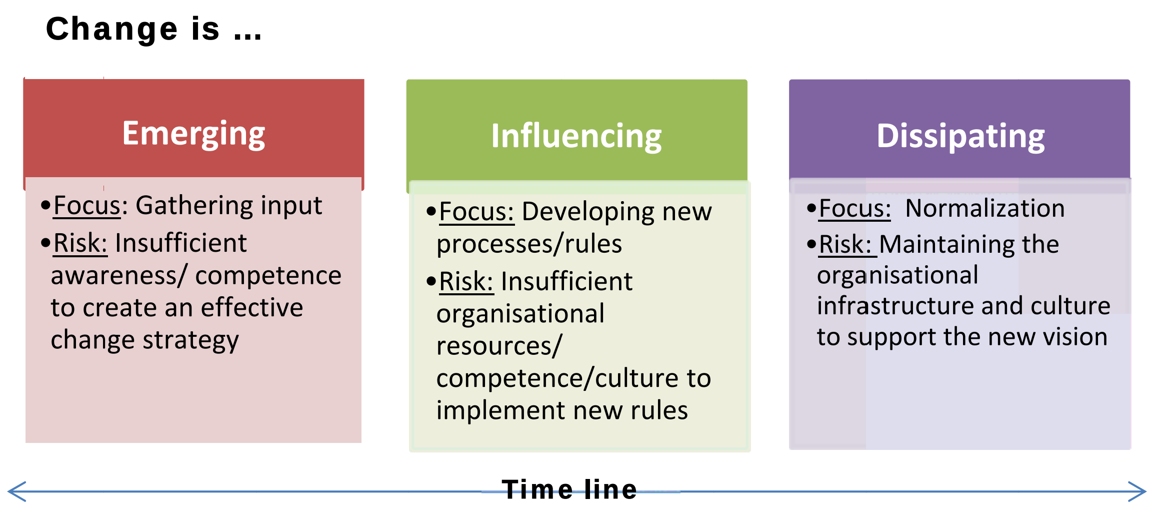

Figure 14 Change risk management life cycle *(D. Baranzini, Ergonomica, adapted from the presentation at CARS 2017)*

The OECD has recently studied the long term impacts on safety when hazardous sites change hands. In this process the study collected numerous examples of successful and unsuccessful changes of ownership. As a result of its work, the OECD is publishing a short guidance to make both government and industry aware of the possible hazards and pitfalls during and after a change of ownership. (**Figure 13** on page 52) depicts typical responsibilities in this context.) The guide is intended for use as a tool to help ask the right questions and take the right actions.

Based on a survey of member companies of the European Chemical Industry Council (CEFIC), industry strongly supports the OECD guidance, recognizing that it fills an important gap in the safety management framework consistent with the Responsible Care philosophy.

Capacity building for Seveso implementation, or similar chemical accident prevention and preparedness regimes, in "pre-Seveso" countries should also be recognized as organizational change that needs to be managed. Improvements to the legal framework for managing chemical accident risks can create new demands for competence and resources on both government and industry. Gaps and opportunities in the existing system can be identified in advance for developing a strategy and timeline that reduces risk that new needs and requirements will overwhelm the system in the short and medium term. Governments also need change management processes. A model of change risk management that may be applied to capacity building is shown in **Figure 14** above**.**

Internal decisions of a company, such as structural changes, staff reductions, and outsourcing of work to contractors, continue to be factors that can increase risk. Outsourcing of numerous functions to specialized services remains a common practice and an aggravating factor in accident risk. Israel gave an example of an accident in which a subcontractor drilled into an ammonia pipe. The incident caused the death of one fire fighter and injured 20 people.

Colocation of hazardous activities in industrial zones and complexes has many economic advantages because of the efficiencies it offers in terms of delivery of services, supplies, and even people to the sites. Moreover, in highly populated regions, such as Malta, there may also be risk management benefits in concentrating hazardous industries in pockets of land away from urban areas. Attractive coastal areas of seas and rivers, often collocated in the heart of a major city, can come under particular pressure in countries with growing activity in the oil and gas industries.

While industrial complexes bring benefits, these configurations can also create internal risk management challenges. The integrity and operations of interfaces between establishments, common infrastructure, and safety control measures must be somehow jointly managed by different operators to prevent accidents and mitigate their effects. The competent authorities sometimes face situations where the legal responsibilities of each party are unclear, and often have to use their influence to drive sites to make more coherent and reliable arrangements.

6.2. Future implications and potential follow-up

Pursuant to the meeting the CARS Steering Committee met to discuss what ideas could be taken forward from the presentations in this session. The Committee made the following observations:

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. Indeed, many Neighbourhood Countries, such as Algeria, Israel, Jordan, Palestine, Tunisia, and Ukraine, have several industrial parks.[22] Nonetheless, they pose particular challenges for risk management in terms of assigning accountability and ensuring appropriate oversight of common services that can affect safety. Depending on the proportion of hazardous facilities on site, some industrial parks may be vulnerable to domino effects once an accident sequence is triggered.

[22] According to responses to the 2015 JRC Survey of EU Neighbourhood Countries on Chemical Accident Prevention and Preparedness Programmes.

Conclusions: 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.

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. The accident at the BASF site in Ludwigshafen, Germany of October 2016 gives evidence that contractor management requires constant attention.

The seminar did not include presentations on other organizational change issues, in particular, the impacts of staff reductions, joint ventures, and major structural reorganization on risk management of hazardous sites.

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.

6.3. Additional sources of information

Organization for Economic Co-operation and Development (OECD). 2017. Synthesis report: Special session on facilities handling hazardous substances with ownership change.
http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=env/jm/mono(2016)10&doclanguage=en

OECD guidance on facilities handling hazardous substances undergoing ownership change. Publication pending.

European Commission Joint Research Centre. JRC Lessons Learned Bulletin no.2 Major accidents involving contractors. A collaboration of the EC Joint Research Centre and EU Member State Competent Authorities within the EU Technical Working Group for Seveso Inspections (TWG 2). JRC 77996.
https://minerva.jrc.ec.europa.eu/EN/content/minerva/fb542ac7-0bfe-437b-8ece-3af05d5dc943/llb02contractorspdf

European Commission Joint Research Centre and Norwegian Directorate for Civil Protection. 2012. EU Seveso Inspection Series. Chemical hazards risk management in industrial parks and domino effect establishments: Key points and conclusions for Seveso Directive enforcement and implementation. In collaboration with the EU Technical Working Group for Seveso Inspections (TWG 2).
1) Short report (JRC80649):
https://minerva.jrc.ec.europa.eu/EN/content/minerva/e627c9fb-aab2-4122-bf18-9421cf87b442/sis05shortrmindustrialparksanddominopdf
2) Workshop proceedings (EUR 25664 EN – 2012).
https://minerva.jrc.ec.europa.eu/EN/content/minerva/29254184-bf7a-46d9-89ba-402ce5263e14/sis05rmindustrialparksanddominopdf

European Process Safety Centre. 2003. Process Safety and Risk Management of Chemical Parks. A report by the European Process Safety Centre in conjunction with the Center for Chemical Process Safety
https://www.aiche.org/sites/default/files/docs/embedded-pdf/Chemical%20Parks.pdf

Dambmann, D. and L. Allford. 2003. A walk in the chemical park. IChemE Hazards XVII Symposium. Symposium Series 149.
https://www.icheme.org/communities/subject_groups/safety%20and%20loss%20prevention/resources/hazards%20archive/~/media/Documents/Subject%20Groups/Safety_Loss_Prevention/Hazards%20Archive/XVII/XVII-Paper-54.pdf

European Commission. 2014. EU Common Inspection Criteria Bulletin No. 2. Permit-to-Work. A collaboration of the EC Joint Research Centre and EU Member State Competent Authorities within the EU Technical Working Group for Seveso Inspections (TWG 2). JRC93841.
https://minerva.jrc.ec.europa.eu/EN/content/minerva/ce714a82-a805-4705-abcf-9151beec88a5/cic_issue_2_permit_to_work

7. Substance Classification and Identification of Hazardous Sites

This session consisted of 9 presentations from government and industry experts. The session mainly focused on challenges in applying Seveso substance criteria to identify major hazard sites when the substances involved do not have EU harmonized classifications. Pre-Seveso countries, that is Enlargement and EU Neighbourhood countries, also described how they were working towards the use of Seveso substance or other criteria to identify major hazard sites in their countries.

Why Substance Criteria for Major Hazard Identification is a Priority Topic

The Seveso Directive has established criteria for identifying Seveso sites on the basis of minimum quantities of toxic, flammable and explosive substances, as classified in accordance with the EU CLP Directive (Regulation (EC) No 1272/2008). Many of these substances have EU harmonized classifications listed in Annex VI of the EU CLP Regulation but they are minimum classifications and therefore, they can be challenged. However, there remain numerous substances whose status is determined via self-classification by the manufacturer. The open-ended nature of classification under the EU CLP regulation can create significant challenges in interpreting substance criteria for Seveso implementation, including self-classification of the same non-harmonized substance by different manufacturers, classification and downstream legislation decisions involving harmonized substances with non-harmonized classifications, potential disputes regarding the minimum harmonized classification, inconsistencies in safety data sheets from different producers, and similar issues.

Enlargement and Neighbourhood countries that are in the process of identifying their hazardous sites also face other difficulties. Without Seveso or similar legislation, precise data on substances present on sites may not be available, and countries may use other information to identify major hazard sites. Some countries are in the process of updating their classification systems, to the EU or GHS[1] classifications, and are therefore undergoing a transition process.

What This Session Aimed to Discuss

This session sought presentations that would identify and discuss solutions to cases in which EU/EU-affiliate countries faced ambiguous and/or conflicting substance classifications under the EU CLP regulation in trying to determine a site's Seveso status. Other questions were also of interest to discuss, in particular: Is there consistency across EU/EU-affiliate countries in approaches to the same or similar cases? If not, should there be and if so, how could this be achieved? How can countries share and notify each other about changes in self-classifications?

A more general discussion of how to identify hazardous sites was also targeted, particularly what methods countries can use, other than the Seveso substance criteria to identify hazardous sites, especially in countries where the Seveso Directive has not yet been adopted.

[1] The Globally Harmonized System of Classification and Labelling of Chemicals (GHS) is an internationally agreed-upon standard managed by the United Nations. The EU CLP Regulation is an adaptation of the GHS to the EU classification system.

7.1. Highlights from the session

Many EU and EU-affiliated countries have invested considerable effort to find reasonable solutions to justify decisions regarding Seveso site status when the only basis is a substance with multiple options for classification within the EU CLP regulatory framework This session aired experiences, both successes and challenges, confronted by Member States. Key messages drawn from this session are described below:

The application of the CLP-Regulation to major accident hazards was one of the major changes in adopting the Seveso III Directive. A number of problematic areas have emerged in the practical application. Moreover, even in the new CLP-Regulation, classification according to dangerous properties remains an elusive goal for some substances that by nature are not easily classifiable in this sense.

Some specific issues include:

- Classification of substances for which there are no harmonized criteria, or for which the harmonized criteria do not cover all hazard categories
- Managing the classification of mixtures, in particular where the component substances have different hazard classifications
- Acceptability of the information given in Safety Data Sheets
- Classification of wastes
- Definition of "alternative fuels"
- Managing substances which, in the form that they are available on-site, cannot lead to a major accident.

7.1.1 Observations regarding the influence of CLP-Regulations and REACH on Seveso Directive implementation

The REACH process intends for classification to be an open and dynamic process. It is largely agreed among stakeholders that this approach has important benefits. It provides transparency to users and it can foster dialogue among producers and stakeholders to achieve a balanced result. It also allows new information to be considered as it becomes available. Various speakers pointed out the advantages and disadvantages of the openness of the REACH process as it affected Seveso Directive implementation.

The new regime brings significant opportunity for stakeholder engagement in the EU classification and labelling process. The speaker from the Chemicals Association noted that data transparency made it possible to exchange views on data interpretations so that in the end all parties could reach a scientific consensus. This opportunity represented a significant improvement to allow scientific debate prior to

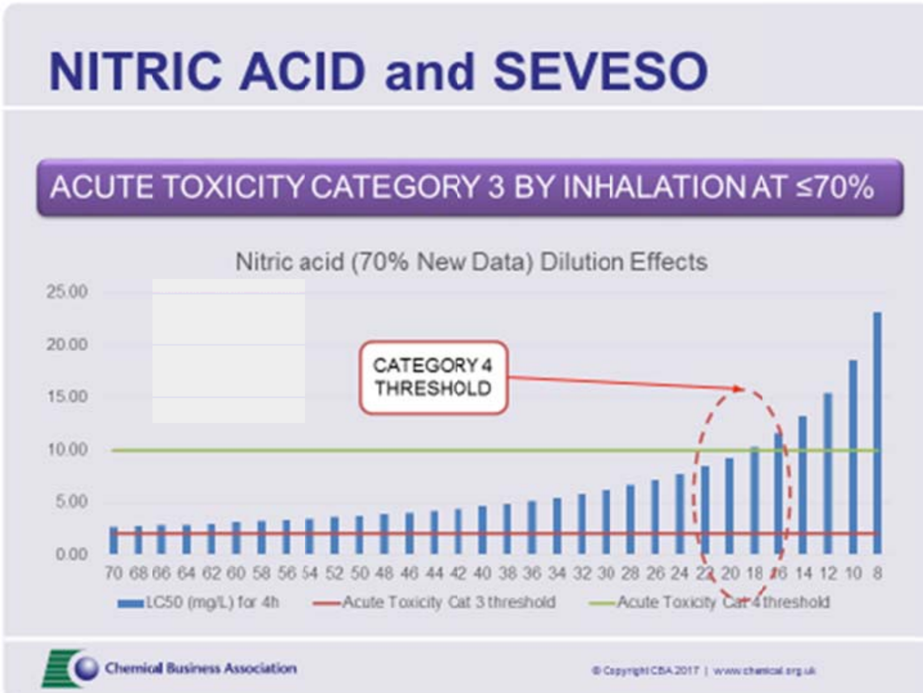

Figure 15 Typical example of how data helps determine substance classification *(Douglas Leech, Chemical Business Association, CARS 2017)*

final classification in the EU process. For example, for nitric acid, a review of test data eventually made a convincing case for classifying this substance as Acute Toxic 3 (see **Figure 15** above).

Some speakers pointed out that there are not enough mechanisms for exchanging views to reach consensus and resolve ambiguities in classification. In many cases, the same substance is assigned different types and levels of classifications by different producers and these differences are never reconciled. In such cases, it is difficult to make a clear determination of the risk management needs of the substance at hand, including how and if they should come under certain regulations such as the Seveso Directive. For instance self-classified substances may have conflicting classifications from different manufacturers, due to differences in analytical results or different interpretations of similar results. Substances with harmonized classifications in Annex VI can be challenged by new data showing that the minimum classification underestimates the actual danger.

Bulgaria listed some options for resolving the negative impacts of self-classification for future discussion among stakeholders:

- Manufacturers and importers routinely update classifications of their substances to the European Chemicals Agency (ECHA) for the CLP inventory

- Where the notification results in different classifications for the same substance, notifiers and registrants shall make every effort to come to an agreed entry in the inventory
- The CLP notification gives generic information on risk management measures for the safe use, storage and disposal of substances and mixtures, including control measures related to accidental exposure of humans or accidents at sites where such substances are used.
- REACH could also establish more defined procedures for collecting and assessing information on the properties and hazards of substances that imposes a higher burden of proof on companies who notify substance classifications
- REACH could require companies to identify and register their substances jointly with other manufactures such that they agree on a substance's self-classification.
- REACH could require companies to make further efforts to identify and manage the risks linked to the substances they manufacture and market in the EU, with giving advice, training or demonstrations on how the substance can be safely handled to downstream users.

7.1.2 Observations regarding Seveso Directive substance criteria

Sweden described how the Seveso Directive criteria do not always render decisive and unambiguous results when applied to the classification of mixtures, particularly when the mixture involves more than one dangerous substance. This type of situation can emerge in association with a number of different activities, but it should be emphasized that the classification of waste in particular is often dependent on this kind of interpretation.

Countries are at liberty to impose stricter criteria than the Directive. Denmark presented new provisions in the Denmark transposition of Seveso covering intermediate storage sites and reductions in qualifying quantities for lower tier sites with ammonia or chlorine that are also > 200 m from populous areas.

7.1.3 Difficulties with UN ADR classification: Organic peroxide

Israel described their struggles with classification of certain formulations of organic peroxides under the current UN classifications for dangerous goods transport, particular as they relate to storage. Class 5.2 defines 5 categories of organic peroxides for storage, ranging from explosive or very fast burning to minor hazards. The classification takes into account the transportation class (7 categories for organic peroxide from A - G) and the burning rate, and assuming that the goods are stored in accordance with the maximum, size, type and material for packaging as required in transport.

Israel has noted that many organic peroxides in commercial use do not have sufficient data to allow decisive classification within the UN system. In particular, without adequate data to confirm a definitive explosive or burning hazard, organic peroxides from some sources, on very little evidence, may be labelled and packaged as minor hazards. In storage, these same substances, despite a lack of sufficient data, may then also be assigned minimum separation distances consistent with other minor hazards.

As a consequence, Israel has taken the approach that:

- Sub-classes A-D shall be treated as explosives
- A TNT equivalent of 80% will be used when there is no other data in the literature

Israel also invited further exploration of the topic with foreign experts.

7.2. Identifying hazardous sites in pre-Seveso countries

Identification of likely sites for Seveso coverage is often undertaken in pre-Seveso countries, such as many Enlargement and Neighbourhood Countries, in order to assess potential resource and competence issues that will arise once new comprehensive legislation is authorized. In the absence of a notification requirement for all hazardous sites, countries will use alternative methodologies and information gathered from existing enforcement and monitoring activities associated with chemicals management, environment and civil protection and labour safety.

Both Kosovo and Armenia described the process they have used to develop hazardous site inventories**.** Kosovo used information available from operators, information already provided by operators, data collected through inspections, as well as an existing inventory of sites in the Department of Environmental Protection for this purpose. In this way, Kosovo was able to identify many major hazard sites, targeting in particular, those using heavy oil, liquefied petroleum gas, diesel, gasoline, and chlorine.

In close co-operation with the UN Development Programme, Armenia has established several priorities for disaster risk reduction, including specifically topics associated with chemical accident risks. In line with this strategy, Armenia is testing the UNEP-OCHA [23] Flash Environmental Assessment Tool (FEAT) methodology to identify a number of hazardous facilities in Armenia. The results of this exercise will then be used to compare results with existing normative guidance, such as how the findings match assumptions used in existing safety passports and response plans associated

[23] The Joint UNEP/OCHA Environment Unit (JEU) is a partnership that pairs the environmental expertise of the United Nations Environment Programme (UNEP) and the humanitarian response network coordinated by the United Nations Office for the Coordination of Humanitarian Affairs (OCHA).

with hazardous sites. Further applications of the methodology could also have implications for consequence analysis, land-use planning and improvements to both local and national emergency response planning.

7.3. Future implications and potential follow-up

Pursuant to the meeting the CARS Steering Committee met to discuss what ideas could be taken forward from the presentations in this session. The Committee made the following observations:

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 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.

Identification of likely sites for Seveso coverage is often undertaken in pre-Seveso countries, such as many Enlargement and Neighbourhood Countries, in order to assess potential resource and competence issues that will arise once new comprehensive legislation is authorized. In the absence of a notification requirement for all hazardous sites, countries will use alternative methodologies and information gathered from existing enforcement and monitoring activities associated with chemicals management, environment and civil protection and labour safety.

Conclusions: 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.

7.4. Additional sources of information

European Chemicals Agency. CLP Inventory. EU database maintained by the European Chemicals Agency containing classification and labelling information on notified and registered substances received from manufacturers and importers. https://echa.europa.eu/information-on-chemicals/cl-inventory-database

UN Globally Harmonized System of Classification and Labelling of Chemicals (GHS). Home Page. https://www.unece.org/trans/danger/publi/ghs/ghs_welcome_e.html

EU CLP Legislation. https://echa.europa.eu/regulations/clp/legislation

European Chemicals Agency. 2017. Guidance on the Application of the CLP Criteria: Guidance to Regulation (EC) No 1272/2008 on classification, labelling and packaging

(CLP) of substances and mixtures. Version 5.0. European Chemicals Agency. Helsinki, Finland. ECHA-17-G-21-EN
https://echa.europa.eu/documents/10162/23036412/clp_en.pdf/58b5dc6d-ac2a-4910-9702-e9e1f5051cc5

Z. Gyenes. 2011. Application of GHS Substances Classification Criteria for the Identification of Seveso Establishments. Report on the Work of the Technical Working Group on Seveso and GHS. Joint Research Centre. European Commission. Luxembourg. EUR 24734 EN
https://minerva.jrc.ec.europa.eu/EN/content/minerva/765297fa-f3f6-4828-bfdb-9dc619853bd6/srtseviighspdf

Questions and Answers Seveso III Directive (Version March 2016). This document contains advice on a number of issues associated with application of Seveso requirements, including application of Seveso substance criteria.
https://circabc.europa.eu/sd/a/68779c2d-772b-43d6-a361-b6c025df4096/Questions%20%26%20Answers%20Seveso-III-Directive%20(version%20March%202016).pdf

Seveso Expert Group website. This public Interest Group contains information on the Seveso III Directive (2012/18/EU) related information documents the work of the Seveso Expert Group (SEG) research related to major accidents reporting, workshops, conferences, seminars, etc.
https://circabc.europa.eu/faces/jsp/extension/wai/navigation/container.jsp

8. Summary of Observations and Conclusions

The Chemical Accident Risks Seminar and Training Workshops was an event designed for competent authorities with Seveso-type responsibilities in EU and EU-affiliated countries. It aimed to produce a highly inclusive and informative event for all countries. Among participants there was substantial diversity in particular in regard to:

- Types of competent authorities participating, including mainly environmental protection, civil protection and labour safety,
- Differences between countries in the types of substances and industries that each country faces, and the intensity of the industrial economy
- A wide variation in regard to programme maturity, especially between EU/EEA countries vs. EU Enlargement and Neighbourhood Countries.

In addition, it was expected that the seminar discussions would result in ideas and topics that could be further explored to improve chemicals risk management in Europe and beyond.

8.1. Seminar achievements in the domain of networking and exchange

The topics were selected on the basis that they were common areas of concern in most countries regardless of their differences. It was also known that almost all country experts would find value in training on the ADAM and RAPID-N consequence and risk assessment tools.

There is substantial evidence that the specific objectives of the workshop were met as indicated in **Table 2** on page 67.

In addition to evaluations, the atmosphere surrounding the event was dynamic, in particular, there was proactive participation of diverse participants in the discussions during the seminar sessions and trainings. The person-to-person dialogue among participants and with JRC staff also appeared to confirm that many participants were enthusiastic and motivated by the event. Specifically in regard to the ADAM and RAPID-N tools, many experts expressed genuine appreciation for the new possibilities that the tools offer competent authorities who typically have far fewer resources than industry dedicated to consequence and risk assessment.

8.2. What was learned and the work ahead

As indicated in the session summaries, the seminar and training event stimulated considerable reflection, introduced some new findings, confirmed some preconceptions and clarified some misconceptions, and in particular offered numerous

Table 2 Evidence of Seminar Achievements by Objective

Objective: To identify the need for further work by the Seveso community on new emerging risks/new developments in the area of industrial accident prevention The seminar addressed five different topics associated with chemical accident risks, based on input from competent authorities by email exchange and in the Steering Committee. A number of observations within each session led to conclusions about potential future areas of work as identified in the "Future implications and conclusions" sections of this document. Both training and further tools development for consequence and risk analysis of chemical and Natech accidents were identified as ongoing needs in competent authorities in EU and EU-affiliated countries.
Objective: To expand the existing EU/EEA exchange network to include all EU-affiliated countries Seventy (70) experts from 30 different EU and EU-affiliated countries, participated. 7/10 EU-affiliated countries and 16/20 EU/EEA countries made presentations. Participant evaluations indicated that there were benefits for both Seveso and pre-Seveso countries. Network and exchange was rated as a valuable outcome in 18 out of 25 (72%) of participant evaluations. Some initiatives for bilateral support between Seveso and Enlargement/Neighbourhood Countries are currently underway (Romania-Moldova, Norway-Israel)
Objective: To rejuvenate exchange between EU/EEA countries that had diminished in recent years 2/3 of Seveso countries participated in the event. Member States priorities were well-represented in the agenda that covered cross-cutting issues for Seveso implementation and risk management in general. Conclusions in this report are intended to support future collaboration and exchange on key issues for managing chemical accident risks in future.
Objective: To provide an opportunity for training on the JRC's flagship risk analysis products for Seveso competent authorities, the ADAM (chemical accidents) and RAPID-N (Natech accidents) consequence and risk assessment tools. Fifty-two (52) participants (73%) requested and received training on the ADAM (chemical accident) and RAPID-N (Natech) consequence and risk assessment tools during the event. Participation was relatively evenly distributed between Seveso and pre-Seveso countries. The JRC is following up on bilateral training requests emerging from the workshops (e.g., Bulgaria, Ukraine). Based on the feedback, more multilateral and bilateral workshops will be planned in 2018 and beyond.

ideas for future collaboration and exchange. Some central themes are highlighted in relation to each topic in the paragraphs that follow.

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 accident 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 to earthquake-triggered Natech risk assessment since some years.

Indeed, the JRC has provided technical support to Member States in chemical accident risk assessment for more than 25 years. The advances in IT technology now make it possible for the JRC to deliver more targeted and wide-ranging support through user-friendly and sophisticated applications. It is expected that these tools may become embedded into core functions of many competent authorities – in environmental protection, civil protection and labour safety, in particular - in the EU and EU-affiliated countries in coming years.

While safety performance indicators (SPIs) have been in use in many companies (mostly large multinationals) 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. (Although these reportable indicators represent a narrow range of measures, they serve a slightly different purpose than site-specific measures since the public is the targeted audience rather than any specific site.) 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 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.

The issue of maintaining site and process infrastructure and equipment 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 in this group, cyber safety and security is the newcomer. The seminar featured an interesting mix of presentations from industry, researchers, and government authorities. 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 create 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 possibly 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. This topic is likely to become a mainstream part of process safety exchanges for the long term future.

The field of process safety has long recognized the importance of safety management systems to address 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 have a tremendous influence in 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. Among all the information needed to make good risk management decisions, every risk assessment starts with hazard identification. Every hazard identification starts with the identification of dangerous substances on site. To manage risks effectively, sites have to know each dangerous substances on site, how dangerous it is, how much there is of it, and what it can do if planned controls of the danger fail.

Nonetheless, 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 that can be generically applied to a set of problems that affects many substances.

8.3. 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.

KJ-05-17-235-EN-N

JRC Mission

As the science and knowledge service of the European Commission, the Joint Research Centre's mission is to support EU policies with independent evidence throughout the whole policy cycle.

EU Science Hub
ec.europa.eu/jrc

@EU_ScienceHub

EU Science Hub - Joint Research Centre

Joint Research Centre

EU Science Hub

doi:10.2760/441341

ISBN 978-92-79-76909-2