

European Commission - Directorate-General Environment

Review of the monitoring system under the Seveso-III-Directive, including the development of indicators

Interim report



Report for

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Doc Ref. 40082-01

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Document revisions

No.	Details	Date
1	Interim report	14 May 2018
2	Final interim report	12 June 2018

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1. Introduction

1.1 This report

This is the draft interim report for contract No 070201/2017/765428/SFRA/ENV.C.4 between the European Commission and Wood¹ in collaboration with INERIS and EU-VRi. It concerns the “Review of the monitoring system under the Seveso-III-Directive, including the development of indicators”.

This report presents the outcome of stakeholder consultation conducted as well as our preliminary results from tasks 2-5 and first indications on tasks 8 and 9.

The report indicates clearly in each section the state of play of the task and the work yet to be completed.

1.2 Monitoring systems under the Seveso Directive

The monitoring system under Directive 2012/18/EU (the Seveso-III Directive) has three main components:

- a) Reporting on implementation of the Directive in Member States by 30 September 2019 and every four years thereafter according to Article 21(2)). The objectives of this monitoring is to gather information on national implementation of the Directive, including for example frequency of testing of the external emergency plans and inspections so as to assess the compliance of Member States with the requirements of the Directive².
- b) Reporting on establishments (eSPIRS) according to Article 21(3). The aim of this reporting is to gather statistical information on establishments covered by the Directive, including tier and activity details.
- c) Reporting on accidents (eMARS) according to Article 18. The aim of this reporting is to exchange information and lessons learnt from accidents at establishments falling under the scope of the Directive.

There are other monitoring systems including for example complaints and infringements.

The current monitoring system has been in use for many years. Despite being deemed appropriate, it is necessary to assess whether it can be further improved, especially in view of the deadlines for updating the relevant Commission Implementing decisions for reporting during 2018 and 2019.

1.3 Project objective

As a consequence, the primary objective of the project is to provide support to the Commission on the review of the current monitoring system established under the Seveso-III-Directive. The monitoring system is to be reviewed for the Seveso-III-Directive, but at the same time considering the Commission’s Better Regulation Guidelines and the Commission report on actions to streamline environmental reporting.

Based on this review, the project will provide clear recommendations for short-term improvements and an action plan towards further improving the monitoring system in the long-term. The work will include the

¹ Previously Amec Foster Wheeler.

² For the review of the monitoring and reporting on implementation, the analysis has been based primarily on the reporting under the Seveso II Directive, as the first reporting under the Seveso III directive has not yet been completed.

identification and where necessary the development of suitable monitoring indicators, including flagship indicators.

In preparation for an expected future evaluation of the Seveso III Directive, the Better Regulation guidelines foresee the use of indicators to assess progress made by an EU intervention in achieving its objectives. Through a previous study³ it was recognised that more work is required to develop optimal indicators.

This project therefore aims to:

- Obtain a clear understanding of monitoring needs and objectives as well as the related requirements and expectations;
- Establish a meaningful set of indicators that would support proper monitoring in line with the Better Regulation Guidelines and policy needs; and
- Conduct a feasibility check and get a clear understanding of the obstacles that may be encountered in obtaining the relevant data for indicators or deploying the proposed improvements to the monitoring system (including recommendations for further improvement).

The outcome of the project will feed into new Commission Implementing Decisions on reporting and where relevant the update of electronic reporting tools. Furthermore, it will also feed into the Commission Report due under Article 29 of Directive 2012/18/EU in 2020.

Finally, the work is conducted in reference to a fully developed intervention logic which is presented in Appendix A . The intervention logic has been revised following comments received on the inception report.

1.4 Progress with the project

The table below presents the progress made under each Task and the next steps.

Table 1.1 Overview of the progress with the project

Task	Work completed	Next steps
Task 0 – Data collection	An online survey was sent to selected stakeholders in order to gather views on monitoring systems. The survey was tailored to categories of stakeholders. A total of 66 written responses were received. Exchanges with individual stakeholders were held (Insurance Europe and the MAHB) and further discussions are planned. Follow up interviews were held with the MAHB and the EEA.	Follow up interviews will be conducted with the OECD and selected Member States.
Task 1 – Intervention logic	The intervention logic presented in the proposal was refined for the purpose of the inception report. Comments were received on the inception report and were taken into account to produce a revised intervention logic presented in this interim report.	This task is complete.

³ Amec Foster Wheeler, 2017

Task	Work completed	Next steps
	The task also included the mapping of stakeholders to be involved in the project which was completed.	
Task 2 – Identification of needs and requirements for monitoring	The responses from stakeholders to the online survey were reviewed in order to identify, analyse and describe the needs expressed from the monitoring system. This identification of needs includes an analysis of the needs, possible options to address them and whether it would be possible for the European Commission to meet these needs considering existing limitations (e.g. competence, costs)	This task is complete. However, further refinement will be carried out based on further inputs from the project workshop. Additional needs might then be identified which will be critically analysed.
Task 3 – Review of the current monitoring system	The responses from stakeholders to the online survey were reviewed in order to analyse the current monitoring system. This feedback was supplemented by the expert feedback gathered during an internal INERIS workshop on the topic.	This task is partially complete. The feedback from interviews and the workshop will allow us to refine the analysis. Further analysis will cover the outstanding points identified in the project's terms of reference.
Task 4 – Key drivers for performance	The responses from stakeholders to the online survey were reviewed in order to conduct a first identification of key drivers for performance. The preliminary results will be tested during the project's workshop.	This task is partially complete. The feedback from interviews and the workshop will allow us to refine the analysis. The next iteration will present our selected key drivers for performance.
Task 5 – Review of socio economic impacts of major accidents	A review of the literature available on socio-economic impacts of major accident has been conducted. A review of the type of socio-economic information presented in databases was also conducted. In addition, the online survey asked questions on the use of the European Scale of Industrial Accidents (ESIA) ⁴ . On the basis of the information available, the analysis reviewed the socio-economic impact of accidents caused by corrosion in refineries, and the impacts of major accidents reported in database for three main categories of establishments (general chemical, petrochemical and agricultural industries).	The analysis will be refined based on comments received. We propose to ask the French authorities to present both ARIA and their use of the ESIA during the stakeholder workshop (Task 11).
Task 6 – Monitoring indicators	The responses from stakeholders to the online survey were reviewed in order to identify possible monitoring indicators. Pros and cons of specific indicators were identified.	The recommended monitoring indicators will be identified based on feedback received during interviews and the workshop. Data needs to satisfy the indicators selected will be described.
Task 7 – Flagship indicators	The responses from stakeholders to the online survey were reviewed in order to identify possible flagship indicators. Pros and cons of specific indicators were identified.	The recommended monitoring indicators will be identified based on feedback received during interviews and the workshop. Data needs to satisfy the indicators selected will be described.

⁴ <https://www.aria.developpement-durable.gouv.fr/en-cas-daccident/echelle-europeenne-des-accidents-industriels/>

Task	Work completed	Next steps
Task 8 – Benefits and obstacles	The work under this task is integrated within the previous tasks by attempting to identify benefits and obstacles to the development of indicators.	A more precise overview of benefits and obstacles will be presented for the selected monitoring and flagship indicators.
Task 9 – Short term improvements	A list of short term improvements was identified and are presented in the concluding section of this report.	The short term improvements will be refined and updated based on comments received and further progress will be made in the project.
Task 10 – Long term improvements	A list of long term improvements was identified and these are presented in the concluding section of this report	The list of long term improvements will be refined and updated based on comments received and further progress will be made in the project.
Task 11 – Workshop	The venue and date for the stakeholder workshop have been agreed. 'Save the date' emails were sent to potential participants. Formal invitations have been issued Suggestions for content and possible sessions are included in the interim report.	Agenda to be finalised Presentations for the day to be sent for comments Delivery and moderation of the workshop on the day

1.5 Structure of the report

The report is structured as follows:

- Section 2 presents the outcome of the stakeholder consultation undertaken to date.
- Section 3 presents the identification of needs and requirements for monitoring systems.
- Section 4 presents the review of the current monitoring system.
- Section 5 presents the key drivers for performance identified.
- Section 6 presents the review conducted of socio-economic impacts of major accidents.
- Section 7 presents initial work on development of indicators for monitoring and flagship indicators.
- Section 8 presents initial conclusions on the potential improvements to monitoring in both the short and long term.
- Section 9 presents next steps for the project.
- Appendix A presents the intervention logic.
- Appendix B presents the outcome of the literature review on the socio-economic and wider impacts of major accidents.

2. Outcome of the stakeholder consultation

The aim of the consultation was to gather feedback and insights from a range of stakeholders on the usefulness of the current monitoring system and, if appropriate, possible ways to improve it. The questionnaire focused on the monitoring and reporting requirements as described in the Directive.

The questionnaire was developed by the project team and reviewed by the Commission. Questions covered the following topics:

- Needs and requirements for monitoring;
- Analysis of the existing monitoring process;
- Understanding key drivers for performance;
- Socio-economic impacts of major accidents;
- Establishing indicators; and
- Flagship indicators.

The consultation was launched online on 9 February and ran until 29 March 2018. The questionnaire was distributed to four stakeholder groups. In order to adjust the questions to the audience and maximise the response rate, each group responded to a tailored set of questions. The groups consulted were:

- Member State competent authorities;
- Industry associations;
- European Commission and international organisations, including governments from non-EU countries; and
- NGOs, research institutions and academia.

The response rate varied depending on the stakeholder group, being relatively high among Member State authorities but rather low within the other stakeholder groups, especially industry. A summary of the number of responses is as follows:

- **Member State authorities:** 29 responses (27 complete, 2 incomplete).
- **Industrial associations:** 6 responses (5 complete, 1 incomplete).
- **EU and other international organisations:** 13 responses (6 complete, 7 incomplete).
- **NGO and research institutions:** 18 responses (7 complete, 11 incomplete).

The responses to the consultation have been used to identify whether an adaptation of the data collected might be necessary to allow the establishment of policy indicators to better monitor and communicate on the achievements of the Directive.

3. Identification of needs and requirements for monitoring

3.1 Overview

The aim of this section is to present our understanding of stakeholders' needs that the monitoring system should address. This is based on the feedback received from stakeholders who were requested to identify all the needs that, in an ideal world, the monitoring system could respond to. The second step is a critical review of these needs by assessing whether, if they were satisfied, they would lead to an improvement on the quality of monitoring, whether they would do so in a cost-efficient way and whether it would lead to an overall improvement in the efficiency of the Directive.

3.2 Identification of the needs

When reviewing the needs, it is important to keep in mind that the information from the monitoring system is used by a range of stakeholders with different objectives. As such, it was expected that this section would identify a range of needs, reflecting the use made of the information by the different types of respondents. For example, some stakeholders are mostly providers of inputs (i.e. Member State competent authorities providing information to meet the reporting requirements) whereas others are mostly users of outputs (e.g. NGOs using analysis produced by the MAHB on eMARS).

The list of needs / use made of the information is presented in the table below. It includes a 'shortened' version of the needs and quotes from the responses received (non-exhaustive) to provide further context.

Table 3.1 Overview of the needs identified by stakeholders

Shortened version of the needs identified	Extracts from stakeholder's feedback related to the need ¹
From reporting on establishments (eSPIRS)	
Identify number and location of establishments in eSPIRS	<ul style="list-style-type: none"> • "Seveso status need to be updated from Seveso II to Seveso III like in reporting on establishments" –CA • "driving force behind a lot of the digitalisation-work in Denmark that would otherwise have struggled to get prioritized" –CA • "Information on EU level on establishments does not have much value on national level. It is nice to know, but not very important for policy making." –CA • "Directing enquiries on location" - CA • "Actually we do not use the eSPIRS data directly. For information purposes we use the statistics produced by the EC JRC MAHB" –CA • "Reporting to the eSPIRS seems unnecessary complicated and time-consuming." –CA • "Very interesting information." – Trade association • "should provide insight on the "fluctuations" among the establishments/organizations entering/leaving the list" – Research Institute
Find establishments for a specific activity in eSPIRS	<ul style="list-style-type: none"> • "we use e-Spurs to identify where to find a particular type of industry" - CA • "Reporting on establishments give an opportunities to access very useful information about the number, type and location of establishments" –CA • "We do use eSPIRS-data to identify establishments at a certain location and to find other establishments for a certain type of activity." –CA • "At the national level, the data reported to eSPIRS are useful for the activities of inspections of these establishments." –CA

Shortened version of the needs identified	Extracts from stakeholder's feedback related to the need ¹
Identify establishments in neighbouring countries in eSPIRS	<ul style="list-style-type: none"> • "We get information, which establishments are international" –CA • "Identification of transboundary risks." –CA • "understanding what establishments are located around LT in neighbouring countries" – CA
From reporting on implementation of the Directive	
Compare situations with other Member States / benchmarking	<ul style="list-style-type: none"> • "It is important to have an overview and to compare with other Member States in order to share good practices" –CA • "to compare situations in different countries" –CA • "The implementation report is an interesting document, which shows us a certain number of indicators and which allows us to compare ourselves with the other EU member states." – CA • "The implementation report allows us to compare ourselves with the other EU member states and reveals eventually weak spots, where we have to improve ourselves." –CA • "Data can be used as an enforcement benchmark tool." –CA • "Basis for comparison with other member states." –CA • "Use it to benchmark our performance. For example on level of testing of emergency plans or frequency of inspection." –CA • "to compare with other MSS" –CA • "for comparison between LT and other countries" –CA
Identify practices of Member States	<ul style="list-style-type: none"> • "Conclusions from the reports help to identify good and bad areas in the national implementation of the directive. They are also used to learn about different practices used in other Member States" –CA • "We are interested in solutions from other countries on how to improve safety, but policies cannot wait for another reporting round." –CA • "Issues and facts about the implementation of the Directive in the legislative system of each country. The information provided should be concrete and representative of the current situation in each MS." – Research Institute
Learn about implementation at EU level	<ul style="list-style-type: none"> • "Because this has changed over the years this is the reporting that is the least clear. However the Progress towards less 'complicated' questions from the reporting is a great improvement. I believe the part about the testing of emergency plans is the most relevant parameter to actually predict degree of implementation" –CA • "Interesting insights in terms of the trends on the number of establishments in other Member States and on the enforcement of the legal obligations." –CA • "- EU-wide control of implementation of the Seveso Directive by the Member States (based on the assessment of all reports of the Member States provided by the Commission)" –CA • "Overview of implementation." –CA • "General information on how the Directive is implemented in different Member States." – CA • "Here we get information on status of implementation in the different MS, interesting for us mainly for benchmarking purposes within the different areas of implementation (like for example external emergency planning)" –CA
Information to train inspectors	<ul style="list-style-type: none"> • "[information on implementation] helps us to improve our supervisory guidance to our operational supervisory authorities" –CA • "Potential use for learning from accidents to shape inspection activity" –CA • "Main source to identify improvement opportunities. For instance, information from other MS related to testing emergency plans; guidance for coordinated joint inspections; procedures and experience of accessing to justice, are good example" –CA
Identifying and responding to new implementation issues through implementation report	<ul style="list-style-type: none"> • "The implementation report could be a source of information about the different approaches of Member States on specific subjects. Maybe there could be, in each report, a (non- mandatory) question about a specific Seveso instrument (e.g. safety report assessment procedures, deadlines, etc.)." –CA • "We want to exchange experience with other countries. Not wait for a future reporting format when everyone has its solutions in place. EU reporting information is old by the time we get it. It does not help new implementing issues." –CA

Shortened version of the needs identified	Extracts from stakeholder's feedback related to the need ¹
Deficiencies identified during inspections to be presented in implementation reports	<ul style="list-style-type: none"> • "Adding information on the deficiencies identified during regular inspections and emergency plan drills." –CA • "How often Seveso establishments are inspected in other Member States and what are the important findings of the inspections. " –CA
Deficiencies identified during testing to be presented in implementation reports	<ul style="list-style-type: none"> • "Adding information on the deficiencies identified during regular inspections and emergency plan drills." –CA
From reporting on accidents (eMARS)	
Lessons learned from major accidents in eMARS	<ul style="list-style-type: none"> • "An annual bulleting of accidents would also be useful: a summary of the accidents occurred (e.g. can any trends/similarities between accidents/industry types be found?) Summary could include graphics but also discussion to highlight the key points. Bulletin could give valuable information for benchmarking not only for authorities but also for the industry. " –CA • "Part of learning from accidents is that they are being investigated and the experiences are being taken." –CA • "It is useful to learn from accidents which have already happened and to identify suitable accident scenarios for each kind of equipment, installation or substance during the appraisal of the safety report, when preparing an inspection and when establishing emergency planning scenarios." –CA • "Useful, especially to the operators, that access the database to perform the historical analysis of accidents needed for the safety report's risk analysis." –CA • "useful for operators, inspection, authorities - lessons learned " –CA • "To train / inform Seveso officers / inspectors" –CA • "Keep up to date with lesson's learned" –CA • "To gain some information on accidents and present them during some workshops with authorities, operators, stakeholders." –CA • "Information of major accidents in extractive waste facilities is very important information for the assessment of the effectiveness of the Extractive Waste Directive." – European Commission
More advanced functions of eMARS with fully searchable database on accidents and available in other languages	<ul style="list-style-type: none"> • "Because the system is not intuitive also there has been no commission checks on how often and what the different member states report. This has the effect that member states are able to not prioritize this reporting." CA • "Decision from 2009 is not fully in line with the new Seveso III Directive" –CA • "We mainly use the Bulletins and statistics produced by the EC JRC MAHB, which are based on the reported accident and establishments. Establishing more searching options would facilitate a better usefulness of the eSPIRS and eMARS." –CA • "The usefulness of the information would increase if the delay in publishing the accident description in eMARS wasn't so long." –CA • "Polish version of the database would be added value." –CA • "Reports should be quicker available + more focus on lessons learned." CA • "We would like to use accident reports to complete existing information in the ARIA database. As data became more anonymous with the new version of eMARS, it's difficult to match these accidents with ours (for example the new version of eMARS does not publish the country where the accident occurred)." –CA • "Companies must use it when documenting their safety." – CA • "Many improvements needed in the eMARS form" – MAHB • "eMARS hard to use in terms of following number of accidents reported per annum, and possible normalization for interpretation of the possible trends. - Also analysis for root causes or similar is next to impossible. We need new approach to allow such uses." – Research Institute
Number of near misses reported in implementation reports or through eMARS	<ul style="list-style-type: none"> • "Reporting of near misses should be encouraged. Guidance on what is to be considered as an "interesting near miss" could help." - CA • "Internally, we register all the accidents and 'near misses' reported to the Competent Authority." –CA • "Near misses tell some story as well" – CA

Shortened version of the needs identified	Extracts from stakeholder's feedback related to the need ¹
	<ul style="list-style-type: none"> • "Information concerning accidents should include also near-misses and should come at preliminary stage (at first) and then completed when official investigation results are ready." – Research Institute
For all reporting streams	
Information for public participation from all reporting streams	<ul style="list-style-type: none"> • "[on eSPIRS] Useful and important only as information for the public and for public participation" –CA • "The establishment are visible on a map on the internet for everyone to see." – • "[on eSPIRS] public information" –CA • "[on eSPIRS] use as the database for wild public" –CA • "Exchange of good information and educational aid" – Industry
Information on Safety Management Systems and how they are deployed	<ul style="list-style-type: none"> • "I think so yes but these things are bit difficult to monitor." –CA • "Definitely!!! MAHB has proposed this as a separate category for causes in its design improvement proposal. " – MAHB • "If this is to be reported, it might be reported in connection with reporting of typical findings from inspections?" –CA • "This is important but not possible to report the quantitative information." –CA • "Human and organisational aspects of safety should deserve more attention in the reporting of the Seveso Directive" –CA • "No, there are better ways to exchange information on improving measures. " –CA • "Yes, covering SMS would be important. The experiences of regular inspections would include this topic." –CA • "This is complex - difficult to anticipate how the questionnaire would look and how different member states would accommodate." –CA • "Human and organisational aspects of safety are complex to synthesize and the reporting of these aspects would be difficult to achieve." –CA • "NO, I think that the process of learning from accidents should be prioritized and e-MARS is the best tool for that." –CA
Information on socio economic impacts of major accidents	<ul style="list-style-type: none"> • "Those kind of data are difficult to obtain but of high relevance" – Research Institute, SI • "That usually also NOT considered in the scope of risk assessments - but should be." – Research Institute, • "Developing modelling that looks at some economic impacts of major accidents." –CA • "Planning to establish such a system." –, CA • "We find it difficult to get all the data needed, not least the economic, but also personal injury is limited information about." – CA • "Difficult since the socio economic impacts often take long time to be visible." –CA
No need for some / all of the monitoring data	<ul style="list-style-type: none"> • " we don't use the data as we already have the same information" –CA • "[on eSPIRS] There is no need for and no use." –CA • "[on eSPIRS] Not usually used" –CA • "Exchange of information on good practices on how to implement the directive is good for a workshop. Reporting is not necessary to come to that exchange and learning from each other." –CA • "I do not use the data reported to eSPIRS" –, Several CAs • "I do not use the data reported to eMARS" – • "[on eMARS] In practice, we do not make use of the collected data." –CA

The needs identified by the different categories of stakeholders are presented in the table below. The table presents the number of respondents that identified the needs or use in the first column as relevant.

Table 3.2 Number of times needs are identified by stakeholders based on their category

	Member States	Industrial Association	European Commission and other international organisations	Academia, NGOs and other
Identify number and location of establishments	4	1	1	
Find establishments for a specific activity	4	1	1	1
Identify establishments in neighbouring countries	4			
Compare situations with other Member States/ benchmarking	9	1		1
Identify practices applied in Member States	7	1		1
Learn about implementation at EU level	11	1		3
Information to train inspectors	3			
Identifying and responding to new topics	1			
Deficiencies identified during inspections	4			1
Deficiencies identified during testing	1			1
Lessons learned from major accidents	17	3	3	
Improvements to the eMARS database	7		1	1
Information on near misses	2		1	1
Information on Safety Management Systems	12		3	
Information to be used for public information	1	1		1
Information on socio economic impacts of major accidents	3	1		2

	Member States	Industrial Association	European Commission and other international organisations	Academia, NGOs and other
No need for some / all monitoring data (depending on specific reporting stream)	10			2

3.3 Critical review of the needs

The table below provides our analysis on the needs expressed, the extent to which these are already addressed and wherever a gap appears. Our analysis also includes our general comments, possible options to meet the need and our view on potential limitations, costs and benefits in addressing these needs.

Table 3.3 Review of the needs identified by stakeholders and our analysis

Need Identified	Our analysis
No need for monitoring data (depending on specific reporting stream)	<p><u>Comment:</u> One respondent indicated having no need at all for the monitoring data. Other nine respondents indicated having partial need for the monitoring data. The eSPIRS data was most often quoted as not used / needed followed by the eMARS data. However, this feedback does not cover the analysis of the data from the MAHB which was identified as very useful.</p> <p><u>Options to meet the need:</u> For stakeholders identifying no need for the monitoring data, there appears to be limited scope to make the information more relevant.</p>
Monitor compliance with the requirements of the Directive	<p><u>Comment:</u> The reporting on the implementation every three and now four years is used in order to gather information on the implementation of the Directive and understand the level of compliance in Member States. Such information can be used also for possible infringement proceedings.</p> <p><u>Options to meet the need:</u> The reporting appears to meet this need, even though further details in the reporting might be suitable and support additional understanding of the implementation levels.</p>
Identify number and location of establishments	<p><u>Comment:</u> The identification of the number and location of establishments is considered to be a need by stakeholders, in particular being able to communicate basic information on Seveso establishments, for example following a media request. From the responses provided, stakeholders are not necessarily attached to the data being presented in eSPIRS. Further comments on integrating this reporting with other environmental reporting (e.g. the EU Registry on industrial sites project merging data from E-PRTR and IED¹) and making it compatible with the INSPIRE Directive were received.</p> <p><u>Options to meet the need:</u> The eSPIRS reporting could be integrated with other environmental reporting, for example the EU Registry on industrial sites. When addressing this need it is important to take into account the current work from the European Commission on streamlining environmental reporting². Information from the current 'Promotion of best practices for national environmental information systems and tools for data harvesting at EU level'³ might be useful to consider as it focuses on improving reporting websites.</p> <p><u>Potential limitations:</u> Changes to the eSPIRS database, including merging it into other systems, would need to take into account costs and benefits. While initial costs might be important, an integrated reporting could reduce the administrative burden for Member States and over time reporting costs would reduce. In turn, benefits would arise from better use of the data available and cross referencing of the data would provide further context on establishments (e.g. linking to E-PRTR emissions data).</p>
Find establishments for a specific activity	<p><u>Comment:</u> Similar to the previous need, being able to identify establishments engaged in a particular activity was found useful by stakeholders. It was also suggested that it would assist if activity level analysis was provided, for example by showing the evolution in the number of establishments by tier and by activity. This was seen as a way of gaining an understanding of the dynamism of a specific industrial sector. It would also presumably help to understand drivers such as establishments coming within scope as other legislation changes e.g. CLP classifications.</p> <p><u>Options to meet the need:</u> Changes made to the eSPIRS database should retain the option to search by activity so that this need continues to be addressed. In addition, some analysis at activity level could be requested as part of the regular analysis of the data on establishments that is conducted.</p> <p><u>Potential limitations:</u> This need is largely already met. Addressing the need for additional analysis could generate some additional costs from the time required to process the data and provide the analysis. However, it would allow more information to be generated from the reported data.</p>

Need Identified	Our analysis
Identify establishments in neighbouring countries	<p><u>Comment:</u> This need was identified despite the existing requirement in the Seveso Directive to provide information directly to neighbouring Member States in the event of establishments having the potential for creating a major accident with transboundary effects (Article 14).</p> <p><u>Options to meet the need:</u> This need indicates that reporting to eSPIRS does not replace the notification obligation in the legislation and further questions might be included in the implementation reports to verify that this information is shared in practice and regularly updated.</p> <p><u>Potential limitations:</u> Addressing this need would not generate additional costs apart from additional reporting time.</p>
Compare situations with other Member States/ benchmarking	<p><u>Comment:</u> The importance of the use of the information generated for comparison / benchmarking is apparent from stakeholders' feedback.</p> <p><u>Options to meet the need:</u> There would be value in focusing further the analysis of the implementation on comparing Member States' practices. Furthermore, stand-alone comparative analysis of Member States' practices such as inspections, or testing of emergency plans (two of the most often quoted provisions of the Directive) could provide additional value to Member States from the reporting.</p> <p><u>Potential limitations:</u> Addressing this need could result in additional costs (for example support for additional reporting) however it would also add value to the existing reporting streams.</p>
Identify actual practices in Member States	<p><u>Comment:</u> Comments highlighted that implementation reporting can provide information on whether provisions are implemented but not how this is done. There seems to be further need for the implementation reporting to present actual practices (and possibly best practices) and solutions to practical issues encountered.</p> <p><u>Options to meet the need:</u> It is important to understand the purpose of the different reporting streams. The implementation reporting which occurs every four years is not the best suited to exchange of information. The feedback received highlights the benefits from activities such as meetings of the Seveso Expert Group and Joint Mutual Visits organised by the MAHB. Having such events more frequently might be a more appropriate means of exchanging information. Specific events could focus on exchanging information on provisions of the Directive and Member States' practices (e.g. a workshop on testing emergency plans that would identify different practices and solutions to issues encountered).</p> <p><u>Potential limitations:</u> Addressing this need would result in additional costs for example with the organisation of a workshop, the support for such a workshop and potentially transport for attendees. The costs could be reduced by organising the workshop adjoining a Seveso Expert Group (SEG) meeting. Benefits of such events would depend on the attendance and participation of Member States. Attempting to capture such information within Member States implementation reports would likely create a substantial additional burden on member states and would likely be challenging to report upon.</p>
Learn about implementation at EU level	<p><u>Comment:</u> There appears to be general agreement that this need is being fulfilled by the analysis of the implementation reports. Furthermore, information on transposition is presented in Eur-lex⁴ including a link to all the transposing measures in each Member State. This information is transparent and readily available.</p>
Information to train inspectors	<p><u>Comment:</u> Feedback indicated that the information from the implementation reports and the lessons learned analysis from the MAHB are used as part of the training of inspectors and Seveso officials.</p> <p><u>Options to meet the need:</u> This need appears to be fulfilled already, however it might be useful to keep this use of the information in mind when drafting the material and try to identify examples of best practices, to which attention can be drawn to during training sessions. It might also be useful to consider whether this need can be further met, by asking in the first instance Member States whether they would like more on this aspect (e.g. training events for inspectors, training event for inspectors' trainers and guidance on inspection including a training section).</p> <p><u>Potential limitations:</u> Training of staff is a national prerogative, as such the European Commission cannot prescribe specific training material. Addressing this need further (e.g. by organising training events for inspectors for example) would result in costs.</p>

Need Identified	Our analysis
Identifying and responding to new topics	<p><u>Comment:</u> The feedback highlights that the reporting system lacks reactivity and fails to capture and treat new issues.</p> <p><u>Options to meet the need:</u> Addressing this need should not be through the implementation reporting system. It could be better suited to include a recurring 'emerging issue' slot during the Seveso Expert Group discussion meetings where better reactivity can be ensured. Indeed, this would allow free discussions on new topics being identified at Member State level and not need to wait for formal reporting on the matter.</p> <p><u>Potential limitations:</u> Addressing this need would not result in additional costs.</p>
Deficiencies identified during inspections	<p><u>Comment:</u> Information on inspection practices and number of inspections are included in the implementation reports. Based on feedback received it could be valuable to have more insights into the type of deficiencies identified by Member States during inspections.</p> <p><u>Options to meet the need:</u> This could be addressed by increasing the visibility of existing initiatives such as the Mutual Joint Visits or the work of the Technical Working Group on Inspection (TWG 2) both of which are highly relevant to this topic. . In addition adding questions in the implementation questionnaire on this topic could be valuable, as the issues are not likely to vary a lot in between reporting periods.</p> <p><u>Potential limitations:</u> Both of these options have costs and benefits. The first one (i.e. TWG 2) would allow more exchange on the topic selected, and could be accompanied by an overview of inspection practices at Member State level but would require costs for the organisation of the event, support of the workshop and possible attendance of stakeholders. The second option (i.e. including in implementation reporting) is less costly as it would require only marginal additional time to report and analyse, but would be less interactive and slower.</p>
Deficiencies identified during testing	<p><u>Comment:</u> Information on the way emergency plans are tested and the number of plans tested during the reporting period are included in the implementation reports. Based on the feedback received it would be valuable to have information on the type of deficiencies identified during testing.</p> <p><u>Options to meet the need:</u> The same options are identified as for the previous need.</p> <p><u>Potential limitations:</u> The same limitations are identified as for the previous need.</p>
Lessons learned from major accidents	<p><u>Comment:</u> One of the main needs identified from the reporting under the Seveso III Directive, the lessons learned from major accidents, are seen as a very valuable source of information.</p> <p><u>Options to meet the need:</u> Overall the feedback is very positive and the needs are met to some extent with only limited improvements identified (e.g. an annual overview, including trends analysis). However based on changes to the eMARS database (see below) more improvement could be made by making the lessons learned more complete.</p> <p><u>Potential limitations:</u> Addressing this need in an improved way (e.g. annual summary, additional analysis) could lead to additional costs for the MAHB in preparing the extra work. An alternative would be better search functions for the database to allow Member States to do their own analysis.</p>
Improvements to the eMARS database	<p><u>Comment:</u> A range of possible improvements to the database are included and described by both Member States and the MAHB. Some Member States appear to be aware of planned changes for the eMARS design and fully support this. Furthermore, some of the suggestions made from the MAHB (e.g. being able to use all fields as a search filter) are also identified by Member States as valuable.</p> <p><u>Options to meet the need:</u> A list of possible changes to the database are presented in Section 8.2.</p> <p><u>Potential limitations:</u> Addressing this need would require further exchange with the MAHB to understand the range of changes that can be made and the associated costs. Addressing this need should also take into account the current work from the European Commission on streamlining environmental reporting⁵.</p>
Information on near misses	<p><u>Comment:</u> Near misses are being monitored and reported at national level in some Member States and it was suggested that this information could be shared at EU level. The feedback seemed to indicate an interpretation of the requirement of near misses that differs from the legislation. Indeed while Annex VI</p>

Need Identified	Our analysis
	<p>also includes near misses in accidents to be notified, several stakeholders understand this reporting as voluntary. Near misses identification has a cultural component that might vary from Member State to Member State.</p> <p><u>Options to meet the need:</u> Further reporting of near misses, draft guidance on the identification of near misses including a methodology to be used at EU level. These would not be useful for statistical purpose necessarily but would provide further lessons learned.</p> <p><u>Potential limitations:</u> The differing interpretation on the compulsory nature (or not) of the reporting of near misses can hamper addressing this need. Furthermore the absence of a common approach to identifying near misses at EU level would limit the comparability of the data. Both options would result in costs.</p>
<p>Information on Safety Management Systems</p>	<p><u>Comment:</u> Despite their limitations, the current monitoring system already provides information regarding some provisions of the directive (internal and external emergency planning, safety reports, inspections, etc.) however, no information is available on the way Member States handle the human and organisational factors issues through safety management systems.</p> <p><u>Options to meet the need:</u> Addressing this need could be done by adding questions to the implementation reporting questionnaire. However feedback from Member States was quite mixed on whether this could be done, in particular due to the complexity of the issues relating to safety management systems. It is worthwhile to note that this is addressed in the TWG 2 on Seveso Inspections that has published common inspection criteria pertaining to some elements of safety management systems.</p> <p><u>Potential limitations:</u> Prior to addressing the need, it would be useful to further test the need based on the mixed feedback from Member States on the suitability of reporting such information.</p>
<p>Information to be used for public information</p>	<p><u>Comment:</u> Respondents indicated that information available publicly online is useful for public information and general education of the public, for example providing information neighbouring establishments.</p> <p><u>Options to meet the need:</u> Addressing this need would require raising awareness of material existing at EU level providing information on the Seveso Directive (e.g. leaflets, summaries of reports).</p> <p><u>Potential limitations:</u> None identified</p>
<p>Information on socio economic impacts of major accidents</p>	<p><u>Comment:</u> There are only limited information on socio economic impacts of major accidents, and while three Member States are currently working on developing systems to monitor this, there does not seem to be a general methodology on assessing and reporting these costs.</p> <p><u>Options to meet the need:</u> The European Commission could produce guidance on monitoring and reporting socio economic impacts of major accidents and refine the reporting of such impacts in eMARS. The European Scale of Accidents could be used to guide the monitoring and reporting of socio-economic impacts, however this might need some modernisation.</p> <p><u>Potential limitations:</u> Addressing this need would require additional costs for providing guidance to Member States on a common approach to identify and report socio economic impacts so that these can be reported (through eMARS) and then analysed and compared. The benefits from addressing this need would be an increased understanding of impacts of major accidents which could benefit both Member States and the industry. The modernisation of the European Scale would require some additional work.</p>

Note 1: http://cdrtest.eionet.europa.eu/help/ied_registry

Note 2: http://ec.europa.eu/environment/legal/reporting/fc_actions_en.htm

Note 3: <http://www.eis-data.eu/>

Note 4: <http://eur-lex.europa.eu/legal-content/EN/NIM/?uri=CELEX:32012L0018>

Note 5: http://ec.europa.eu/environment/legal/reporting/fc_actions_en.htm

3.4 State of play and further work to be completed

This task is considered to be complete. However further refinement will be carried on based on comments received from the workshop.

4. Review of the current monitoring system

4.1 Overview

This section is dedicated to the review and analysis of the ability of the current monitoring system to answer the variety of needs expressed by stakeholders and capture all relevant aspects of the Directive's implementation and impacts.

The reviewing of a monitoring system requires a combination of:

- Users' perceptions in order to collate experiences with regard to clarity, feasibility and usefulness criteria; and
- Expert assessment in order to examine the monitoring system under criteria of scientific validity and rigour.

Our analysis therefore relies not only on the responses collected through the questionnaire but also on the findings from an internal workshop gathering INERIS experts on the topic. Accordingly, in addition to the questionnaire sent to relevant stakeholders, including Member States representatives, an INERIS internal workshop has been organised with the objective of discussing how the current monitoring system succeeds in providing a representative picture of the reality of the Directive, its implementation and its application. Nine practitioners were involved in order to cover the variety of themes considered in the Seveso Directive including land use planning, safety reports, safety management systems and emergency planning.

From the analysis we suggest an innovative categorisation of the variety of uses associated to the monitoring system and an evaluation of the current configuration to provide satisfactory answers.

Overall, the review of the current monitoring system, is intended to address the following questions:

- What are the strengths and weaknesses of the current monitoring system?
- To what extent does the current monitoring system comply with the Better Regulation Guidelines?
- Are actions necessary as a result of the roadmap for action included in the report by the Commission on Actions to Streamline Environmental Reporting?
- To what extent does the current monitoring system comply with other horizontal legislation or guidance on environmental reporting (e.g. INSPIRE Directive).
- To what extent does the current monitoring system comply with other relevant guidelines on monitoring and indicators (e.g. OECD)?
- To what extent does the current monitoring systems address other identified policy and communication needs, not explicitly specified in the Seveso-III-Directive and subsequent Commission Implementing Decisions?
- Is there double-reporting, overlap or other unnecessary administrative burden? Does the current monitoring system collect information which is eventually not used? Can information available from other sources be used for the purposes of the monitoring system under the Seveso-III-Directive and vice-versa?
- What is the perception of stakeholders towards the current monitoring system? What suggestions exist for its improvement?

- If identified during the performance of the task: what good practices exist in Member States and in other policy areas?

4.2 Feedback on current monitoring systems: questionnaire analysis

Tables 4.1 and 4.2 below presents a synthesis of the answers to the questionnaire provided respectively by the member states and international organisations and demonstrate the perception of stakeholders toward the current monitoring systems and suggestions for its improvement.

Table 4.1 Member States' responses on questions relating to the review of the monitoring system

Member states responses		
Questions	Responses	Comments
What is your overall perception of the current monitoring system of the Directive?	Neutral: 7 Positive: 16 Negative: 2	Positive appreciations of the current monitoring system have been associated with the following strengths: Lot of information is made available allowing benchmarking between member states' practices. It is believed to be sufficient to appreciate the level of implementation of the directive. Complementary to the above, some positive responses also came with suggestions for improvements that are listed in the following alongside the limitations pointed out by neutral and negative responses: A lot of information is entered in the system but very [little] is useful. Reporting burden perceived as high. Double reporting Only accident reporting is considered as useful. Difficulty to access useful information.
Do you have horizontal suggestions on how to improve the monitoring system?	No: 9 No response: 11 Suggestions: 5	Rely on big data to combine information collected from different monitoring systems. Less information on the basis of need to know, not on the basis of nice to have. The monitoring system should also address the adequacy of the scope of the Seveso directive and in particular evaluate if increases in the number of establishments are justified in terms of major accident hazard potential. Separate information on number of installations from implementation reporting and to integrate eSPIRS (obligatory data fields) into EU-Registry reporting. Better access and better presentation of data.
Is there any good practice with regards to monitoring from your Member State you would like to share?	No: 11 No response: 11 Suggestions: 3	Suggestions included: Publication of Seveso establishments' performance in connection with inspection activity. Elaboration of an electronic system for Seveso reporting concerning eSPIRS and eMARS including an electronic workflow from operators via local authorities to the national level. Provide detailed guidance on assessing safety reports and MAPP.
The tri-annual³ reporting is structured according to Decision 2014/896/EU. Do you think the content of the reporting is appropriate, sufficient and useful? Explain why or why not.	No: 2 Yes: 13 Unclear: 1 No response: 5	Suggestions included: Favour information on concrete best practices rather than on "nice to know" information. It is not clear whether information is useful and for whom Complete with the following information:

Member states responses

	Suggestions: 3	Conclusions of regular inspections. Types and number of deficiencies identified in regular inspections. Experiences of internal and external emergency plan drills. Risk management measures prescribed by the authorities.
Is there any overlap or duplication of tasks due to the reporting on the implementation of the Directive? If yes, please describe.	No: 9 Yes: 10 No response: 5 Suggestions: 2	Overlaps identified are the following: Double reporting of the number of establishments in eSPIRS and implementation reports. Some questions in the reporting system for the "Convention on the Transboundary Effects of Industrial Accidents" are very similar to those in the Seveso reporting system and partially overlap Some suggestions were also formulated: A unified EU register for all Seveso related information. Connect national and EU registers.
Lessons learnt shows that an important part of majority of accidents is caused by human and organisational factors. Accordingly, rooms of improvement might lay in the human and organisational aspects that are formalised through SMS (Safety management Systems). In the current reporting system, there is no reference to the way SMS are deployed. Do you think human and organisational aspects of safety should deserve more attention in the reporting of the Seveso Directive? If so, why and how?	Yes: 18 No:4 No response:1 Suggestions: 4	A large majority of respondents agreed on the relevance of human and organisational factors in shaping safety performance. SMS are therefore believed to be a key lever to achieving the directive's objectives. However, important concerns are expressed on the way such aspects could be monitored through indicators or specific questions. We provide in the following a more detailed account of these concerns: Difficult to quantify SMS related information. Difficult to anticipate how the questions would look like and how different member states would accommodate. Difficult to get relevant details on SMS from operators. SMS related aspects should be considered exclusively in eMARS (lessons learned) but not in prevention context. The following suggestions have been formulated: SMS related aspects should better be addressed in seminars, SEG, TWGs and MJVs. Force reporters in eMARS to address lessons on SMS level. Report on aspects of the SMS addressed during inspections. Non mandatory questions in the implementation reporting.
Assessing the number and location of establishments in the EU is vital to understand the development of the associated risk for citizens. Member States currently need to report on the number of establishments twice, in the reporting to eSPIRS under Article 21(3) and in the report on the implementation of the Directive (Article 21(2)) because the reporting of establishments to eSPIRS does not include a requirement on the frequency of data updates. Establishing an obligation for regularly updating eSPIRS could overcome this double reporting and would allow eSPIRS to achieve its objectives better. Would you favour such an integration of the reporting on the number of establishments under eSPIRS? Would you see any obstacles?	Yes: 15 No:6 Further analysis required:1 No response: 3	Although a majority of responses are in favour of such an integration in eSPIRS, some strong resistance is observed in the negative responses, especially regarding the burden of a more frequent updating of information in eSPIRS.
Major accidents meeting criteria of annex VI are to be reported within a year after their occurrence. Until the data can eventually published often several years pass by. This hampers the objective of rapid information sharing and identification of relevant trends. Do you	Appropriate: 13 Inappropriate (too long): 3 Inappropriate (too short): 1	Many of the respondents consider the one year delay as appropriate regarding the technical and sometimes juridical complexity of accidents. They therefore do not suggest shortening this time scale and do not see any possibility of accelerating it.

Member states responses

believe this timescale is appropriate? What options do you see to accelerate the process? What obstacles exists to reporting faster?	No responses: 6 Suggestions: 1	Some other contributions pointed the fact that accident reporting requirements are subtler in the sense that they already include a fast reporting track that can be incrementally completed by newly available information. Suggestions go in the same direction by suggesting an incremental reporting that is periodically enriched by technical and juridical information when they become available.
Do you believe the format requested by Decision 2009/10/EC for the reporting of major accidents is appropriate? If no, please specify what you think should be added or removed	Yes: 13 No: 0 No response :5 Suggestions: 5	The following improvement suggestions have been formulated: Report the worst case scenario that could have occurred. Update the system with respect to Seveso III nomenclature. ⁵ Distinguish direct and root causes. Align eMARS reporting with other great EU databases (ARIA, ZEMA, etc...) Simplify in a way that approaches the AIDA reporting scheme developed by JRC.
Beyond the number of major accidents, are you aware of any other indicators that could be used to monitor the effectiveness of the Directive? If yes, which ones?	No: 7 No response: 8	The following improvement suggestions have been made: Number of non-compliance during inspections. Additional indicators can be obtained by analysing the factors identified in eMARS as causing accidents. Number of all major accidents, not only those reportable through annex VI. Indicators from OECD guidance on safety performance indicators. The extent of consequences of major accidents. Number of establishments using appropriate process safety performance indicators and the performance levels within those. Near misses

Table 4.2 International organisations' responses on questions relating to the review of the monitoring system

International organisations		
Questions	Responses	Comments
What is your overall perception of the current monitoring system of the Directive?	Neutral: 1 Positive: 4 Negative: 0 No response: 8	Opinions formulated here disregard implementation questionnaire to which respondents do not have access ⁶ .
Does the current system deliver the information meeting your needs?	Yes: 4 Partially: 1 No response: 8	The use of NACE categories by some countries in eSPIRS creates a problem in analysing the industry sectors associated with Seveso sites
Do you have suggestions on how to improve the monitoring system? Please respond by distinguishing each reporting stream	No: 4 No response: 8	
	Only two comprehensible	Respondents point out the following aspects:

⁵ Note that this has since been updated by the MAHB

⁶ Note that these are public so unclear whether the comment refers to a difficulty of identifying how to access

International organisations

Beyond the number of major accidents, are you aware of any other indicators that could be used to monitor the effectiveness of the Directive in reducing the disaster risk? If yes, which ones?

response has been given

Near misses could be considered as a relevant complementary means of assessing risk levels. Major accident statistics are not representative due to their rarity. Look at other type of chemical accidents in non-Seveso sites (pipelines for example). Such reporting could be a requirement under the civil protection mechanism

Lessons learnt shows that an important part of majority of accidents is caused by human and organizational factors. Accordingly, rooms of improvement might lay in the human and organizational aspects that are formalised through SMS (Safety management Systems). However, in the current reporting system, there is no reference to the way SMS are deployed. Do you think human and organizational aspects of safety should deserve more attention in the reporting of the Seveso Directive? If so, why and how?

Yes: 4
No response: 8

All respondents agreed on the relevance of integrating this aspect in the reporting. The following suggestions have been made:
Report on typical inspection findings regarding SMS aspects.
Already suggested as a separate category of causes by the MAHB in its design improvement proposal.

Do you have suggestions on how to improve the monitoring systems?

No relevant information provided here.

4.3 Analysis based on the feedback from stakeholders

The answers from stakeholders highlight the following complementary remarks and analysis:

- With respect to the efficiency criterion (i.e. the ability to collect information in an optimised way), many respondents pointed to the overlap in data collection regarding the number of establishments. Concerns have also been expressed regarding the frequency through which this information should be collected. These kinds of concerns are very common in all reporting systems as information providers tend to want to minimise reporting efforts, especially if the benefits are perceived as limited. In terms of suggestions for improvement, different leads have been discussed, the most important being the development of a unified EU register and an improvement of national and EU registers.
- Regarding the relevance and quality of the information currently reported, some concerns over their usefulness have been raised. It appears that many are in demand for additional information, especially regarding inspection practices and accident descriptions.
- With respect to the ability of the current monitoring system to demonstrate a real impact of the directive on the risk levels to which EU citizens are exposed, respondents agree to a large extent on the weak statistical representativeness of the number of major accidents making such a figure a poor estimator of risk trends. Various improvement suggestions have been made such as for example extend accidents accounts to incidents and non-Seveso establishments, encourage further near misses reporting, collate information on number of non-compliance issues identified during inspections.
- Almost all respondents share the opinion that human and organisational aspects of safety should not be overlooked. However, important concerns are raised over the capacity of a monitoring system to capture these aspects. Some respondents are open to suggestions

whereas a few others are reluctant to see any integration of these dimensions in a future evolution of the monitoring system. We share the observation that human and organisational aspects expressed through safety management systems are complex and require careful treatment if one is looking to report on them. However the monitoring system should not be seen as a tool able to perfectly describe complex situations but rather a tool that helps raising awareness and providing inputs on key topics for further discussion. In other words, the complexity of SMS related matters should not stop the monitoring system from addressing them but should orient it towards a more modest purpose e.g. being the production of valuable inputs for workshops or working groups dedicated to this topic.

- The perception of the current monitoring system is overall positive despite the limitations raised by some Member States and discussed in the points above. When further analysing Member States' comments, a link could be made between their positive or negative aspects and the use made by the Member State. Indeed, positive comments were found to be correlated with benchmarking of Member States' practices, public information through information made available by eSPIRS and finally the ability to rely on eMARS findings and lessons learnt to enrich risk scenarios considered in safety reports. Negative comments were associated with the ability of the monitoring system to assess the Directive's impacts or to identify emerging topics to be shared and discussed amongst Member States. Accordingly, the coexistence of positive and negative perceptions is not to be seen as conflicting but rather as a reflection of the various aspects of the monitoring systems with respects to different needs.

4.4 Feedback on current monitoring systems: internal workshop analysis

In addition to the above, the internal INERIS workshop allowed for a bottom up analysis based on individual and collective experiences at INERIS about the way the Seveso Directive's requirements are translated into practices. More precisely, the participants were asked to reflect on the following two questions:

- What are the main strengths and weaknesses of the current monitoring system?

This first question aimed at assessing the ability of the current monitoring system to faithfully and exhaustively capture the mechanisms triggered by the implementation of the Seveso III Directive and its actual effects on industrial risk levels. Practitioners were asked to rely on their experience to identify key aspects they believe the monitoring system succeeds or fails to grasp and report at the EU level.

- If needed, what are the main evolutions you would suggest to improve the current monitoring system performances?

Participants were asked to point out the mechanisms or aspects of the Directive they consider key in its functioning and still missing in the current reporting system.

The workshop participants were split into three small groups in which thoughts and findings on the two previously described questions were systematically shared and discussed with all other participants.

From this internal INERIS workshop, the following key aspects were identified that are complementary to the elements provided through the online survey:

1. The accident reporting framework is perceived as rich as it allows to explore technical and organisational mechanisms behind major accidents. In doing so, lessons learnt can be highly profitable for the whole EU community despite the 1 year minimum delay (sometimes much longer) required to collect and organise the data.
2. The Seveso Directives have successively defined and enriched the set of provisions believed as required in every risk management policy: safety reports, land use planning, safety management

systems, emergency planning, and inspection by Member States authorities, MAPP and public information. The group agreed that the current reporting system does not address in a fair way all of these provisions as some of them remain poorly treated or even not addressed. For instance, despite the importance of Safety Management Systems to maintain risk levels within acceptable limits through organisational arrangements, however information on this aspect is broadly absent from the reporting systems. Safety reports are also key in getting establishments to know their risks and orient their risk management policy.

3. The Member States' tri-annual⁷ questionnaire is focused on whether some of the Seveso Directive policy levers are actually implemented rather than discussing the quality of this implementation and whether it produces tangible results. For instance, regarding inspections, the questions address mostly the issue of planning design and effective realisation leaving aside the issues of quality of inspections and tangible follow-up actions. The group agreed that issues of inspectors training, type of inspections (planned vs unannounced) or inspection topics should benefit from a sharing of experiences at the EU level.
4. All participants agreed on the need to further explore the way impacts on risk levels should be monitored beyond the figure of the number of major accidents. This issue is a core topic of the monitoring system review as it strongly determines whether all efforts are deployed in the right direction.

With respect to the elements provided by the questionnaire and the internal INERIS workshop, it appears clear that the Seveso III monitoring system is at the centre of a variety of uses and expectations developed by different stakeholders. With respect to the needs expressed in section 2 and the INERIS experts workshop presented above, we have identified four distinct categories of needs that are detailed in table 4.3 below. Each of these needs is further split into sub categories in which relevance for the variety of stakeholders identified is specified. It is important to put the results into context, in particular considering that the stakeholders invited to the consultation were mostly technical experts located in Member States, as such they might not identify some items as needs that would be identified by other within their Member States.

Table 4.3 Review of the needs against the current monitoring system of the Seveso III Directive

Categories of needs associated to the monitoring system	Sub categories	Relevance with respect to stakeholders' needs			Associated comments
		EC	MS	Others ⁸	
Enforcement and implementation	This addresses the extent to which each Member State has actually put in practice each provision of the directive.				This first need is already fulfilled, to some extent, with the reporting on implementation. It could be beneficial to supplement the existing monitoring by extending the current monitoring system to cover all the Directive's provisions, including the Safety Management Systems. Member States' feedback should be considered in this respect.
	In practical terms, the sub categories associated with this need are the implementation of:	X	X		
	Safety reports, including the consideration of domino effects.	X	X		
	Internal and external emergency planning	X	X		
	Land Use Planning	X	X		
	Public information	X	X		
Safety Management Systems					

⁷ Now every four years

⁸ Including establishments operators

Categories of needs associated to the monitoring system	Sub categories	Relevance with respect to stakeholders' needs			Associated comments
		EC	MS	Others ⁸	
Impacts and objectives achievement	The Directive's intervention logic presents a clear set of direct and indirect objectives to be achieved. Responses to the questionnaire have pointed to the inadequacy of the current monitoring system to demonstrate whether or to what extent the Directive achieves its objectives especially regarding reduction of risk levels in the EU. Accordingly, work is required to support the Commission and Member States in demonstrating the achievements of the Directive's objectives in particular:				This second category of needs is of interest to Member States and the European Commission as both are expected to demonstrate at their respective levels the level of objectives' achievement. Tools to be developed should be similar at the Member State and European Commission levels as the later will simply rely on the aggregation of information provided by each Member State. The statistical significance of major accidents being poor, it is necessary to explore other ways of characterising evolutions of risk levels including incidents statistics or evolutions in terms of populations living in Seveso regulated areas. Seveso industries in Europe should play a key role here being major providers of input data, especially regarding economic aspects of safety.
	Reduction of risk levels	X	X	X	
	Socio economic impacts of the directive	X	X		
	Public access to information and participation in decision making.				
Benchmarking	Benchmarking appeared to be an important need for Member States as they are looking for elements of comparison on the extent and the way each of the Directive's provisions is implemented across the EU.	X	X		Member States appear to be the first "consumers" of such reporting. However, the European Commission may also benefit from building a global picture of the variety of Member States' practices.
Support debates and discussions	A few respondents underlined the need for the monitoring system to help uncover key dynamics or emerging topics.	X	X		Indicators on implementation should be used as valuable inputs for these discussion. Accordingly, punctual and limited collection of information regarding an emerging topic can be envisioned to provide Member States and the European Commission with a reactive tool providing valuable and timely information.

4.5 Analysis of strengths and weaknesses of the current monitoring systems

The following sections cover the extent to which the current monitoring system satisfies the needs identified above as well as other criteria including requirements of the EU Better regulation guidelines.

4.5.1 Monitoring system performance against categories of needs

Enforcement and implementation

The current monitoring system provides information on implementation of the Directive through a 4-yearly detailed questionnaire where the deployment of a large set of the directive provisions is evaluated. Indeed, the questionnaire items cover emergency planning, land use planning, safety information and inspections. However, this evaluation is still not exhaustive as, for example, there is no reference to whether Safety Management Systems are actually deployed in establishments and inspected by the authorities. Similarly, there is no reference to whether establishments are producing (as required and on time) their safety reports and to what extent these documents provide satisfactory demonstration of knowledge of risks.

Accordingly, a first weakness identified is that the implementation questionnaire does not address exhaustively all of the Directive's provisions.

Complementary to this, an important question when addressing implementation is the capacity of the monitoring system to capture whether Member States are making available adequate human and technical resources for the directive to have a real impact on safety. For instance, national authorities staffing may vary in terms of number (per establishment for instance) and competence (quality and updating of training). These aspects are of particular importance as various major accidents, including Bhopal and more recently Deep-Water Horizon have pointed to a lack of authorities' supervision and staffing and information on these aspects is not monitored / reported upon. Another information gap is on whether additional guidance has been made available to stakeholders on the changes introduced by the Seveso III Directive.

A second weakness identified at this level is the lack of monitoring of resources dedicated to implementation at the Member State level. Such information could identify any important discrepancies in resource allocation from one country to another.

The implementation reporting does not currently address the following:

- Key provisions of the Directive are not covered in the questionnaire, for example Safety Management Systems and details on safety reports.
- The questionnaire does not address explicitly the issue of resources and staffing made available by Member States to ensure effective ongoing implementation.

Impacts and objectives achievements

The Directive's main objective is to ensure a high level of protection for human health and the environment for European populations exposed to hazardous industrial activities. One of the information sources currently used to assess whether this objective is being met is data on the number of major accidents, as collected in eMars. As pointed out by multiple responses to the questionnaire, relying exclusively on this figure to assess the Directive's impacts on risk levels is insufficient. Since, major accidents are, fortunately, extremely rare, their statistical representativeness is poor. Furthermore, a lack of accidents is not synonymous with safety as proved by the large number of near misses recorded throughout industrial history. Therefore, it is worth questioning whether the current monitoring system provides enough information on how risks associated with major industrial accidents change over time.

In order to improve eMARS's ability to provide the Commission with a better representation of risk levels, we agree with some of the respondents on the relevance of further integrating near misses⁹ and major accidents in non-Seveso establishments to eMARS reporting. In addition, and to better learn from past accidents, it would be highly beneficial to define a typology of causes in accident reporting that can be easily matched with Safety Management Systems items (including for example learning from incidents, management of change, mechanical integrity, maintenance, procedures). In doing so, eMARS could identify information on key organisational deficits that need to be addressed at the EU level.

Finally, regarding the issue of delays in accident reporting, it appears reasonable to accept a certain gap between accident occurrence and reporting if one is expecting an enriched and exploitable analysis of accidental mechanisms, including organisational ones. Therefore, we believe it necessary to remind users that accident reporting requirements already include a fast reporting track that can be incrementally completed by newly available information.

Additional detailed suggestions for modification of the eMARS reporting fields were included as part of the responses which are valuable and could be presented to Member States for their approval.

We also suggest other means of monitoring the the Directive's achievements not only through accident and incident reporting but also through other means such as:

- *The improvement of safety awareness and information available to the general public.* A well-informed public is a safer public as it is aware of the risks faced and the right behaviour to adopt in case of emergencies. This could be assessed qualitatively by including a question on this topic in the implementation questionnaire.
- *The impacts of land use planning policies.* Reducing population density around hazardous plants translates into risk reduction even if the hazardous potential and accidental records are unchanged. Therefore, tracking the ability of the directive to reduce, or at least, avoid worsening population density in hazardous areas could be a relevant measure of success of the directive. This approach has already been deployed by the French authorities following the changes to land use planning introduced after the Toulouse catastrophe in 2001.
- *The extent to which prevention efforts outweigh mitigation efforts.* Despite the importance of mitigation efforts in Member State policies, prevention should remain a priority where possible as it allows for a higher reduction in risk levels. For instance, French authorities use the amounts of annual industrial investments in safety prevention and the resulting areas of territory no longer subjected to risks to demonstrate the efficiency of its risk policy. A similar approach could be adopted at the directive level to assess whether it leads to greater prevention efforts which, automatically, contribute to risk reduction.

By relying on the number of major accidents figure, the current monitoring system displays important weaknesses in terms of its ability to monitor changes in risk levels for EU populations.

Actions to reduce this weakness could include:

- Extend eMARS reporting to non-Seveso establishment major accidents and encourage further reporting of near-misses
- Consider using other proxies to measure changes in risk levels: levels of risk awareness amongst exposed populations, efficiency of land use planning policies or levels of prevention efforts comparatively to mitigation ones.

⁹ It is worth reiterating here that several respondents seem to believe that near misses are not currently reported in eMARS and seem unaware of the wording of Annex VI which includes near misses.

Benchmarking

EU Member States display have variable levels of experience with respect to the Seveso Directive's implementation. This may be reflected in the range of both positive and negative comments on the performance of the current monitoring system.

The implementation questionnaire addresses far more the issue of *what is done* than the one of *how it is done*. However this is a reflexion on the objectives of the implementation reporting whose focus is on getting information to assess compliance of the Member States with the Directive.

Respondents have pointed out several aspects for which additional information would be welcomed:

- How is inspectors' trainings organised? How do they organise their inspections?
- Which categories of deficiencies are observed during inspections and what steps are taken to remedy this?
- What deficiencies are identified during emergency plans testing and steps taken to remedy this?
- How are management systems being inspected?

It is important to note these items, as they are important, however the implementation reporting is not the best forum to address all of them. Indeed, for some of these needs (e.g. training of inspectors, inspection of management systems) existing information sharing platforms such as the Mutual Joint Visits organised by the MAHB might be a better suited forum.

Support debates and discussions

A few respondents highlighted the need for the monitoring system to be more proactive by providing opportunities to share new or emerging topics between Member States. However, here again, the implementation reporting which is conducted every 4 years might not be the best suited arena for such exchanges. These could be better addressed as part of a recurring agenda item of the Seveso Expert Group, or even through the creation of an online platform to share experiences and questions in a fast and interactive way.

4.5.2 Monitoring system performance with respect to EU Better Regulation guidelines

In chapter 5, the EU better regulation guidelines discuss requirements of monitoring systems associated with EU legislation.

First, it sets out the following four aspects to be systematically monitored:

- a. Implementation: Adoption of national measures required to comply with the EU legislation.
- b. Application: Changes observed in the realisation of objectives.
- c. Compliance and enforcement: extent of compliance by businesses, measurements taken, inspections carried out and court cases pursued.
- d. Contextual information: relate to developments that are not intentionally related to the policy intervention, although they may be influenced by it.

With respect to the three first aspects, we have seen earlier that the current monitoring system addresses them. However, there is a weakness in addressing the fourth aspect i.e. unintentional impacts of the Directive. Indeed, the current monitoring system does not provide insights in to the way that the Directive and its evolution over time has influenced other aspects of the European industrial system, especially with regard to

safety costs for the industry and regulatory constraints that may impede EU competitiveness comparatively to other large industrial areas such as the USA or Asia.

Secondly, particular attention is given to the necessity of carrying out regular verifications both by the Commission and by external stakeholders so to provide an enriched perspective of regulatory performance. The Seveso III Directive satisfies to a certain extent these requirements as 4 years implementation reports are produced and regular collection of data is performed through eMARS and eSPIRS. Any additional work by international organisations could also be of value.

The monitoring system addresses implementation, application and compliance requirements, although in an imperfect way with possible improvements as discussed. However, it fails to address the issue of unintentional consequences. On the positive side, regular efforts to reinforce the monitoring system with external expertise exist and deserve to be maintained.

4.5.3 Monitoring system performance with respect to streamlining of environmental reporting

Streamlining is of key importance to monitoring and reporting systems, as pointed out under several frameworks. Indeed, it is identified as a requirement in the EU Better Regulation Guidelines and is the subject of the 2017 EU action plan (COM(2017) 312). As part of this section we identify several streamlining opportunities.

The first elements discussed here are those provided by the respondents to the questionnaire who pointed out the following weaknesses:

- Double reporting of the number of establishments in eSPIRS and the implementation questionnaire.
- Some respondents have the feeling that not all information collected is valuable or useful.
- Reporting under UNECE Convention on the Transboundary Effects of Industrial Accidents¹⁰ overlaps on a few aspects with Seveso reporting: identification and notification of hazardous activities with the potential to cause transboundary effects; steps taken to prevent major accidents; and preparedness testing and cooperation and exchange.
- Reporting under the Environmental Liability Directive includes information on the number of cases of environmental damage and financial coverage for environmental damage liability.

It is worth emphasising the already ongoing efforts deployed by the European Commission services to improve the monitoring system performance with regard to this aspect. For example, the timing of reporting under the UNECE TEIA and the Seveso reporting are now aligned so that the first one can feed into the second one. However here, it is important to highlight the differences. The UNECE TEIA is mostly an exchange of information process while the implementation reporting is a compliance verification process.

Furthermore a review of the actions defined in the EU action plan (COM(2017) 312) found that several are already translated into effective initiatives as described in below:

- Action 2 initiates a rolling work programme in which thematic working groups supervise streamlining of reporting obligations under environmental legislation. The Seveso reporting system is part of the 2018-2020 rolling work programme¹¹.

¹⁰ Working group implementation, UNECE, TEIA <https://www.unece.org/env/teia/wgimplementation.html>

¹¹ <http://ec.europa.eu/environment/legal/reporting/pdf/FC%20Reporting%20-%20rolling%20WP%20incl%20annex%20-%20version%2002.2018.pdf>

Figure 4.1 Seveso reporting as part of the rolling work programme 2018-2020

Seveso III Directive (2012/18/EU)	24	Directive 2012/18/EU Seveso III	Report on implementation	Article 21.2	2018 / 2019	N.A.	2019	0%	effectiveness & efficiency (indicators, textual) & coherence	No	link to IED
Legislation (short name)	A.0 Core inventory reference A1. Inventory reference no. A2. Title with link to source		A.1 Layer 1 obligation reference A4. Short description	A4. Core reference information A6. Legal base for reporting (Article)	Inclusion in the rolling work programme, if yes, when?	Evaluation planning	Next reporting	Current EEA role (2016)	Possible issues for improvement (FC evaluation outcome)	Possible issues for legislative amendment	Comment

- Action 6 has identified Seveso establishment location as one of the priority datasets for which a full implementation of the INSPIRE Directive is envisioned¹².

Figure 4.2 Location of Seveso establishments as a priority dataset for full implementation of INSPIRE

Priority data set list (PDS list) for eReporting V2.0

Original list no.	Theme	Fitness check for reporting			Relevant data sets		Proposed mapping to the hierarchical INSPIRE code list for metadata keywords				
		Title of legislation	Reporting requirement	Originally defined data sets for environmental reporting	Data set no.	Identified specific data sets	Label_1 (Level 1: indication of legislation)	Label_2 (Level 2: originally defined spatial data set)	Label_3 (Level 3: specific topic - identified specific data set)	Label_4 (Level 4: specific sub-topic - identified specific data set)	Additional information on INSPIRE code list
45 (46)	Industrial emissions	COMMISSION RECOMMENDATION of 22 January 2014 on minimum principles for the exploration and production of hydrocarbons (such as shale gas) using high-volume hydraulic fracturing (2014/70/EU)		40) Location of boreholes	40.01	Boreholes for hydraulic fracturing	Recommendation 2014/70/EU	Boreholes (Recommendation on hydraulic fracturing)	Boreholes for hydraulic fracturing (Recommendation on hydraulic fracturing)		
44	Industrial accidents	Directive 2012/18/EU Seveso III	Location of and information on establishments	39) Location of establishments	39.01	Seveso III location of establishment	Directive 2012/18/EU	Establishments involving dangerous substances (SEVESO III Directive)			

- The fitness check of reporting of EU environmental policy performed in 2017¹³ identifies the opportunity to streamline reporting of the IED directive, European Pollutants Release and Transfer Register (E-PRTR), Seveso directive, and the Extractive Waste Directive. This opportunity is also confirmed by some feedback received and there is a clear possibility to streamline the reporting on establishments from the Seveso Directive (eSPIRS) with the ongoing streamlined EU Registry of Industrial Sites. Based on discussions with the EEA, this would be technically possible. There are other considerations however, including political and technological (e.g. different reporting format) to be considered. Adding extractive waste facilities into the inventories would avoid double reporting under all these overlapping legislations.

In addition to these initiatives, we see at least two additional items required by the action plan that could be addressed more thoroughly in the next versions of the reporting system:

- Action 8: Promote the wider use of citizen science to complement environmental reporting. This action relates to our previous suggestion of considering population awareness and understanding of risk levels in the monitoring system as well as their contextual knowledge to inform EU policy makers of the everyday reality of Seveso risks.

¹² <https://ies-svn.jrc.ec.europa.eu/projects/2016-5/wiki>

¹³ <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52017SC0230&from=EN>



- *Action 10: Strengthen cooperation with relevant international organisations with the view to streamline reporting and information management between the EU level and the international level. We see in this action a good opportunity to provide satisfactory responses to the weaknesses pointed out by the respondents and presented above.*

Whilst the opportunity of streamlining the data collection process is supported, we acknowledge the necessity raised by some respondents to consider also the organisational aspects of such streamlining as required competences and associated responsibilities may differ from one reporting channel to another. For instance, when asked about the opportunity of reporting on establishments / installations / sites under the Seveso, IED and EWD reporting, warnings have been raised that the diversity of reporting requirements between these various Directives could lead to extra technical and organisational costs for example to update the reporting format and templates and for staff to get used to new reporting and data verification systems. Accordingly, if streamlining is a virtuous objective to be pursued, attention should be paid to its technical and organisational consequences for data providers.

Finally the analysis of stakeholders' feedback identified possible ways of increasing synergies on the reporting on accidents. A possible way forward identified was creating an EU portal with links to sites that provide accident reports on technological risks including offshore installations, aviation, nuclear activities etc. That way lessons could be learnt from each other with minimal impacts on the way inputs are made. Additionally accidents from non-Seveso sectors (including Offshore accidents of mining waste accidents) could be reported in the eMARS database. It was also indicated that criteria for reporting of events are being developed as part of the Extractive Waste legislation which could be taken into account to foster a harmonised identification and reporting of accidents and near misses.

Despite some weaknesses, we identified positive initiatives that are already taking place to improve the situation, including the consideration of Seveso related datasets for the full implementation of the INSPIRE directive.

However, there is a need to investigate the technical and organisational consequences of possible future streamlining initiatives so to avoid unintended costs and complications for data providers.

4.5.4 International guidelines on policy reporting and indicators

The 2016 report produced by the team¹⁴ included a review of a large set of international guidelines on policy monitoring practices and frameworks and concluded on two key recommendations which remain relevant for the present work:

1. For the policy maker to capture wider aspects of the performance of regulation, it is necessary to go beyond final impact indicators by identifying and monitoring intermediate results for which the link to final objectives achievement is proven. This was discussed in section 4.4.1 through the suggestion of collecting data on citizens' risk awareness, efforts dedicated to prevention and impacts of land use planning policies on population exposures to risks.
2. All regulations generate unintended consequences that deserve the full attention of policymakers. This recommendation fully rejoins the requirement by the EU Better Regulation guidelines to address contextual information we discussed in 4.4.2.

4.6 State of play and further work to be completed

At this stage, we restructured the large set of stakeholders' expressed needs into 4 categories that we examined thoroughly to evaluate the ability of the current monitoring system to provide satisfactory answers.

¹⁴ Analysis and summary of Member States' report on the implementation of directive 96/82/EC on the control of major accident hazards involving dangerous substances, chapter 7 (monitoring indicators).

In addition, we also analysed the monitoring system with respect to the EU Better Regulation guidelines, the EU streamlining action plan and international guidelines.

These elements will be further discussed in the stakeholder workshop in order to be amended and completed as necessary.

5. Key drivers of performance

5.1 Overview

This section focuses on the identification of key drivers of the Seveso III regulatory system. We define a key driver of performance as any aspect, within or out of the regulatory mechanism that may have a strong impact on the final objective of the Directive being met (i.e. the reduction of risks from industrial accidents). By identifying these drivers, we expect to provide policy makers with clear indications on where to focus monitoring capabilities so to get the highest value of information.

It is unclear which measures within the Seveso Directive are considered to be most effective and efficient and which ones contribute but are less vital. This section is intended to provide a better understanding of this issue. Furthermore, in case of non-compliances, such knowledge would allow the assessment of where corrective actions by the Commission would be most effective. The section covers:

- Operator's obligations (notification, major accident prevention policy, safety management systems, safety plans, internal emergency plans);
- Competent authorities' obligations (external emergency plans, inspection, land-use planning); and
- Citizen's rights (public information, participation in decision making, access to justice).

Consideration is also given to whether there are other drivers, not included in the Seveso-III-Directive, that play a noteworthy role. Where it turns out that it is currently not possible to fully understand the drivers, solid proposals are included on how to close knowledge gaps.

In order to achieve these objectives, our methodology relied on the combination of three sources of knowledge:

- Feedback from the online survey from various categories of stakeholders, especially representatives of Member States.
- Safety experts familiar with Seveso Directive's mechanisms and their impact on risk levels.
- Literature analysis regarding technical, regulatory and more globally societal mechanisms having a significant impact on final levels of industrial risks.

5.2 Results on key drivers identification through the questionnaire

The individual ability of the various provisions of the Seveso III Directive to impact final level of risks has been approached in the questionnaire through a quantitative scale distinguishing 5 levels (1 to 5). The respondents were asked to provide their personal assessment on the relative contribution of each provision to achieve the directive's objectives. The average scoring of each assessed disposition is given in the table below.

Table 5.1 Respondents scoring of the various Directive's provisions (indicators) with regard to their individual contribution to risk reduction and the Directive's objectives

	Notification system	MAPP	SMS	Safety report	Internal emergency planning	External emergency	Inspection	LUP	Public information	Public participation	Access to justice
Member States (22 responses)	4.1	4	4.4	4.6	4.6	4.5	4.7	4.5	3.7	3.3	3.2
EU and other international organisations (5 responses)	4.2	3.8	5	4.6	4.8	4.6	4.4	4.6	4.2	4	3.4

Two comments can be made here:

- Member States responses are quite homogeneous in the sense that all technical and organisational provisions are believed to be important whereas elements pertaining to public participation are perceived as less useful¹⁵ in achieving the Directive's objectives. This aspect is particularly concerning if we know that important evolutions in EU and several national policies have taken the path of increasing public involvement in risk related policy making.
- Respondents from EU and international organisations have a more differentiated approach. MAPP is for instance an organisational arrangement for which impact on risk levels is perceived as low whereas SMS, safety reports, emergency planning and LUP receive the highest scores. Public involvement is quite positively rated although the issue of facilitating access to justice regarding environmental matters appears to raise scepticism.

At this stage, these elements require additional attention through interviews of experts and some representatives of these two categories of stakeholders, as well as further discussion at the stakeholder workshop.

5.3 Identification of key drivers through experts discussions and literature analysis

5.3.1 Overview

This section presents a complementary analysis based on internal discussions at INERIS combined with a literature review. We distinguish two categories of drivers, the first highlights within the Seveso Directive the provisions believed as having the most important impacts on the final levels of risks from major accidents. The sectors regulated under the Seveso Directive are also influenced by other drivers of different categories: technical, societal and regulatory. We therefore discuss these external drivers in a second distinct category.

5.3.2 Internal drivers of performance

High risk industrial systems are complex in the sense that they imply multiple layers – technical, human, organisational- and a large variety of stakeholders: inter alia industry, national and EU authorities, local

¹⁵ This can be nuanced by considering that stakeholders invited to the survey were technical experts, already familiar with technical provisions of the Directive.

communities, technical experts. A natural consequence of this complexity is the need for policy makers to rely for their intervention on a combination of complementary levers whose individual impacts are limited but whose combined effect is necessary to achieve required objectives.

The Seveso directive fully fits within this description as it relies on the following four complementary mechanisms:

- Improving industry's management of the risks that they generate.
- Deploying required mitigation measures including land use planning and emergency plans.
- Fostering public risk awareness and participation in decision making.
- Deploying competent and independent inspection authorities.

The following sections describe why each of these mechanisms is key for the directive's overall performances and how their respective impact on various aspects of the industrial system make them all of comparable importance.

Improving industry's management of the risks that they generate

No risk governance is possible without extensive knowledge of the risk scenarios generated at an establishment and the terms of their everyday management. This aspect is addressed by three provisions in the Seveso Directive:

- Safety reports identify risk scenarios and the appropriate safety barriers to reduce those risks to within acceptable limits. They are accordingly the first building block of every risk management process.
- The Major Accident Prevention Policy (MAPP) is a descriptive document listing the global orientations of the company regarding the issue of major risks.
- The Safety Management System structures the organisational efforts and responsibilities for addressing the list of risk scenarios and maintaining safety performance on a daily basis. The importance of SMS and associated organisational arrangements is well established in literature. For example, the JRC (Kawka and Kirchsteiger; 1999) have established that 66% of the major accidents reported to eMARS are caused by latent SMS failures and the deeper the failure the higher the consequences.

If safety reports and SMS are complementary in the sense that the second handles the risk scenarios identified by the first and both are of central importance, the MAPP remains a high-level document with little impact on the everyday practice of risk management. Accordingly, and with respect to this first mechanism, we recommend considering safety reports and SMS as key drivers of the directive performance.

Deploying required mitigation measures including land use planning and emergency plans

Land use planning and emergency plans are two provisions targeted at organising the way risks can be mitigated by means of improving cooperation between the industry and stakeholders. Indeed, land use planning aims to reduce population exposure to risks whilst emergency planning tackles the issue of optimising rescue services in case of accidents.

These mechanisms are key if one is to remember that despite all efforts, it remains out of human reach to exhaustively identify risk scenarios and prevent all possible technical, human and organisational factors from combining to produce a major accident.

Public awareness and participation to decision making

For land use planning and emergency plans to be effective, it is crucial to ensure full cooperation of local communities, including the general public but also local decision makers. For instance, reducing population concentration around Seveso plants comes at a price as it goes against the natural tendency of intensifying economic activities and reducing daily commute of workers. In order for this policy to be accepted and costs to be shared between the various stakeholders, it is necessary to deploy participative processes where risk awareness is raised and collective decisions are made making them accepted and legitimate.

Accordingly, and in contradiction with the feedback from stakeholders that rated public participation low as a key driver, we suggest allocating a similar level of importance as we have observed the impact of this mechanism in improving stakeholders' cooperation and public acceptance of Seveso related policies.

It is also worth recalling that this suggestion is in accordance with action 8 of the streamlining action plan discussed earlier and dedicated to the importance of further considering citizen sciences in environmental reporting.

Deploying competent and independent inspection authorities

Risk governance policies are built upon the principle of industries being responsible for their risks and authorities being in charge of controlling their compliance with regulation. Maintaining this balance in interactions between these two major actors is key for the success of the Seveso directive.

We discussed earlier how endowing inspection authorities with adequate level of resources and staffing is key for the Directive's implementation. In addition, literature already discusses the importance of further enriching the quality of inspection-industry interactions to improve the final levels of risks. Two key mechanisms are suggested:

- Jain et al (2017) emphasise the importance of further developing leading process indicators in order to serve as a basis for discussions and priority settings for both industry efforts and inspection themes. Such a mechanism has already proved its positive impacts for workplace safety where records of incidents have started to go down after reporting of dedicated indicators has become mandatory.
- In their paper on inspectors' abilities to correctly evaluate the risk levels of Seveso establishments, Lindhout and Reniers (2017) emphasize the importance of uniformity in the way inspections are conducted and the need for standard regulator appraisal methodologies. In other words, developing benchmarking on these aspects is expected to positively act on the final levels of risks.¹⁶

To summarise, we agree on the equal importance of a subset of the Directive's provisions being: safety reports, SMS, land use planning, public information and participation and finally inspections by authorities. We suggest considering the MAPP as a secondary priority for monitoring.

5.3.3 External drivers of performance

Complementary to the above, we discuss in the following a set of drivers that have a direct or indirect influence on the final levels of major risks in Seveso establishments

Evolution of external threats

Industrial systems are and will be experiencing an evolution of the external threats to which they may be exposed. A first category of emerging threats is the one resulting from climate change and the increase in

¹⁶ [https://pure.tudelft.nl/portal/en/publications/risk-validation-by-the-regulator-in-seveso-companies\(fe9e3b39-04af-472e-a59b-615384616a40\)/export.html](https://pure.tudelft.nl/portal/en/publications/risk-validation-by-the-regulator-in-seveso-companies(fe9e3b39-04af-472e-a59b-615384616a40)/export.html)

intense climatic episodes. Heatwaves, storms and flooding are expected to become important triggering events for which dedicated risk assessment and management methodologies are required. A second category of emerging threats is those relating to security issues, including cyber-attacks and terrorist attacks. Here again, the security of Seveso sites is already recognised as being of increased importance.

Economic dynamics

Economic globalisation has the potential to produce negative effects on the management of Seveso plants. Indeed, like any other economic good, Seveso plants have become tradable goods to which formulae for rapid profitability, standardisation of practices, high personnel turnover or subcontracting are applied. Unfortunately, maintaining high levels of process safety performance requires the exact inverse: stability in personnel and practices, favouring long term profitability and investments, acknowledging specific safety cultures and valuing internal knowledge developed through experience.

These economic trends are therefore to be acknowledged as negative drivers of industrial risk levels.

Process vs occupational safety

In a recent event organised by INERIS, the head of the Environment Health and Safety department of an international company revealed that 90% of his reporting to the executive board was focused on occupational safety and only 10% on process safety¹⁷. This reflects the strong occupational safety regulation, the mandatory reporting of dedicated indicators (lost time or fatal accident rate), fear of litigation and certain reputation competitiveness among companies, positively enhanced by the Responsible Care commitment (Jain et al, 2017). A striking illustration of this tendency was the BP Texas City accident revealing how the refinery EHS was managed using only occupational health indicators whilst no management attention was given to several process safety incidents.

Accordingly, enhancing the deployment of process safety dedicated management tools, including process safety indicators, is a key driver that should help improving industry's capability to handle technical and organisational latent dynamics leading to major accidents.

Improve industrial appropriation of scientific development

Reinforcing the ability of the academic world to get a better grasp of industrial needs whilst inviting the European industry to further engage in research and development partnerships dedicated to all aspects of process safety should highly improve the industry capabilities to master their risks and consequently, improve their performances.

Other external drivers

Additional drivers should be considered in more details and include the effect from other environmental legislation, such as the Industrial Emissions Directive, the Environmental Liability Directive, occupational safety legislation for chemicals. Non-legislative drivers are also important, in particular international guidelines and standardisation process (e.g. ISO, CBRM) and the role of insurance. We propose to gather feedback from stakeholders on these during the workshop.

5.4 State of play and further work to be completed

The discussion above combines questionnaire responses and expert analysis to provide a set of key performance drivers for the Seveso directive. This work is expected to lay the grounds for a more in depth discussion during the forthcoming stakeholders' workshop.

¹⁷ While there can be some overlap between process and occupational safety, the distinction is that occupational safety focuses on personal safety, while the process safety considers humans, the environment and the business. <https://ichemeblog.org/2014/11/09/ten-differences-between-process-safety-and-occupational-safety-day-166/>

6. Review of socio-economic impacts of major accidents

6.1 Overview

While the current reporting framework for major accidents is primarily focused on the prevention of major accidents, it also has the objective of limiting the impact of major accidents should they occur. Currently, the accident reports often include limited information on the impact of an accident, and typically only information about immediate impacts such as fatalities and insured damage. Where information on environmental damage or socio-economic impacts is provided, it is often not provided in a structured or consistent manner, which makes analysis difficult.

The aim of this section is to present the information gathered following an investigation of the information available on socio-economic impacts of major accidents. Information was sought through the stakeholder consultation, but also through review of literature and alternative data sources. This section also discusses the responses received from the stakeholder consultation on the extent to which the European Scale of Industrial Accidents (ESIA) is used by Member States to report on the socio-economic impacts of major accidents, and the obstacles in the way of its widespread use.

6.2 Review of available information on socio-economic impact of major accidents

A review of the literature available was undertaken to identify information on socio-economic impacts of major accidents. There is very little literature taking an overall view on socio-economic impacts of major accidents, but rather the literature mainly comprises articles focusing on specific individual accidents and incidents. Our review focused on the following aspects: whether quantification of costs was available, what costs were taken into account and what impact on communities and mental health was mentioned.

In addition to the literature below, a report has very recently been published by the OECD¹⁸ and appear very relevant to this project. It will be reviewed and considered in the next stage of the project.

A summary of the type of costs mentioned in the reviewed reports is presented in the table below, while an extended version is presented in Appendix B.

Table 6.1 Summary of costs information identified in literature

Document title	Type of costs covered
Handbook for Estimating the Socio-economic and Environmental Effects of Disasters, 2003, European Commission for Latin America and the Caribbean (ECLAC)¹⁹	<ul style="list-style-type: none"> • 2nd section: methods for estimating damage and losses to social sectors, with separate chapters on housing and human settlements, education and culture, and health • 3rd section: Services and physical infrastructure, including chapters on transport and communications; energy; and water and sanitation • 4th section: damages and losses to productive sectors, with separate

¹⁸ OECD Reviews of Risk Management Policies - Assessing the Real Cost of Disasters - The Need for Better Evidence <https://www.oecd-ilibrary.org/docserver/9789264298798-en.pdf?expires=1528714971&id=id&accname=id24042&checksum=0CED623EDF4466C1964B49F94186B079>

¹⁹ https://repositorio.cepal.org/bitstream/handle/11362/2782/S2003701_en.pdf;jsessionid=1EE20DF9E2F0EF091A988C4E623AF3BE?sequence=1

Document title	Type of costs covered
	<ul style="list-style-type: none"> chapters on agriculture and fisheries, industry, trade and tourism 5th section: Overall, cross-sectoral and macroeconomic effects, with separate chapters on environmental damages, the differential effect of the disaster on women, the impact on employment and income, a damage overview that provides a procedure for calculating total direct and indirect losses, and the effects of the disaster on the main macroeconomic aggregates
Modelling the economic impacts of an accident at major hazard sites, 2015, UK, Health and Safety Executive²⁰	<ul style="list-style-type: none"> Harm to people (non-financial human costs and financial costs) Evacuation (immediate and long-term) Building damage (residential and non-residential) Business disruption (loss of business and relocation) Emergency services
Modelling the human and economic costs of major industrial accidents, 2016, Aldridge et al²¹	<ul style="list-style-type: none"> Causality impacts Disruption and temporary relocation of businesses Building damage Evacuation and emergency service requirements
The cost of reputational damage when a major accident occurs, 2015, Kyaw et al²²	<ul style="list-style-type: none"> Cost of reputational damage following an accident
Impacts of Major Offshore Oil Spill Incidents on Petroleum Industry and Regional Economy, 2017, Taleghani et al²³	<ul style="list-style-type: none"> Negative impact on occupations, incomes, tariffs, and profits, costs by clean-up activities Positive impact of economic compensation on employment and wages
COCO-2: A Model to Assess the Economic Impact of an Accident, 2008, Health Protection Agency²⁴	<ul style="list-style-type: none"> Indirect losses that stem from directly affected businesses losses due to changes in tourism consumption recovery after an accident and health costs
The Buncefield Incident 11 December 2005: The final report of the Major Incident Investigation Board, Volume 1, 2005, Buncefield Major Incident Investigation Board²⁵	<ul style="list-style-type: none"> Summary of the economic impact of the incident, comprising of compensation for loss, cost to the aviation sector, emergency response and the costs of the investigations Simple calculations of the range of costs for implementing recommendations for avoiding overfilling tanks with petrol
A Socio-Economic Cost Assessment Regarding Damages to Underground Infrastructures, 2013, Cirano²⁶	<ul style="list-style-type: none"> Damage related to indirect costs to underground infrastructure
Marsh Largest loss in the hydrocarbon industry²⁷	<ul style="list-style-type: none"> Review of largest business interruption claims for Business interruption insurance Property losses

²⁰ <http://www.hse.gov.uk/research/rrpdf/rr1055.pdf>

²¹ <https://www.scopus.com/record/display.uri?eid=2-s2.0-84979502160&origin=resultslist&sort=r-f&src=s&st1=Industrial+accidents+impacts&nlo=&nlr=&nls=&sid=2d238d6b787fb283c60d5d0b05ac6c2d&sot=b&sdt=b&sl=43&s=TITLE-ABS-KEY%28Industrial+accidents+impacts%29&relpos=8&citeCnt=0&searchTerm=>

²² <https://www.scopus.com/record/display.uri?eid=2-s2.0-84958999601&origin=resultslist&sort=r-f&src=s&st1=Industrial+accidents+economic+impacts&st2=&sid=429361f08983ec7a7749b66b7f80ced6&sot=b&sdt=b&sl=52&s=TITLE-ABS-KEY%28Industrial+accidents+economic+impacts%29&relpos=12&citeCnt=5&searchTerm=>

²³ <https://www.scopus.com/record/display.uri?eid=2-s2.0-85010207334&origin=resultslist&sort=r-f&src=s&st1=Industrial+disasters+social+impacts&st2=&sid=718600bf9b6d3f560bc971a4d733d6cc&sot=b&sdt=b&sl=50&s=TITLE-ABS-KEY%28Industrial+disasters+social+impacts%29&relpos=2&citeCnt=1&searchTerm=>

²⁴ https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/415529/HPA-RPD-046_for_website.pdf

²⁵ <http://www.hse.gov.uk/comah/buncefield/miib-final-volume1.pdf>

²⁶ https://www.scga.ca/files/2013Socio_Economic_Cost_Assessment.pdf

²⁷ <https://www.marsh.com/us/insights/research/the-100-largest-losses-in-the-hydrocarbon-industry-1974-2015.html>

Document title	Type of costs covered
Corrosion-related accidents in refineries, lessons learned from accidents, JRC²⁸	<ul style="list-style-type: none"> Review of costs reported from accidents in refineries including environmental clean-up and restoration costs

A summary of the type of impacts on community and mental health in the reviewed reports is presented in the table below, while an extended version is presented in Appendix B.

Table 6.2 Summary of community and mental health impacts identified in literature

Document title	Type of impacts covered
A study of posttraumatic disorders in children who experienced an industrial disaster in the Briey region²⁹	<ul style="list-style-type: none"> Post traumatic disorders in children who were directly or indirectly involved in an industrial disaster Assessment of the respective impact of traumatic exposure, parental disorders and sociodemographic variables on the post traumatic disorders of children Anxiety, trauma
The aftermath of an industrial disaster³⁰	<ul style="list-style-type: none"> The relationship between objective stressors, the workers' own feelings and the reaction of their families after the explosion and a review of the training, attitude to the workplace, general outlook and received crisis support Traumatisation, coping style and crisis support was assessed
Chernobyl's Legacy: Health, Environmental and Socio-Economic Impacts and Recommendations to the Governments of Belarus, the Russian Federation and Ukraine³¹	<ul style="list-style-type: none"> Radiation exposure Deaths due to acute radiation syndrome (ARS) Cancer mortality Leukaemia, Solid Cancers and Circulatory Diseases Reproductive defects Persistent psychological and mental health problems resulting from rapid relocation, breakdown in social contacts, fear and anxiety about health effects Release and deposit of radioactive material Agriculture, aquatic and forest contamination Economic cost related to response and health care to affected population, radiation monitoring, radioecological improvement of settlements and disposal of radioactive waste Impact on local economy Impact on local communities
Psychological effects of a disastrous hydrogen fluoride spillage on the local community³²	<ul style="list-style-type: none"> Psychological effects of hydrogen fluoride spill on members of the community and their relationships with physical symptoms and changes in psychological effects occurring as time passed after the accident Anxiety levels

²⁸ <https://minerva.jrc.ec.europa.eu/EN/content/minerva/51beddd7-1149-4230-928d-a225bf39471a/tr01corrosionrefineriespdf>

²⁹ <https://www.scopus.com/record/display.uri?eid=2-s2.0-0035057789&origin=resultslist&sort=r-f&src=s&st1=Industrial+disasters+social+impacts&st2=&sid=718600bf9b6d3f560bc971a4d733d6cc&sot=b&sdt=b&sl=50&s=TITLE-ABS-KEY%28Industrial+disasters+social+impacts%29&relpos=11&citeCnt=48&searchTerm=>

³⁰ <https://www.scopus.com/record/display.uri?eid=2-s2.0-0030629222&origin=resultslist&sort=r-f&src=s&st1=Industrial+disasters+social+impacts&nlo=&nlr=&nls=&sid=718600bf9b6d3f560bc971a4d733d6cc&sot=b&sdt=b&sl=50&s=TITLE-ABS-KEY%28Industrial+disasters+social+impacts%29&relpos=21&citeCnt=27&searchTerm=>

³¹ <https://www.iaea.org/sites/default/files/chernobyl.pdf>

³² <https://www.scopus.com/record/display.uri?eid=2-s2.0-85029361085&origin=resultslist&sort=plf-f&src=s&st1=industrial+accident+psychological+impact&st2=&sid=4698475b33ef3704506f56eda27489e3&sot=b&sdt=b&sl=55&s=TITLE-ABS-KEY%28industrial+accident+psychological+impact%29&relpos=4&citeCnt=0&searchTerm=>

Document title	Type of impacts covered
An industrial disaster. Disaster behaviour and posttraumatic stress reactions³³	<ul style="list-style-type: none"> Acute, subacute, prolonged and chronic posttraumatic stress reactions to disaster trauma
Possible risk factors for acute stress disorder and post-traumatic stress disorder after an industrial explosion³⁴	<ul style="list-style-type: none"> The prevalence of acute stress disorder (ASD) and post traumatic stress disorder (PTSD) following an industrial explosion The variables which can be the risk factors for PTSD
Immediate psychological impact of the deepwater horizon oil spill: Symptoms of PTSD and coping skills³⁵	<ul style="list-style-type: none"> Psychological impact and coping styles of the Deepwater Horizon Oil Spill on Gulf Coast residents
Mental health of workers in Toulouse 2 years after the industrial AZF disaster: First results of a longitudinal follow-up of 3,000 people³⁶	<ul style="list-style-type: none"> Association between various factors describing exposure to the disaster and anxiety and depressive symptoms Psychological distress The study revealed links between the industrial disaster and psychological distress 2 years afterwards. The results about risk factors differ according to sex, and identify particularly vulnerable populations. It should guide preventive interventions in such situation.

The survey of stakeholders attempted to identify the categories of socio economic impacts to consider. Industry stakeholders provided the following as an indication of what could be considered: costs to the establishment compared to the gains of the industry (as a % of the turnover for example), direct damage, fatalities, injuries, reputational damage, damage propagation to external stakeholders, time/spatial damage, recovery time, lost functionality.

In a second step a review of the costs presented in databases was conducted both in the EU and beyond. The search was extended as, amongst EU Member States, it appears to be only one Member State with such information presented in a database (France). Furthermore, three Member States indicated that work is in progress in order to gather this information in a more systematic manner (Estonia, Hungary and the UK).

The following databases include information on socio-economic impacts of accidents:

- eMARS: the database managed by the JRC includes information on costs in some instances; however this is not always the case.
- ARIA³⁷: French Ministry of Ecology, Energy, Sustainable Development listing the accidental events which have, or could have, damaged health or public safety, agriculture, nature or the environment. The reporting is done using the European Scale of Industrial Accidents (ESIA)

³³ <https://www.scopus.com/record/display.uri?eid=2-s2.0-0023059805&origin=resultslist&sort=plf-f&src=s&st1=industrial+accident+psychological+impact&nlo=&nlr=&nls=&sid=4698475b33ef3704506f56eda27489e3&sot=b&sdt=b&sl=55&s=TITLE-ABS-KEY%28industrial+accident+psychological+impact%29&relpos=50&citeCnt=6&searchTerm=>

³⁴ <https://www.scopus.com/record/display.uri?eid=2-s2.0-84897050877&origin=resultslist&sort=plf-f&src=s&st1=industrial+disaster+post+traumatic+&st2=&sid=3c384830d6f4957c3f71c256083af6d4&sot=b&sdt=b&sl=50&s=TITLE-ABS-KEY%28industrial+disaster+post+traumatic+%29&relpos=6&citeCnt=1&searchTerm=>

³⁵ <https://www.scopus.com/record/display.uri?eid=2-s2.0-84865269758&origin=resultslist&sort=plf-f&src=s&st1=industrial+disaster+post+traumatic+&st2=&sid=3c384830d6f4957c3f71c256083af6d4&sot=b&sdt=b&sl=50&s=TITLE-ABS-KEY%28industrial+disaster+post+traumatic+%29&relpos=9&citeCnt=11&searchTerm=>

³⁶ <https://www.scopus.com/record/display.uri?eid=2-s2.0-69849104306&origin=resultslist&sort=plf-f&src=s&st1=industrial+disaster+post+traumatic+&st2=&sid=3c384830d6f4957c3f71c256083af6d4&sot=b&sdt=b&sl=50&s=TITLE-ABS-KEY%28industrial+disaster+post+traumatic+%29&relpos=16&citeCnt=8&searchTerm=>

³⁷ <https://www.aria.developpement-durable.gouv.fr/the-barpi/the-aria-database/?lang=en>

which assesses economic consequences. Some of the detailed reports include quantification of costs of accidents.

- JST Failure Knowledge database³⁸: managed by the Japan Science and Technology Agency; it includes quantification of costs of some accidents, including remediation, social impacts including loss of reputation.
- ZEMA database: managed by the German Federal Environmental Agency, includes information on costs from property and environmental damages inside and outside the establishment³⁹.

6.3 Review of socio-economic impacts of major accidents

6.3.1 Overview

In order to review in more detail socio-economic impacts of major accidents, a report on impacts of major accidents from corrosion in refineries was reviewed, along with the eMARS and ARIA database. The focus on refineries is opportunistic and due to the fact that an in-depth study had been done for that sector by the MAHB. While representative of a large sector of industries under the scope of the Directive, the refinery sector is not the only one and other sectors are addressed in following sections based on our analysis of databases.

6.3.2 Impacts of major accidents due to corrosion in refineries

Refineries form an important category of Seveso establishments. In 2014 a total of 142 Seveso establishments were categorised as 'petrochemical, refineries'.

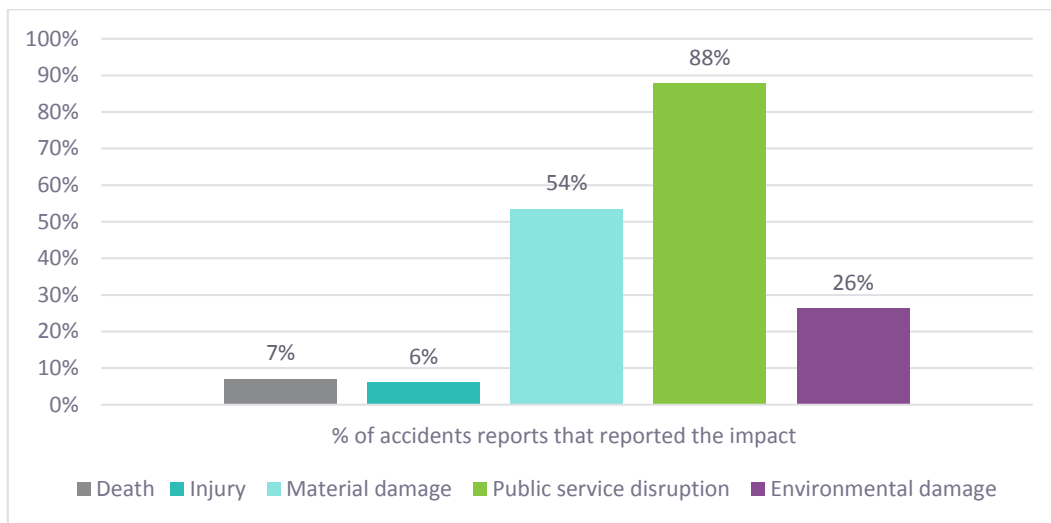
The Joint Research Centre conducted a study of corrosion-related accidents in refineries in EU and OECD countries since 1984 and based on 99 reports of important refinery accidents in which corrosion of equipment was identified as the reason leading to the accident event⁴⁰. The study identified five main impacts resulting from an accident event, namely: deaths, injuries, material damage, environmental damage and public service disruption. Based on the data from the reports, public service disruption and material damage was the most commonly reported impact. Nearly 88% of the accident reports reviewed reported some form of public service disruption resulting from the accident, and 54% reported on resulting material damage.

³⁸ <http://www.shippai.org/fkd/en/cfen/CC1000030.html>

³⁹ <http://www.infosis.uba.de/index.php/de/site/12981/zema/index.htm>

⁴⁰ <https://minerva.jrc.ec.europa.eu/EN/content/minerva/51beddd7-1149-4230-928d-a225bf39471a/tr01corrosionrefineriespdf>

Figure 6.1 Proportion of reviewed accident reports reporting on the five main accident impacts



To evaluate the severity of each of these impacts, the study developed a consequence ranking criteria methodology based on the European Scale of Industrial Accidents. For material and environmental damage, the level of impact was assessed using a logarithmic scale from Low to High for costs starting with < €10,000. Human consequences, production loss and public disruption was approximated using the European Scale of Industrial Accidents, condensed into 5 categories. These consequence ranking criteria developed by the JRC are shown in Table 6.3 .

Table 6.3 Consequence ranking criteria developed based on the European Scale of Industrial Accidents

	Deaths	Injuries	Material Damage	Environmental Damage	Public Service Disruption
Very High	>100	>1000	>€ 1,000,000	€ 1,000,000	>1 month
High	11-100	101 – 1000	€ 100,001-1,000,000	€ 100,001-1,000,000	1 week to 1 month
Medium	0-10	11-100	€ 10,001-100,000	€ 10,001-100,000	1 day to 1 week
Low	0	1-10	€ 1-10,000	€ 1-10,000	>1 day
None	0	0	0	0	0

Source: JRC, 2013, Corrosion-Related Accidents in petroleum Refineries

Material and environmental damage

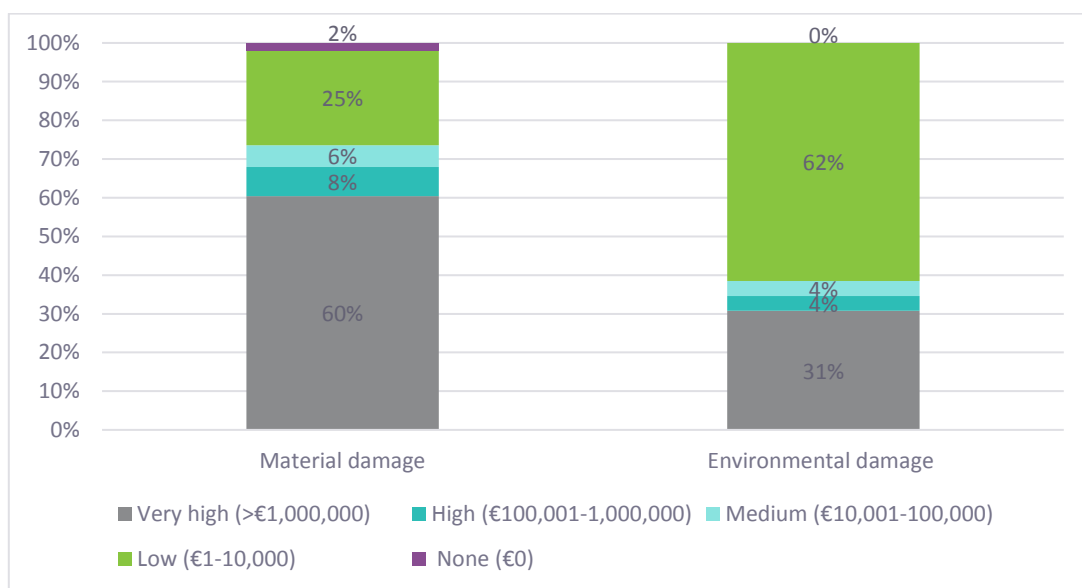
Material and environmental damage were the next most commonly reported impacts of accident events, each reported in 54% and 26% of the reviewed accident reports respectively.

Nearly 60% of the accidents which reported on material damage, resulted in the most severe category of material damage, i.e. incurring costs greater than €1,000,000. A quarter of the reviewed accidents resulted in a "low" level of material damage, incurring costs in the range of €1-10,000. Only 2% of the reviewed accidents resulted in no material damage.

Nearly a third of the accident reports that reported on environmental damage resulted in a “very high” level of damage, i.e. greater than €1,000,000. The vast majority of the accidents (62%) that resulted in environmental damage incurred costs in the range of €1-10,000. None of the accident reports reported no environmental damage.

The total material costs of the refinery accidents since 1984 reported was €748,386,332, whereas the total environmental restoration and clean-up costs was estimated to be €698,615,706. When considering this figure it is important to consider that this is only a partial picture as the completeness of the reporting since 1984 has varied. For comparison purpose, the Buncefield major accident has been estimated to cost €1.3 billion⁴¹.

Figure 6.2 Proportion of reviewed accident reports reporting on material and environmental damage of varying severity



Death and injury

Death and injury was the least reported impact, reported by only 8% and 18% of the reviewed accident reports respectively.

A total of 67 deaths and 219 injuries were reported in all the reports, with two accidents accounting for the majority of the deaths and injuries.

6.3.3 Impacts of major accidents in top 3 establishments' activities

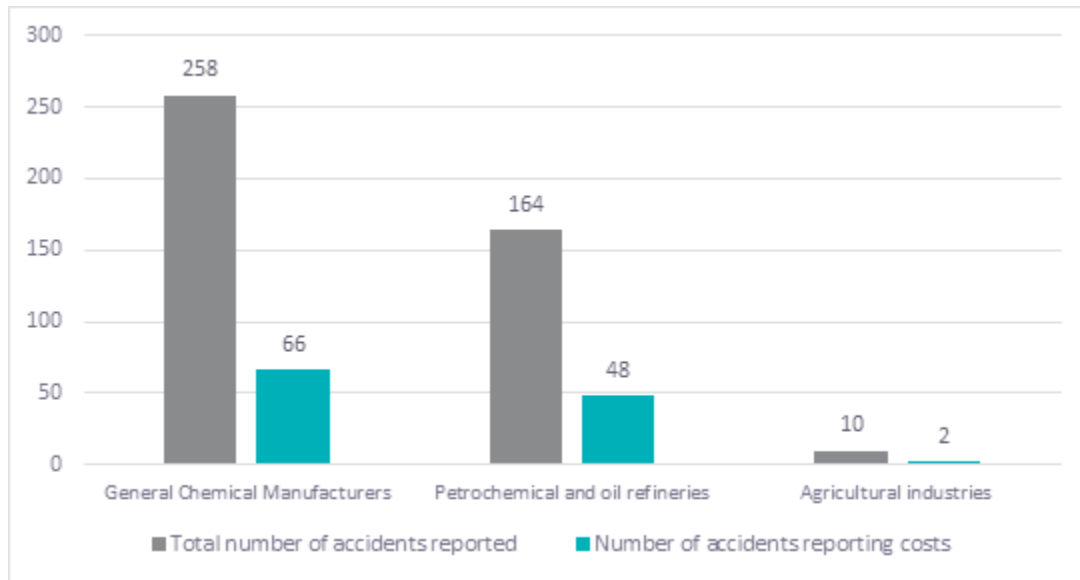
eMARS is the official reporting database for submitting accident reports to the European Commission based on the criteria set out in the Seveso III Directive. Currently, the database holds information on over 700 accidents and near misses since 1982 from across the Member States. The information contained within the database includes accident description, involved substances, causes and consequences of the accident, lessons learnt etc. although the extent of information provided varies from case to case.

A review of the accident reports submitted by general chemical manufacturers, petrochemical and oil refineries and agricultural industries⁴² found that less than a third of the reports in each case reported on the costs incurred due to the accident.

⁴¹ <http://www.hse.gov.uk/comah/buncefield/miib-final-volume1.pdf>

⁴² These three categories were selected as covering a large number of establishments but also representing a range of different activities.

Figure 6.3 Total number of accidents reported and the proportion of reports providing cost data



Out of the three industries, the most accidents were reported by general chemical manufacturers, followed by the petrochemicals industry and lastly by the agricultural industry.

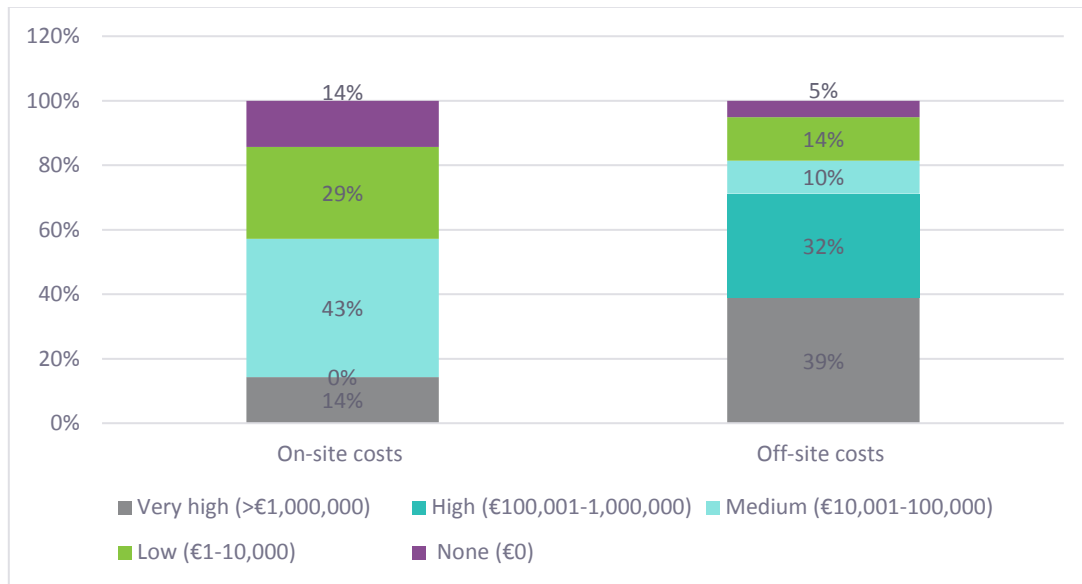
General chemical manufacturers

A total 258 accident reports were submitted by general chemical manufacturers, out of which only 66 provided data on costs. When inputting data on an accident event, eMARS requests operators to provide information on on-site and off-site costs incurred following the accident. These costs arise as a result of material losses, response, clean-up, restoration costs and other reasons.

Of the accident reports that included information on costs, 11% included information on on-site costs, whereas almost 90% included information on off-site costs. This could be because the bulk of the costs incurred were off-site or possibly because there is a reluctance to divulge data for on-site costs.

To evaluate the severity of the costs reported, the Consequence Ranking Criteria methodology from Table 6.3 was applied.

Figure 6.4 Severity of on-site and off-site costs reported by general chemical manufacturers following an accident



Nearly 40% of the off-site costs reported within the accident reports submitted by general chemical manufacturers were of a “very high” level, i.e. greater than €1,000,000, and almost a third were of a “high” level, incurring costs in the range €100,001-1,000,000.

On the other hand, the majority of the on-site costs reported (43%) were of a “medium” level, i.e. within the range of €10,001-100,000. Only 14% of the on-site costs reported were of a “very high” level. Generally, the off-site costs incurred by general chemical manufacturers following an accident were greater than the on-site costs.

Petrochemicals and oil refineries

A total of 164 accidents were reported on the database by petrochemical and oil refineries, out of which only 48 reported on the costs incurred.

Similar to the case of general chemical manufacturers, the vast majority of the costs reported occurred off-site, with 90% reporting off-site costs and only 10% reporting on-site costs.

Furthermore, nearly 60% of the off-site costs reported were of a “very high” level, sustaining over €1,000,000 in damages. On the other hand, only 20% of the on-site costs reported were of a “very high” level. Most of the on-site costs reported were evenly split between the “medium” and “high” level, in the range from €10,001-1,000,000. Again, as in the case of general chemical manufactures, off-site costs were greater in number and of a higher severity than on-site costs.

Agricultural industries

Only 10 accident reports were submitted onto the database by agricultural industries, out of which only 2 provided cost data. These two reports provided data on only off-site costs and no information on on-site costs was provided.

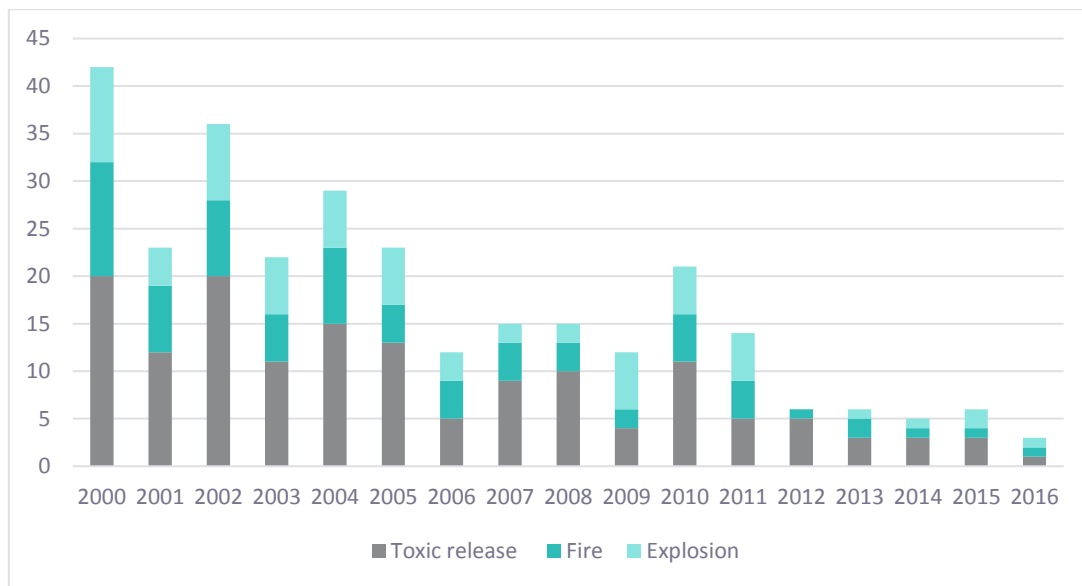
One accident report reported that no off-site costs were incurred, while the other reported off-site costs of €600,000, falling within the “high” level.

6.3.4 Impact of major accidents by type of accidents reported in the ARIA database

Based on the categories suggested in the Health and Safety Executive report from 2015⁴³, industrial accidents can be broadly grouped under three types of hazardous phenomena: fire, toxic release and explosion. These hazardous phenomena were mapped onto the ARIA database to assess the impact of major accidents by type of hazardous phenomena reported in the database.

The number of accident reports, falling under each of the three phenomena, submitted onto the database between the years 2000-2016 was as shown in Figure 6.5.

Figure 6.5 Number of accident reports per hazardous phenomenon submitted on the ARIA database between 2000-2016



Note: the declining trend observed is likely to be a reflexion on the time taken for major accidents and incidents to be fully reported rather than a decrease of these incidents

As can be seen from Figure 6.5, most of the accident reports submitted on the ARIA database across the years were related to toxic release of substances. This was followed by accidents related to fire for most of the years, although explosion related accidents were reported more often than fire related accidents in 2003, 2005, 2009, 2011 and 2015. It should be noted here that the number of accident reports submitted onto the ARIA database is not the same as the total number of accidents that occurred during this period.

In order to assess how the economic impact varies for these three types of accidents, average cost data per hazardous phenomenon was derived from the HSE report (Table 6.3). This cost data covers the costs related to harm to people, evacuation, building damage, business disruption and emergency services.

Table 6.4 Average cost data per accident type derived from data in the HSE report

Hazardous phenomenon	Toxic release	Fire	Explosion
Cost per site (€ million)	171	55	285

⁴³ HSE, 2015, Modelling the economic impacts of an accident at major hazard sites

In most cases, the average cost incurred by a site is greatest in the case of an explosion, followed by toxic release of substances and lastly by fire. The HSE report provides further details on the elements included in order to estimate costs for each of these phenomenon.

This average cost data per hazardous phenomenon was applied to the accident report numbers obtained from the ARIA database to assess how the economic impact varies by accident type. This is shown in Figure 6.6.

Figure 6.6 Total cost associated with hazardous phenomena involved in accident reported on the ARIA database (€ billion)



Across almost all the years, apart from 2009, 2011, 2015 and 2016, toxic release of substances resulted in the greatest cost. This is as expected because accidents related to toxic release were the most commonly reported on the ARIA database. For all the years, the cost incurred due to fire related accidents is the lowest. Here again, the decreasing trend in costs since 2010 is more of a reflexion on the lag due to reporting and estimating the consequences of these accidents than an indication on the reduction of accidents.

6.4 Scalability of alternative systems reporting socio-economic impacts of major accidents and synergies with EU system

The European Scale of Industrial Accidents (ESIA) was introduced by the Committee of Competent Authorities of the Member States in 1994 and is based on technical parameters designed to characterise the effects or consequences of accidents. While not applied at EU level, it is the basis of the ARIA database managed by the French authorities.

The scale is organised as follows.

Figure 6.7 European scale of industrial accidents as used by the ARIA database



As part of the stakeholder consultation, efforts were undertaken to identify obstacles to the adoption of the ESIA. In total there were 15 responses identifying obstacles to the adoption of the ESIA; 2 responses by EU and other international organisations; 10 responses from Member States; and 3 responses by Non-Member States. Responses were mixed with some Member States not using it (and not being aware of it), some using the ESIA for internal studies or for communication with others organisation and finally others using it to report on socio-economic impacts of major accidents. All expressed difficulties with getting cost information and doubts in the fact that data that would be obtained would be comparable. One highlighted that when there is no data on costs (i.e. unknown) the ESIA portrays this as no costs, which is counter intuitive. Industry representatives were more positive on the potential use of ESIA while it was noted that adjustments would be needed (e.g. to match internal accounting systems). As such a Technical Working Group could be set up to work on the modernisation of the scale and prepare it to be adopted at EU level.

While there seems to be mixed opinions on the use of ESIA at European level, partly due to a lack of familiarity and knowledge with the scale, a possible development could be to develop guidance on quantifying and reporting socio-economic impacts from major accidents.

Some comments highlighted general difficulties with reporting socio-economic impacts of accidents, in particular that the impacts can take a long time to be visible. It was also highlighted that Member States have different systems for accounting for these impacts which might not be directly comparable. However, these issues should not prevent efforts to further the understanding of reporting socio-economic impacts of accidents and valuable information could be obtained from the range of approaches adopted by Member States.

Exchanges were held with the representative of the insurance sector in Europe and it appears that wider socio-economic impacts of major accidents beyond likely claims for damage costs are not specifically considered by the insurance sector yet. A review of the approach presented by Lloyd's⁴⁴ seemed to indicate that pollution clean-up is not usually included in insurance policies, or are covered by specific additional policies. Potential damages are estimated based on e.g. vapour cloud explosion simulation for physical damage. Environmental damages appear to be assessed separately by environmental liability underwriters, however the focus seems to be on legal pay-outs from the incident rather than the physical damages themselves. The Lloyd's disaster scenario specification for 2017⁴⁵ includes reference to an industrial accident of release of chlorine from an industrial site. The scenario recommend developing a physical model of the incident, assuming area and populations affected and the effects of chlorine (as an example). It does not address specific environmental aspects under this scenario. A review of literature identified only a report from 1986 on the topic⁴⁶.

6.5 State of play and further work to be completed

The work completed so far has addressed most of the requirements of the task. The content will be updated with any additional information identified during the workshop and the review of the report from the OECD.

The last step of this task will be to extract costs data from the ARIA database and compare these to the estimated costs and those included in the eMARS in order to provide a broad estimate of the magnitude of costs that major accidents are triggering.

We propose to invite the French Competent Authority to present their database and the use of the ESIA to participants at the project workshop, as a basis for discussion on how to generate and exchange information on socio-economic impacts of accidents.

⁴⁴ <https://www.lloyds.com/>

⁴⁵ <https://www.lloyds.com/market-resources/underwriting/realistic-disaster-scenarios-rds/scenario-specification-2017>

⁴⁶ Insuring and Managing Hazardous Risks: Seveso to Bhopal and beyond, April 1986 <http://pure.iiasa.ac.at/id/eprint/2776/1/ER-86-011.pdf>

7. Initial work on development of indicators for monitoring of the Seveso III Directive

7.1 Overview

The objective of this section is to present our initial work on indicators for monitoring the Seveso III Directive. The online survey sent to the different types of stakeholders (Industry, Member States, Non Member States, EU) from February to March 2018, had dedicated sections on establishing monitoring indicators (Part 6) and flagship indicators (Part 7). In this section, a preliminary analysis from the online questionnaire in respect to the development of indicators to monitor the Seveso III Directive is made. In addition, an introduction to the development of composite indicators to compare country performance in policy analysis and public communication is provided.

7.2 Establishing indicators

The aim of this part of the survey was to identify suitable indicators that allow monitoring and assessing of the performance of the Seveso-III-Directive. Views were requested, in particular:

- OECD Guidance on Safety Performance Indicators⁴⁷;
- Work conducted by the Disaster Risk Reduction Management Knowledge Centre on Sendai indicators and disaster loss data⁴⁸; and
- Sustainable Development Goals Indicators⁴⁹.

The views expressed in the survey are summarised below:

- The current OECD Safety Performance Indicators are largely for sites, and since they are not harmonized through the EU, they might not fit policy indicators directly. However, Safety Performance Indicators provide useful information which could be used to build policy indicators.
- The Sendai Indicators and the Sustainable Goals Indicator are broadly designed and most of them are not applicable to chemical accidents where progress is defined by more frequent unreported accidents with localised effects.

As such these indicators sets were not identified as useful for the purpose of this project.

The majority of the respondents agreed that the current Seveso related indicators used at the facilities level cannot be used to measure the effectiveness of the Directive in the prevention of chemical accidents, because the current Seveso Indicators:

- are not used to understand the consequences of accidents for people and the environment;
- do not provide enough information to judge whether the levels of safety have evolved along time;
- do not provide enough information to understand the implementation of lessons learn from previous accidents; and

⁴⁷ <http://www.oecd.org/env/ehs/chemical-accidents/guidanceonsafetyperformanceindicators.htm>

⁴⁸ <http://drmkc.jrc.ec.europa.eu/>

⁴⁹ <https://unstats.un.org/sdgs/indicators/indicators-list/>

- do not provide enough information to understand the implementation of the provisions on domino effect and land use planning.

Stakeholders were asked to indicate which type of Seveso related indicators they are currently using, and their answers listed the following indicators:

- Lost-time accidents / days away from work;
- Near misses and improvement suggestions;
- Serious Potential Incidents;
- French UIC indicators: Guide ICCA (International Council of Chemical Associations), March 2017⁵⁰;
- API⁵¹; and
- CEFIC⁵².

7.3 Flagship indicators

In order to allow for effective communication with regard to the degree of compliance, progress made in prevention of major accidents and risks to which citizens are exposed, a set of flagship indicators are to be developed. The survey attempted to identify if one or several flagship indicators could allow the following to be depicted in a simple manner:

- The overall degree of compliance with the Directive (over all requirements);
- The progress made in preventing major accidents and limiting their impact; and
- The average risk of a citizen being exposed to a major accident.

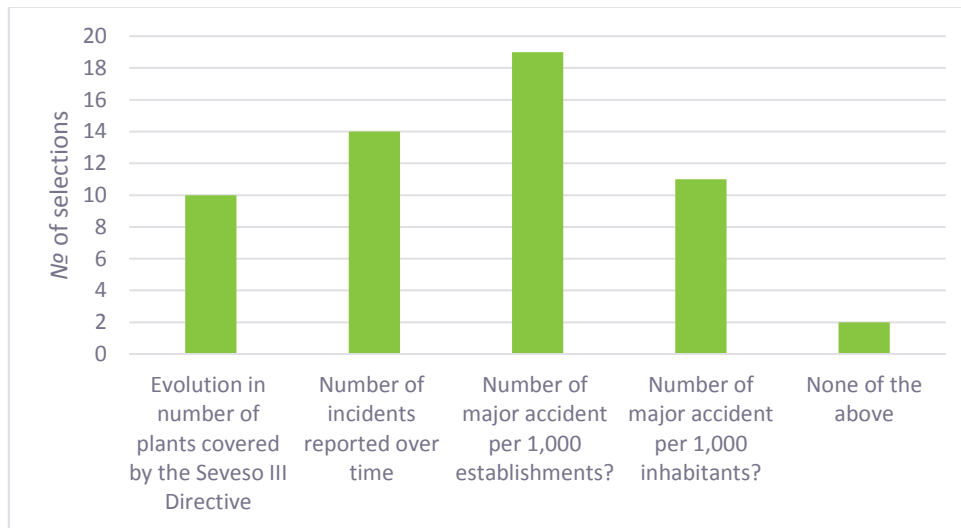
The answers from the respondents were not homogeneous. Some of the respondents did not agree with the development of flagship indicators (30%), the main reasons were related to the lack of relevant data about the progress in preventing major accidents (e.g. the number of accidents is small number to be statically meaningful). The other respondents (70%) selected one or more of the following indicators base of the suitability to communicate the effectiveness of the implementation (See Figure 7.1).

⁵⁰ <http://www.uic.fr/Actualites-et-publications/Publications/Guides-techniques/DT-118-Indicateurs-de-securite-des-procedes>

⁵¹ <http://www.api.org/oil-and-natural-gas/health-and-safety/process-safety/process-safety-standards/rp-754>

⁵² <http://www.cefic.org/Responsible-Care/Performance/>

Figure 7.1 Indicators best suited to communicate the effectiveness in the implementation of the Seveso Directive



It can be observed that most of the respondents agreed with communicating the effectiveness in the implementation of the Seveso III directive by using the above indicators. The indicator reflecting the number of major accidents per 1,000 establishments was considered appropriate by the most respondents. Other respondents considered that none of the mentioned indicators are suited to monitoring the implementation of the Directive, and that while the indicators listed provide useful information to the public, they are not indicating the success or effectiveness of the Seveso III Directive. Furthermore, some stated that including indicators per 1,000 inhabitants would be statistically meaningless, as the number of major accidents are too low and there is a large difference in industry density per region.

The following flagship indicators were suggested by the respondents of the survey:

- Number of major accidents per number of Seveso establishments;
- Number of major accident per inhabitants;
- The Norwegian Petroleum Safety Authority⁵³, has developed risk indicators to report major accidents such us:
 - ▶ Number of hydrocarbon leaks exceeding 0.1 kg/s;
 - ▶ Number Leaks exceeding 0.1 kg/s, normalised against working hours;
 - ▶ Number of serious incidents and incidents involving damage to structures;
 - ▶ Total indicator for major accidents per year;
 - ▶ Total indicator for major accidents per year, normalised against working hours;
 - ▶ Consequences for humans and the environment outside the establishment;
 - ▶ State of compliance, deviations found in inspections;
 - ▶ Total of socio-economic loss;
 - ▶ Environment affected by the accidents;

⁵³ <http://www.ptil.no/risk-level/category876.html>

- ▶ Damage to property; and
- ▶ Number of inhabitants living on endangered area (based on consequence analysis or take into account the iso-risk curves).

7.4 Development of composite indicators

Composite indicators have been developed by the OECD (the Statistics Directorate and the Directorate for Science, Technology and Industry) and the Econometrics and Applied Statistics Unit of the Joint Research Centre (JRC) of the European Commission⁵⁴. Composite indicators can be used to rank country performance over time in areas such as industrial competitiveness, sustainable development, globalisation and innovation. Composite Indicators are a useful tool in policy analysis and communication⁵⁵.

The OECD Glossary⁵⁶ defines: "A composite indicator is formed when individual indicators are compiled into a single index, on the basis of an underlying model of the multi-dimensional concept that is being measured".

In other words, composite indicators are mathematical combinations of a set of sub-indicators that have no common meaningful unit of measurement. As such Composite Indicators can facilitate an interpretation of the results. However, it is important to note that these indicators can also give a misleading message or wrong policy conclusions if they are poorly constructed or misinterpreted. A critical assessment evaluating pros and cons of composite indicators has been published by the OECD⁵⁷ and summarised in the table below:

Table 7.1 Pros and cons of composite indicators

Pros of Composite Indicators	Cons of Composite Indicators
<ul style="list-style-type: none"> • Allow complex or multi-dimensional issues to be summarised • Illustrate a country's performance • Judgements could be made on Countries' efficiency • Facilitate communication with citizens. • Benchmark of countries for best performance • Illustrate which countries represent the priority for improvement efforts 	<ul style="list-style-type: none"> • Provide misleading or non-robust policy messages • Provide simplistic conclusions • Higher data requirements • The outcome may reflect weak data in some dimensions • The outcome may ignore dimensions of performance that are not measurable

Source: OECD

Examples of composite indicators are provided below:

- Environmental Sustainability Index (ESI): The measure provides an indication of overall progress towards environmental sustainability. The measure is a composite profile of national stewardship based on a compilation of indicators from underlying datasets.

⁵⁴ <https://composite-indicators.jrc.ec.europa.eu/>

⁵⁵ Saltelli, A., Munda, G., Nardo, M. (2006). "From Complexity to Multi-dimensionality: the Role of Composite Indicators for Advocacy of EU Reform." *Tijdschrift voor Economie en Management*. Vol. LI, 3.

⁵⁶ OECD Glossary <http://stats.oecd.org/glossary/detail.asp?ID=6278>

⁵⁷ OECD (2008), *Handbook on Constructing Composite Indicators. Methodology and User Guide*. Paris: Organisation for Economic Co-operation and Development.

- Air Quality Index (AQI): This is a number used by government agencies to communicate to the public how polluted the air currently is or what the forecast is.
- Environmental Performance Index (EPI): Ranks 180 countries in regard to 24 performance indicators across 10 categories covering environmental health and ecosystem vitality. The metrics provide a measure at a national scale of how countries are to establish environmental policy goals.

7.4.1 Steps for building a composite indicator

The steps are as follows:

1. Theoretical framework: In this step the multidimensional phenomenon to be measured is defined. It provides the basis for the selection and the combination of variables into a meaningful composite indicator (involvement of experts and stakeholders is envisaged at this step).
2. Data Selection: In this step the quality of the available basic indicators will be checked, as well as its metadata. The selection is based on how the basic indicators were measured, country coverage and relevance.
3. Imputation of missing data: In this step an estimate of missing values will be made.
4. Multivariate analysis: In this step, the suitability of the dataset will be evaluated. The underlying structure of the data is checked along two main dimensions: individual indicators and countries.
5. Normalisation: This step is carried out to make the variables comparable.
6. Weighting and aggregation: The weighting and the aggregation procedures should be selected so that they respect the theoretical framework and the data properties.
7. Uncertainty and sensitivity analysis: This step will assess the robustness of the composite indicator and it will identify possible sources of uncertainty in the development of the composite indicators. The sensitivity analysis will later determine which of the uncertainties are more influential in the scores and/or ranks.
8. Back to the data: This step will check the correlations of the composite indicators. The results of the composite indicators might be dominated by only a few indicators.
9. Links to other indicators: The dimensions of the composite indicator should correlate with other simple or composite indicators.
10. Visualisation of the results: In this step the visualisation technique is chosen to communicate the composite indicators to the public. The communication should be clear and accurate.

7.5 State of play and further work

The answers from the survey to the development of basic indicators and flagship indicators for monitoring of Seveso III implementation are not homogenous. While 70% of the respondents agreed and proposed indicators for monitoring the Seveso directive, other respondents expressed disagreed. They argued that major accidents occur with very low frequency, and are potentially high consequence events, so the number of major accidents, cannot provide a reliable input for indicators or demonstration of trends. However, it was highlighted that the number past major accidents provided useful information and id to some extend a performance indication in the sense they show how much the EU has been able to reduce major accidents. In addition to that, the number of accidents and its root causes are helpful in giving visibility to encourage the vigilance over chemical accidents and to analyse what is driving risk over time.

The future work in developing policy indicators will explore the suitability of the indicators proposed by the respondents (e.g. the indicator reflecting the number of major accidents per 1,000 establishments) and identify what is needed to develop such indicators. Special attention will be given to the indicators published by Norwegian Petroleum Safety Authority, because as highlighted by the respondents to the survey, they provide a way to measure country effectiveness in HSE.

Policy indicators will be developed by identifying the following attributes:

- Evaluation Criteria based on the EU Better Regulation guidelines;
- Operational objective;
- Indicator name;
- Definition;
- Unit of measurement;
- Data source incl. data availability, and
- Frequency of measurement.

The proposed indicators in this chapter and its attributes are the basis for the discussion at the stakeholder workshop. The candidate indicators will be discussed in the workshop to identify whether the suggested metrics answer the final user needs and the available data input. Data providers, data users and stakeholders should agree upon the meaning and interpretation of the final set of indicators.

Once the basic policy indicators are defined, the development of flagship indicators will look at the guidelines for the development of composite indicators. Composite indicators have been used as a solution when there is a need to compare country performance over time of policy analysis. However, as described in chapter 7.4, there is a need to have reliable basic indicators linked to reliable and accurate metadata. According to the survey responses, obtaining such a data to build composite indicators for monitoring the Seveso III directive might have its own challenges.

8. Initial conclusions on improvements of monitoring under Seveso Directive

8.1 Overview

This section presents our initial conclusions on possible improvements at short term and long term based on the feedback received by stakeholders and our analysis. For each improvement identified, an associated action plan is presented.

8.2 Short term improvements

Short term improvements are those that can be made to affect the 2019-2023 reporting period⁵⁸. Considering the proximity of this period, any improvements which would substantively affect the way data is collected at Member State level is listed under long term improvements.

One short term improvement has been identified, concerning templates for reporting.

- **Improvement:** Modify the reporting template for numerical responses.
- **Description:** Change the reporting templates for quantitative responses to allow numerical data (e.g. number of establishments, external emergency plans tested, establishments inspected etc.) to be reported annually, thus allowing for variation of the number of establishments and the change in tier throughout the reporting period.)
- **Actions:**
 - ▶ DG Environment to check with SEG that this change would be definitely welcome and not create additional burden.
 - ▶ DG Environment to draft a new template.
 - ▶ DG Environment to update the reporting decision to include the new template.

8.3 Long term improvements

Most of the possible improvements identified are long term, as they either involve additional questions to be included in the implementation reporting, additional research areas or changes to the structure of the reporting. A total of 7 long term improvements have been preliminary identified and are described below. We expect further improvements to be identified and described in the next steps of the project.

Note that this list is provisional and will be further amended and completed based on feedback received at the workshop.

⁵⁸ Decision 2014/ 896/EU describes the information to be reported for the 2015-2018 period and every four year period following this. <https://publications.europa.eu/en/publication-detail/-/publication/7a13c3f3-81ca-11e4-89f7-01aa75ed71a1/language-en>

Table 8.1 Overview of the long term improvements and related actions

#	Improvement	Description	Actions
1	Further the reporting of near misses	Reporting of near misses is recognised as useful however many Member States do not report them. It could be through unavailability of the data but also wider misunderstanding of the possibility to do so as part of the existing framework.	DG Environment and MAHB to remind Member States that reporting of near misses is possible and encouraged through eMARS. DG Environment to set up a Technical Working Group to identify ways to define near misses, to draft guidance on identifying and reporting near misses. DG Environment to consult and share with Member States the results of the Technical Working Group work.
2	Modernising the EU Scale of Industrial Accidents	Linked to the issue of understanding and identifying near misses, the modernisation of the EU Scale of Industrial Accidents would be beneficial to allow a common understanding of assessing impacts of major accidents.	DG Environment to confirm with Member States interest for this action DG Environment to set up a Technical Working Group to identify ways in which the scale could be amended. Note should be taken of those Member States making use of it already (e.g. France). DG Environment to share with Member States the results of the Technical Working Group work. This could include a formal guidance on using the Scale.
3	Further understanding of socio- economic impacts of accidents	Further guidance and support is needed to improve the reporting of socio-economic impacts of major accidents; this requires additional work to understand the scale of the work necessary and the development of an EU wide methodology through a research project (e.g. FP 9).	DG Environment to agree funding and write terms of reference on a project for guidance and improvement of the reporting of socio-economic impacts of major accidents DG Environment could set a Technical Working Group to assist in the drafting task DG Environment to identify suitable support for research (e.g. FP 9 platform) DG Environment to send the request for services
4	Shorten the time for reporting major accident	Reducing the time delay for reporting in order to improve the process of learning lessons. It is important to note here that the delays in reporting is not something in control of the MAHB, however there is scope to encourage faster reporting.	Member States would be required to provide on a voluntary basis an initial notification of an accident within e.g. 1 month of the accident occurring, providing basic information for rapid information sharing. This would allow the MAHB to follow up on outstanding reports and advise Member States on preparing the report if necessary;

#	Improvement	Description	Actions
			In a second stage, Member States would be required to provide any complementary information in line with Article 18 at the latest one year of the date of the accident. Then, Member States would provide on a voluntary basis any update on the impact of an accident that become apparent only after the formal submission of the report (e.g. long term impacts).
5	Increasing synergies with existing reporting streams – reporting on establishments	The reporting on establishments could be streamlined and combined with the reporting on installations under the IED. The EEA is currently working on establishing an EU registry of industrial sites to which Seveso establishments could be reported. Exchanges with the EEA confirmed that this was technically possible but required some changes in practical ways of reporting (using EEA templates and data quality checks) that might in the first instance increase the burden at Member State level. This would diminish again once the systems are established.	DG Environment to consider options with the EEA on increasing synergies with reporting on establishments.
6	Increasing synergies with existing reporting streams – reporting on major accidents	The reporting on major accidents could be put in further context by taking account other chemical industry accidents from non-Seveso sites, including for example accidents reported under the Offshore Safety Directive or under the Extractive Waste Directive. These would allow an exchange of information between both databases but also such accidents could be reported into the eMARS database.	MAHB to comment on the possibility and adequacy of such accidents being included in the eMARS database DG Environment to engage with Member States to understand whether such reporting would be encouraged DG Environment to engage with colleagues in charge of legislation concerned to understand whether such synergies in reporting would be useful and supported If yes, include an additional filter in the database to indicate whether the event reported is from a Seveso establishment or not.
7	More substantive changes to the questions included in the questionnaire on implementation	A range of additional questions could be included in the implementation questionnaire including: Additional question on training of inspectors at national level; Additional question on deficiencies identified during inspections during the reporting period and steps taken to remedy these; Additional question on deficiencies identified during testing of emergency plans during the reporting period and steps taken to remedy these; Additional question on safety management systems; Additional questions related to the impact on land use planning (and hence reduction in risk); Further questions on communication to and awareness raising of the general public;	DG Environment to check with SEG that the additional questions would be welcome and not create disproportional additional burden; DG Environment to draft a new template; and DG Environment to update the reporting decision to include the new template.

#	Improvement	Description	Actions
		Information on prevention efforts made versus mitigation e.g. linked to sums invested (see Section 4); and Additional question on how socio economic impacts of major accidents are being considered and recorded in the Member States.	

9. Next steps

Remaining gaps identified will be addressed through the organisation of a 1-day workshop in Brussels and targeted interviews with selected stakeholders.

The planning for the workshop has been initiated, save the date emails and invitations were sent to potential participants

The next steps of the project will be to:

- Circulate the final interim report to participants at the workshop ahead of the day.
- For the workshop, prepare the agenda as well as preparing materials for the day. The objectives of the workshop are to review whether this monitoring system provides the right level and quality of information, whether other data should be collected to make it more relevant to the users and to identify better ways of monitoring and measuring the success achieved by the Directive. Amongst others, we will discuss the possibility of modernising the European Scale of Industrial Accidents and in that context how the reporting of near misses in the eMARS can be further facilitated; we will also discuss the key drivers for the performance of the Directive (i.e. those elements that contributes the most to the success of the Directive) and will attempt to identify related indicators that could be used to monitor the achievements of the Directive.
- Prior to the workshop, participants are requested to consider the content of this report including the improvements listed so that views on this can be shared.



Appendix A

Intervention logic

See Excel file appended







Appendix B

Literature review of wider impacts of major accidents

Document title	Summary of report	Summary of impacts reported	Impacts of establishment			Impacts for authorities/communities			Wide impacts		
			Direct damage	Subsequent business cost	Image	Physical health	Psychological health	Response cost	Follow-up cost	Environmental consequences	Socio-economic impact
Handbook for Estimating the Socio-economic and Environmental Effects of Disasters	The manual is a tool to assist stakeholders in identifying and quantifying damages from a disaster, through a uniform methodology and proven consistency in over three decades of implementation. It also provides the elements necessary to identify those social, economic, environmental and geographical regions that have been more concerned and that require priority in attention in the reconstruction phase.	<ul style="list-style-type: none"> •Deaths, injuries, response cost, cost of dealing with the injured, cost of health campaigns to prevent epidemics •macro-economic affects, in which disaster modifies performance of the main economic variables of the affected country, affect on GDP, impact on employment • population affected, deterioration in living standards, psychological harm such as depression, anxiety, • destruction of houses, Housing and human settlement vulnerability reduction, temporary housing, relocation 	✓	✓		✓	✓	✓	✓	✓	✓
Modelling the economic impacts of an accident at major hazard sites	This report documents the development, implementation and results of a model to estimate the economic costs of accidents at major hazard sites in Great Britain, focusing on the impacts of the accident, and taking into consideration a broad spectrum of losses. A catastrophe-modelling type approach was used to structure the work, based around model components for hazard, vulnerability and economic cost.	<ul style="list-style-type: none"> • Harm to people, evacuation, damage to buildings, loss of business, relocation of business, emergency services • Costs that are closely related to the accident and can be valued via the market, costs that are not closely related to the accident but can be valued via the market, costs that are closely related to the accident and are not valued in the market, costs that are not closely related and are not valued in the market • Accommodation and food costs, long term accommodation costs, emergency services and other public costs 	✓	✓	✓	✓	✓	✓		✓	



			Impacts of establishment	Impacts for authorities/communities	Wide impacts
		<ul style="list-style-type: none"> Health impacts include injuries and stress induced illness 			
<p>Modelling the human and economic costs of major industrial accidents</p>	<p>This paper presents the first attempt in Europe to model the costs of potential major accidents and produces estimates for GB via a collaborative effort between HSE and Cardiff Business School. This work will assist in continuing to ensure that the level of regulation remains proportionate for the level of risk. An innovative catastrophe modelling approach to estimate the costs of major accidents is presented. Emphasis has been placed on the novel application and re-use of available data sources and techniques. Monetised impacts comprise key direct and indirect effects including casualty impacts, disruption and temporary relocation of businesses, building damage, and evacuation and emergency service requirements.</p>	<ul style="list-style-type: none"> Monetised impacts comprise key direct and indirect effects including casualty impacts, disruption and temporary relocation of businesses, building damage, and evacuation and emergency service requirements. Populations more vulnerable to harm were identified, such as those in hospitals, care homes and childcare facilities. 	<p>✓ ✓</p>	<p>✓ ✓</p>	
<p>Mapping human vulnerability to chemical accidents in the vicinity of chemical industry parks</p>	<p>This paper concentrates on exploring the concepts of human vulnerability and the methodology of analyzing human vulnerability to chemical accidents in the vicinity of chemical industry parks. A conceptual model of human vulnerability to chemical accidents is developed, revealing the roots of human vulnerability and emphasizing its role in risk management. A geographical information system (GIS)-based methodology for mapping vulnerability is proposed and applied to the Nanjing Chemical Industry Park in China. By combining physical vulnerability and social vulnerability spatially, the total vulnerability is revealed to better respond to accidents. It is proposed to improve traffic lines and allocation of medical services, and include vulnerability assessment in land-use planning to reduce future risks. In other words, it seems feasible and effective to reveal physical, social and total vulnerability of residents in the vicinity of chemical risk sources.</p>	<ul style="list-style-type: none"> This paper concentrates on exploring the concepts of human vulnerability and the methodology of analyzing human vulnerability to chemical accidents in the vicinity of chemical industry parks. By combining physical vulnerability and social vulnerability spatially, the total vulnerability is revealed to better respond to accidents. 		<p>✓ ✓</p>	<p>✓</p>
<p>Relationships between impact on</p>	<p>The aims of this paper were (1) to analyze the prevalence of symptoms of post-traumatic stress disorder (S-PTSD) in a population of workers 1 year after an industrial disaster; and</p>	<ul style="list-style-type: none"> Symptoms of symptoms of post traumatic stress disorder (S-PTSD) in workers one year after an accident 		<p>✓</p>	<p>✓</p>



		Impacts of establishment	Impacts for authorities/communities	Wide impacts
employment, working conditions, socio-occupational categories and symptoms of post-traumatic stress disorder after the industrial disaster in Toulouse, France	(2) to assess the role of factors of vulnerability such as the occupational impact of a disaster and economic conditions.	<ul style="list-style-type: none"> Occupational impact of a disaster and economic conditions Impact on the workplace and socio-economic conditions were found to be associated with S-PTSD 		
Psychotropic drug use in a cohort of workers 4 years after an industrial disaster in France	Two years after the 2001 Toulouse industrial disaster, a longitudinal study was set up to evaluate the impact of the disaster. The current sub study examines the medium-term impact (5 years) the incident had on the mental health of 3,004 participants. As part of the monitoring, data relating to the psychotropic drug use of 2,494 participants were collected from administrative databases 4 years after the disaster. Use of psychotropics was higher among women for anxiolytics (10.4% for men and 15.0% for women), hypnotics (10.5% and 17.0%), and antidepressants (7.6% and 11.2%). Exposure to the disaster, especially proximity to the exposure, was significantly associated with the use of antidepressants in men, OR = 3.22, 95% CI[1.57, 6.61]. This was also the case for other exposure factors (saw dead or injured, injured, home damage, death or injury loved one, psychological disorders, exposure toxic fumes): range of OR 1.75 to 2.52 in men, 1.48 to 1.62 in women. In conclusion, this study highlights the medium-term psychological impact of an industrial disaster on psychotropic drug use and the potential for using medical records data as a means for tracking post disaster mental health.	<ul style="list-style-type: none"> The mental health of participants following the Toulouse industrial disaster was studied Use of psychotropic drug use Medium term psychological impact of an industrial disaster on psychotropic drug use 	✓	✓



		Impacts of establishment	Impacts for authorities/communities	Wide impacts
<p>Vulnerability analysis for two accident scenarios at an upper-tier seveso establishment in Romania</p>	<p>Major accidents involving dangerous substances pose a serious threat to the health and safety of local communities and the environment, as well as to the integrity and development of infrastructure where Seveso establishments are located. In some cases, the disastrous effects may affect larger, even cross-border areas. At European level, there are continuous efforts to develop land-use planning policies and regulations to reduce consequences and to prevent future accidents from happening. Hence, research in this field comes to support the current actions and strategies of the European Commission to improve the capacity of the EU Member States to cope with and respond to the identified risks through effective prevention, preparedness and response measures. In Romania, the Seveso establishments are mostly located in or very close to urban areas. This paper analyses vulnerability in case of two different accident scenarios (explosion and toxic dispersion) in Targu-Mures, a city hosting one of the largest Seveso upper-tier establishments in Romania. The approach starts with exposure analysis - the first step in the process of vulnerability analysis - which identifies all the elements at risk, be they social (population, medical facilities, schools), environmental (protected areas, water bodies) or economic (transport infrastructure, buildings, utility and water supply networks, fuel or food storage facilities).</p>	<ul style="list-style-type: none"> • This report identifies all the elements at risk, be they social (population, medical facilities, schools), environmental (protected areas, water bodies) or economic (transport infrastructure, buildings, utility and water supply networks, fuel or food storage facilities) • The vulnerability is assessed based on indicators selected in such way so that they cover the entire range of social, economic, environmental aspects, as well as the existing response capabilities in case of a major accident. <p>The content of the report is not conclusive from this abstract</p>		✓
<p>The employment and population impacts of the boom and bust of Talvivaara mine in the context of severe environmenta</p>	<p>There had been a mining boom in Finland before the current recession. The most ambitious investment was the Talvivaara nickel and zinc mine in Kainuu. The operation phase began in 2008, and for three years the mine produced nickel and zinc according to expectations. Then everything changed: two accidents occurred in 2012, which had severe environmental consequences. There was a failed attempt at corporate restructuring. The production company of Talvivaara is now in bankruptcy, and the national government is financing the mine. Our aim is to present an evaluation of the impact these events had on the employment and population of Kainuu region. Our results</p>	<ul style="list-style-type: none"> • Impact on the employment and population of the Kainuu region of the failed attempt of corporate restructuring following two accidents 	✓ ✓	✓



		Impacts of establishment	Impacts for authorities/communities	Wide impacts
I accidents - A CGE evaluation	for the period 2009-2014 indicate that the Talvivaara mine still had a positive cumulative effect on the employment of Kainuu, in spite of the environmental accidents. The results for the period 2015-2022 suggest that the full implementation of the rejected corporate restructuring plan would have been a tolerable solution for the employment and population of Kainuu region. Considering the uncertain future of the mine, we suggest follow up studies.			
The cost of reputational damage when a major accident occurs	The occurrence of a major accident in today's industry may have several types of direct and indirect consequences. However, the most common techniques of Quantitative Risk Analysis (QRA) mainly focus on direct consequences of an accident on humans and equipment and disregard relatively secondary repercussions, such as damage to the company reputation. This type of consequence may have a serious impact on the company and lead to negative cascading events for the local community, such as the layoff of personnel and the decline of satellite companies. This paper investigates the cost of reputational damage to the industrial company where major accidents have occurred. The analysis covers the accidents occurred in 2001 in Toulouse (France) and in 2005 in Buncefield (UK).	<ul style="list-style-type: none"> • Cost of reputational damage • Reputational cost is measured by the loss in the market value of the company • Results suggested that reputational damage may exceed other economic losses and should be considered priority for the industry 	<ul style="list-style-type: none"> ✓ ✓ ✓ 	
Impacts of Major Offshore Oil Spill Incidents on Petroleum Industry and Regional Economy	Disasters such as offshore oil spills will have a significant negative impact on occupations, incomes, tariffs, and further profits, adding to the struggles of regional area held up in difficulty. Such a broad size of impact can more impair the functioning of the economy of the district. In addition to costs encountered by cleanup activities, industries and individuals dependent on coastal resources can experience huge economic losses. Many other related businesses and sectors can possibly hurt by disruptions and loss of earnings. To better understand different aspects of the problem, we explain the problem through a case study for recent incident in the Gulf of Mexico (GoM), the Deepwater Horizon oil spill (DWH) on April 20, 2010, the worst oil spill disaster in the history of the U.S. start off the coastline of Louisiana in the	<ul style="list-style-type: none"> • Positive impact of economic compensation on Gulf coast employment and wages • Gross damages to economy • Losses in the employment and earnings in Louisiana 	<ul style="list-style-type: none"> ✓ 	<ul style="list-style-type: none"> ✓



			Impacts of establishment	Impacts for authorities/communities	Wide impacts
	Gulf of Mexico. We have conducted study to focus on the positive impact of economic compensation on Gulf coast employment and wages.				
A study of posttraumatic disorders in children who experienced an industrial disaster in the Briey region	Objectives of this article are to study posttraumatic disorders in children who were directly and indirectly involved in an industrial disaster; to assess the respective impact of traumatism exposure, parental disorders and socio demographic variables on the posttraumatic disorders of the children	<ul style="list-style-type: none"> • Post traumatic disorders in children who were directly or indirectly involved in an industrial disaster • Assessment of the respective impact of traumatic exposure, parental disorders and socio demographic variables on the post traumatic disorders of children • Anxiety, trauma • Study revealed that the younger exposed children exhibited the highest psychopathological scores 		✓	✓
The aftermath of an industrial disaster	An explosion in a Danish supertanker under construction in 1994 caused the death of six workers and injured 15. Six months later 270 workers took part in this study, which analyses the relationships between objective stressors, the workers' own feelings and the reactions of their families after the explosion together with training, attitude to the workplace, general outlook, and received crisis help. Traumatization, coping style and crisis support was assessed via the Impact of Event Scale (IES). The Coping Styles Questionnaire (CSQ) and the Crisis Support Scale (CSS).	<ul style="list-style-type: none"> • The relationship between objective stressors, the workers' own feelings and the reaction of their families after the explosion together with the training, attitude to the workplace, general outlook and received crisis help • Traumatization, coping style and crisis support was assessed 		✓	✓
Assessing post-disaster consequences for health at the population level: Experience from the AZF factory	Background: A major explosion occurred in the AZF chemical factory in Toulouse in September 2001. A comprehensive programme of epidemiological surveillance was set up. Objectives: To present an overview of the programme and discuss the methods and potential utility of post-disaster epidemiology. The programme had three objectives: (1) to analyse comprehensively the short-term and long-term effects of air, water and secondary soil pollution on health; (2) to identify health problems needing special attention; and (3) to investigate the long-term direct and indirect effects on the population's health.	<ul style="list-style-type: none"> • The short and long-term effects of air, water and secondary soil pollution on health • Health problems that need special attention • Long-term direct and indirect effects on the population's health 		✓	✓



		Impacts of establishment		Impacts for authorities/communities				Wide impacts	
explosion in Toulouse									
Chernobyl's Legacy: Health, Environmental and Socio-Economic Impacts and Recommendations to the Governments of Belarus, the Russian Federation and Ukraine	Summary of the health, environmental and socio-economic consequences of the Chernobyl Nuclear Accident. Recommendation on health care, research, environmental monitoring and economic and social policy provided for the governments of Belarus, the Russian Federation and Ukraine.	<ul style="list-style-type: none"> • Radiation exposure • Deaths due to acute radiation syndrome (ARS) • Cancer mortality • Leukaemia, Solid Cancers and Circulatory Diseases • Reproductive defects • Persistent psychological and mental health problems resulting from rapid relocation, breakdown in social contacts, fear and anxiety about health effects • Release and deposit of radioactive material • Agriculture, aquatic and forest contamination • Economic cost related to response, social protection and health care to affected population, radiation monitoring, radioecological improvement of settlements and disposal of radioactive waste • Impact on local economy • Impact on local communities • 	✓	✓	✓	✓	✓	✓	✓
COCO-2: A Model to Assess the Economic Impact of an Accident	COCO-2 is a model for assessing the potential economic costs likely to arise off-site following an accident at a nuclear reactor. COCO-2 builds on work presented in detail, and by including more sources of loss. Of particular note are: the consideration of the directly affected local economy, indirect losses that stem from the directly affected businesses, losses due to changes in tourism consumption, integration with the large body of work on recovery after an accident and a more systematic approach to health costs.	<ul style="list-style-type: none"> • Economic costs resulting from short-term counter measures and long-term counter measures and the impacts on the local economic • Loss of tourism income • Production losses • Direct costs like emergency services, evacuation, relocation • Indirect costs like disruption of business, public services, tourism • Losses to agriculture sector • Loss to the UK economy from health effects, such as direct loss of labour due to illnesses and cost for treatment 	✓	✓		✓	✓	✓	✓



		Impacts of establishment			Impacts for authorities/communities			Wide impacts	
		<ul style="list-style-type: none"> • Value of life lost, value of injury, value of labour • Accommodation costs 							
The public health impact of industrial disasters	<p>The recent Deepwater Horizon oil spill and Japanese earthquake/tsunami radiation disaster have increased public concerns regarding the public health impact of industrial disasters. Industrial disasters are known to impose a unique set of challenges for public health emergency response. There are critical gaps in scientific knowledge regarding assessment and control of public health disasters related to industrial releases of hazardous materials. There is also a fundamental lack of familiarity regarding industrial disasters among the public health and medical communities, in general. There are few sources in the current public health literature that review this disaster phenomenon in a comprehensive manner. This article offers a review of the public health impact and unique considerations related to industrial disasters.</p>	<ul style="list-style-type: none"> • Review of the public health impact and unique considerations related to industrial disasters <p>The content of the report is not conclusive from this abstract</p>			✓	✓		✓	
The Buncefield Incident 11 December 2005: The final report of the Major Incident Investigation Board, Volume 1	<p>This report provides an overview of the Buncefield fuel depot in Hertfordshire, England and an account of the incident and immediate response. It also provides a summary of the economic impact of the incident, comprising of compensation for loss, cost to the aviation sector, emergency response and the costs of the investigations. Simple calculations of the range of costs for implementing recommendations for avoiding overfilling tanks with petrol and estimate, in monetary terms are also recommended.</p>	<ul style="list-style-type: none"> • Infrastructural damage • Injuries and health effects resulting from the explosion and fire • Business disruption • Environmental pollution • Disruption to fuel supplies • Economic costs related to compensation claims, costs to aviation industry, competent authority and government response, emergency response and environmental impact 	✓	✓		✓		✓	✓
Market-based approximation of the cost of non-conformance associated with the 2010	<p>Employing a market-based approach, this study provides an approximation of the total cost of non-conformance for BP and firms in the oil and gas industry associated with the 2010 Gulf of Mexico oil spill. Based on changes in market capitalisation of the firms being investigated, this study documents that, at the time the leak was sealed, the spill had resulted in a net loss of approximately \$61 billion to BP, \$17</p>	<ul style="list-style-type: none"> • Approximation of total cost of non-conformance for BP and firms in the oil and gas industry associated with the 2010 Gulf of Mexico oil spill • Report reveals contagion effects for firms directly associated with BP and/or offshore drilling 	✓	✓	✓			✓	✓



			Impacts of establishment			Impacts for authorities/communities			Wide impacts	
Gulf of Mexico oil spill	<p>billion to partners, \$13 billion to the drilling sub-industry, and \$19.0 billion to other integrated oil and gas firms. Results strongly support contagion effects for firms directly associated with BP and/or offshore drilling. Competition effects were also found for firms and sectors of the oil and gas industry not related with BP and/or drilling. Those benefiting from the oil spill (in relative terms) include the main rivals of BP and firms in other oil and gas sub-industries such as exploration and production, storage and transportation, and equipment and services.</p>	<ul style="list-style-type: none"> • Competition effects also reported for firms and sectors of the oil and gas industry not related with BP and/or drilling 								
Risks of Offshore Oil Drilling: Causes and Consequences of British Petroleum Oil Rig Explosion	<p>The British Petroleum oil rig explosion in the Gulf of Mexico has left a legacy of environmental pollution, loss of businesses and health effects. The various stakeholders; British Petroleum, Harliburton, government regulators and Transocean Management Ltd are partly responsible for the safety of Macondo oil rig and they are accountable for negligence, oversight, cost-cutting and shoddy technical fixes which eventually resulted in the explosion. Several species of wildlife and ecosystems were threatened. Efforts were made to cap the well, clean the oil, and rehabilitate affected animals. In spite of the ongoing restoration efforts, there is still uncertainty regarding long-term viability of restored ecosystems</p>	<ul style="list-style-type: none"> • Environmental pollution • Loss of business and health effects • Several species of wildlife and ecosystems were threatened <p>Specific health impacts assessed in the report are not conclusive from the abstract</p>	✓	✓	✓	✓	✓	✓	✓	
A Socio-Economic Cost Assessment Regarding Damages to Underground Infrastructures	<p>The research's general objective is to present a detailed study of damage related indirect costs to underground infrastructures that could be used for damage prevention and as an incentive for best practices. By providing a complete list of socio-economic costs and a realistic damage related costing, this essential step will help convince contractors of the importance of damage prevention as well as help reduce the total damage related costs for everyone (companies, population, municipalities, emergency services, etc.).</p>	<ul style="list-style-type: none"> • Death and injuries • Infrastructural damage • Direct costs related to the cost of replacement materials, costs of materials used, labour costs and administrative costs needed to rehabilitate the damaged infrastructure • Indirect costs include costs arising due to service disruption, administrative costs related to procedures that arise from such accidents, costs related environmental impacts, intervention of emergency services, loss of product, work delays, risk for the workers' health and life, tarnished 	✓	✓	✓	✓	✓	✓	✓	



		Impacts of establishment	Impacts for authorities/communities	Wide impacts
		company image, traffic disturbance, impact on business and firms, evacuations		
Psychological effects of a disastrous hydrogen fluoride spillage on the local community	<p>Background: On September 27, 2012, at 3:43pm, a hydrogen fluoride spill occurred in a manufacturing plant located at the 4th complex of the Gumi National Industrial Complex in Gumi City, South Korea. The present study aimed to evaluate the psychological effects of the hydrogen fluoride spill on the members of the community and to investigate their relationships with physical symptoms and changes in psychological effects occurring as time passed after the accident. Methods: The 1st phase involved a survey of 1359 individuals that was conducted 1month after the spill, and the 2nd phase involved a survey of 711 individuals that was conducted 7months after the accident. The questionnaires included items for assessing demographic characteristics, hydrogen fluoride exposure level, physical symptoms, and psychological status. Physical symptoms were assessed to determine the persistence of irritations. Psychological status was assessed to investigate the impact of event level using the Impact of Event Scale - Revised Korean version (IES-R-K), and the anxiety level was assessed using the Beck Anxiety Inventory (BAI). Results: As the hydrogen fluoride exposure level increased, the impact of event and anxiety levels increased significantly both 1 and 7months after the accident ($p < 0.05$). The mean score of the impact of event levels decreased significantly from 33.33 ± 14.64 at 1month after the accident to 28.68 ± 11.80 at 7months after the accident ($p < 0.05$). The mean score of the anxiety levels increased significantly from 5.16 ± 6.59 at 1month after the accident to 6.79 ± 8.41 at 7months after the accident ($p < 0.05$). The risk of persistent physical symptoms at 7months after the accident was significantly higher in females. The risk of persistent physical symptoms also increased significantly, with increasing age, hydrogen fluoride exposure, and impact of event levels ($p < 0.05$). Conclusions: The present study found that the impact of event level and anxiety level increased with increasing hydrogen fluoride exposure. Anxiety levels</p>	<ul style="list-style-type: none"> Psychological effects of hydrogen fluoride spill on members of the community and their relationships with physical symptoms and changes in psychological effects occurring as time passed after the accident Anxiety levels Study revealed that the risk of persistent physical symptoms at 7 months after the accident was higher in females and the risk of persistent physical symptoms increased significantly with age 	✓	✓



		Impacts of establishment	Impacts for authorities/communities	Wide impacts
	persisted even after time passed. The risk of persistent physical symptoms at 7 months after the accident was higher in females, and it increased with increasing age, hydrogen fluoride exposure level, and impact of event levels.			
Associations between disaster exposures, peritraumatic distress, and posttraumatic stress responses in Fukushima nuclear plant workers following the 2011 nuclear accident: The Fukushima NEWS project study	The 2011 Fukushima Daiichi Nuclear Power Plant accident was the worst nuclear disaster since Chernobyl. The nearby Daini plant also experienced substantial damage but remained intact. Workers for the both plants experienced multiple stressors as disaster victims and workers, as well as the criticism from the public due to their company's post-disaster management. Little is known about the psychological pathway mechanism from nuclear disaster exposures, distress during and immediately after the event (peritraumatic distress; PD), to posttraumatic stress responses (PTSR). Methods: A self-report questionnaire was administered to 1,411 plant employees (Daiichi, n = 831; Daini, n = 580) 2-3 months post-disaster (total response rate: 80.2%). The socio-demographic characteristics and disaster-related experiences were assessed as independent variables. PD and PTSR were measured by the Japanese versions of Peritraumatic Distress Inventory and the Impact of Event Scale-Revised, respectively. The analysis was conducted separately for the two groups. Bivariate regression analyses were performed to assess the relationships between independent variables, PD, and PTSR. Significant variables were subsequently entered in the multiple regression analyses to explore the pathway mechanism for development of PTSR. Results: For both groups, PTSR highly associated with PD (Daiichi: adjusted β , 0.66; $p < 0.001$; vs. Daini: adjusted β , 0.67; $p < 0.001$). PTSR also associated with discrimination/slurs experience (Daiichi: 0.11; $p < 0.001$; vs. Daini, 0.09; $p = 0.005$) and presence of preexisting illness(es) (Daiichi: 0.07; $p = 0.005$; vs. Daini: 0.15; $p < .0001$). Other disaster-related variables were likely to be associated with PD than PTSR. Conclusion: Among the Fukushima nuclear plant workers, disaster exposures associated with PD. PTSR	<ul style="list-style-type: none"> • Peritraumatic distress (PD) and post traumatic stress responses (PTSR) during and immediately after an event • Pathway mechanism for the development of PTSR • It was found that PTSR highly associated with PD. PTSR was associated with discrimination/slurs experience (Fukushima and the nearby Daini plant workers faced criticism from the public due to their company's post disaster management) and presence of pre-existing illnesses 	✓	✓



		Impacts of establishment	Impacts for authorities/communities	Wide impacts
	was highly affected by PD along with discrimination/slurs experience.			
Suicide and disasters, Suicide from a Global Perspective: Psychosocial Approaches	<p>Disasters of all kind are unfortunately frequent occurrences in contemporary world and, as such, cause immense human suffering. The most common natural disasters are hurricanes, floods and earthquakes, supplemented by industrial, nuclear and transportation accidents. Disasters can be analyzed in a physical context as a consequence of natural catastrophe or in a social context as a consequence of human behavior (e.g., terrorism or suicide bombers) (Lopez-Ibor, 2005). Common to all disasters is the enormous capacity to affect a huge number of people at the same time. This can lead to all sorts of stress reactions that can, subsequently, have a profound impact on personal mental health. Intense stressors such as exposure to the dead and dying, bereavement and social and community disruption frequently lead to mental health problems (Norris, et al., 2002). Man-made disasters are caused by human behavior and, thus, cause more frequent and persistent psychological distress than natural disasters (Fullerton & Ursano, 2005). Mass violence is, unfortunately, also common in the contemporary world in spite of a growing trend toward globalization and unification. Violence has many faces and is manifest in wars, ethnic conflicts, terrorist acts and urban aggression. The experiences of many countries and populations in the recent past have shown that wars are often justified with "higher" causes and a "wish to initiate peace." The question "why war," which Freud and Einstein (Freud, 1933) tried to answer years ago, is still an issue of the utmost importance. Wars and terrorism in many parts of the world (e.g., September 11th, terrorist acts in Madrid, London, Turkey and Thailand, wars and conflicts in Afghanistan, the Balkans, Cambodia, Chechnya, Iraq, Israel, Lebanon, Palestine, Russia, Rwanda, Sri Lanka, Somalia and Uganda) reveal that the "malady of death" and the power of destructive forces, both outside and within the individual and society, have never appeared as frequently as they do today.</p>	<ul style="list-style-type: none"> • Man-made disasters are caused by human behavior and, thus, cause more frequent and persistent psychological distress than natural disasters (Fullerton & Ursano, 2005) • posttraumatic stress responses which can lead to additional severe secondary problems such as affective disorders, substance abuse or social and relational problems. All of these conditions lead to an increased risk of suicidal behavior 	✓	✓



			Impacts of establishment	Impacts for authorities/communities	Wide impacts
	Disasters may cause posttraumatic stress responses which can lead to additional severe secondary problems such as affective disorders, substance abuse or social and relational problems. All of these conditions lead to an increased risk of suicidal behavior (Mehlum, 2006)				
Environmental aftermath of the radiation accident at Tomsk-7	An analysis is presented of the environmental effects of the most serious radiation accident recorded after Chernobyl, which occurred in the formerly secret town of Tomsk-7 in Siberia, Russia, on 6, April 1993. Fortunately, it appears not to have become a major industrial crisis or disaster. The causes of the accident are described. It is argued that a mixture of both objective and subjective prerequisites, including specific human, organizational and technological factors, were responsible for the explosion or directly facilitated it. The Tomsk-7 accident's ecological medical, social, and psychological consequences are discussed.	• Ecological, social and psychological consequences		✓	✓ ✓
An industrial disaster. Disaster behaviour and posttraumatic stress reactions	The immediate responses to disaster trauma and the acute, subacute, prolonged and chronic posttraumatic stress reactions over a four year period were studied in 246 industrial employees after a factory explosion. Among the 66 workers most severely exposed during the disaster impact, 37% demonstrated optimal disaster behaviour. High levels of disaster training/experience appeared as the single most important factor in shaping their adaptive and controlled responses. The risk of developing an acute posttraumatic stress disorder was strong in the high exposure group, 43%, and the point prevalence was down to 37% after seven months and 19% after four years. In a medium exposure group and a low exposure group, the prevalences were 23%, 17% and 2%, and 10, 4 and 3% respectively. A poor long-term prognosis was associated with severe exposure to the disaster and with premorbid personality problems. The results indicate that persons at risk of becoming ill and persons with a poor prognosis can be identified within days after a disaster.	• Acute, subacute. Prolonged and the chronic posttraumatic stress reactions to disaster trauma		✓	✓



		Impacts of establishment	Impacts for authorities/communities	Wide impacts
Possible risk factors for acute stress disorder and post-traumatic stress disorder after an industrial explosion	<p>There have been deaths and injuries after an explosion which happened in an industrial region in Ankara in February 2011. The aim of this study was to determine the prevalence of acute stress disorder (ASD) and posttraumatic stress disorder (PTSD), and to determine the variables which can be the risk factors for PTSD. Methods: In this study, we included a total of 197 subjects who were present at the factory building and at the four offices nearby when the disaster occurred. All the participants were assessed one month after the explosion and 157 of them were re-assessed six months after the explosion. Socio-demographic information forms were given and the Clinician-Administered PTSD Scale (CAPS) was administered to the participants one month after the explosion. Psychiatric assessments were done using the structured clinical interview for DSM-IV axis-I disorders (SCID-I). The CAPS was re-applied six month after the disaster. results: At the first-month assessments, ASD was detected in 37.1% of participants and PTSD in 13.7%, whereas PTSD was observed in 16.6% of subjects at the sixth month of the accident. According to the first month data, having any psychiatric disorder before the incident, physical injury, acquaintances among the dead and the injured people, being involved in the incident and seeing dead people were detected as the risk factors for PTSD. At the sixth-month assessment, physical injury, acquaintances among the dead and the injured, being involved in the incident were seen as risk factors for PTSD. conclusion: ASD and PTSD can be seen after an explosion. Having a previous psychiatric disorder and being directly affected by trauma and being injured are the risk factors for PTSD. This study implies that preventive mental health care services should include the management of current psychiatric condition and employee safety issues.</p>	<ul style="list-style-type: none"> • The prevalence of acute stress disorder (ASD) and post traumatic stress disorder (PTSD) following an industrial explosion • The variables which can be the risk factors for PTSD • The study found that having a previous psychiatric disorder and being directly affected by trauma and being injured are the risk factors for PTSD. 	✓	✓
Immediate psychological impact of the deepwater	<p>Five hundred eighty-eight participants completed the Short Post Traumatic Stress Disorder Rating Interview (SPRINT; Connor & Davidson, 2001) and the Brief COPE (Carver, 1997) to determine the psychological impacts and</p>	<ul style="list-style-type: none"> • Psychological impact and coping styles of the Deepwater Horizon Oil Spill on Gulf Coast residents 	✓	✓



		Impacts of establishment	Impacts for authorities/communities	Wide impacts
horizon oil spill: Symptoms of PTSD and coping skills	<p>coping styles of the Deepwater Horizon Oil Spill on Gulf Coast residents. Participants were divided into at-risk and non-risk groups based on their occupations. Results indicated that 28% of the respondents scored above the SPRINT cutoff score, indicating significant levels of posttraumatic stress disorder (PTSD) symptoms. Furthermore, the Brief COPE results revealed that the at-risk group showed a negative correlation between active coping and the level of PTSD-related symptoms. The at-risk respondents also showed negative correlations of PTSD-related symptoms with coping strategies such as acceptance, planning, positive reframing, humor, and religion. Future research directions are also discussed</p>	<ul style="list-style-type: none"> • 28% of respondents indicated significant levels of posttraumatic stress disorder (PTSD) symptoms 		
Course of posttraumatic stress symptoms over the 5 years following an industrial disaster: A structural equation modeling study	<p>The present study examined individual latent changes in posttraumatic stress disorder (PTSD) symptoms over a 60-month period after an industrial disaster. Participants were recruited from survivors of a factory explosion. Participants were assessed retrospectively for peritraumatic reactions and acute stress symptoms. Posttraumatic stress disorder symptoms were then assessed at 6, 15, and 60 months. Using structural equation modeling, the authors tested 3 hypotheses of individual latent change: stability of PTSD symptoms between 6, 15, and 60 months; change between 6 and 15 months; and change between 15 and 60 months. Only one model provided a good fit suggesting that PTSD symptoms evolved between 6 and 15 months after trauma exposure and remained stable at the individual level thereafter. © 2010 International Society for Traumatic Stress Studies.</p>	<ul style="list-style-type: none"> • Latent changes in posttraumatic stress disorder (PTSD) over a 60 month period after an industrial disaster • One model provided a good fit suggesting that PTSD symptoms evolved between 6 and 15 months after trauma exposure and remained stable at the individual level thereafter 	✓	✓
Mental health of workers in Toulouse 2 years after the industrial AZF disaster: First results	<p>On September 21, 2001, the AZF petrochemical factory near Toulouse (France) exploded. A cross-sectional survey of Toulouse workers took place in 2002 and then, a cohort follow-up began in 2003. The aim of this paper is to study the associations between various factors describing exposure to the disaster, and anxiety and depressive symptoms, assessed at cohort inclusion 2 years afterwards. Methods: In</p>	<ul style="list-style-type: none"> • Association between various factors describing exposure to the disaster and anxiety and depressive symptoms • Psychological distress • The study revealed links between the industrial disaster and psychological distress 2 years afterwards. The results about risk factors differ 	✓	✓



			Impacts of establishment	Impacts for authorities/communities	Wide impacts
of a longitudinal follow-up of 3,000 people	<p>2003, 3,006 people were included in the cohort. Psychological distress was measured by the GHQ28 at inclusion. Factors related to exposure to the disaster, such as personal distance from the site, physical injury, immediate psychological symptoms, and material and social effects, came from the 2002 cross-sectional survey. The links between mental health symptoms and exposure were studied in multivariate analyses by logistic regression. Results: The prevalence of psychological distress was 47% at inclusion in the cohort. It varied according to sex and occupational class: blue-collar workers and self-employed people were most highly affected. Factors such as a history of depression, injury to a close friend or family member, sick-leaves and immediate psychological symptoms were associated with psychological distress 2 years later. These associations differed according to sex. Conclusion: This study shows links between the industrial disaster and psychological distress 2 years afterwards. The results about risk factors differ according to sex, and identify particularly vulnerable populations. It should guide preventive interventions in such situation.</p>	<p>according to sex, and identify particularly vulnerable populations. It should guide preventive interventions in such situation.</p>			



wood.

