JRC Scientific and Technical Reports

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Elisabeth Krausmann

EUR 24661 EN - 2010

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JRC 61931

EUR 24661 EN
ISBN **978-92-79-18927-2**
ISSN 1018-5593
doi:**10.2788/82675**

Luxembourg: Publications Office of the European Union

Printed in Italy

Executive Summary

A study on the status of Natech risk reduction in EU Member States was performed by means of a questionnaire survey. The results of the analysis are based on 14 country responses which is too small a population size for drawing robust statistical conclusions. As a consequence, the quantitative results of this study and their interpretation may be subject to some uncertainty. However, a clear tendency towards recognising natural hazards as an important external risk source for chemical facilities could be established. In addition, more than half of the responding countries declared to have suffered one or more Natech accidents with the release of toxic substances, fires and/or explosions and sometimes fatalities and injuries. The natural events that triggered these Natech accidents were not necessarily the ones that were believed to be of major concern so there is a discrepancy between actual causes and risk perception.

A legal framework for Natech risk reduction exists via the responding countries' chemical-accident prevention programmes, but the effectiveness of these programmes in mitigating Natech risk is largely inconclusive. The occurrence of Natech accidents indicates that there may be gaps in legislation, implementation and/or its monitoring that should be addressed to ensure effective Natech risk reduction. In over half the responding countries Natech risk is not addressed in natural-disaster management regulations. Existing technical codes and standards for the design, construction and operation of buildings and structures in industry consider certain natural hazards but their ultimate goal is the safety of human life. Therefore, the prevention of hazardous-substance releases may not be guaranteed and secondary risks due to these releases may not be taken into account. Additionally, some of these technical codes and standards may not be suitable for controlling risks due to hazardous substances. Specific guidelines for Natech risk reduction to support legislation are scarce. Therefore, the development of specific technical codes and guidelines would be required to fully address Natech risk in the EU Member States.

Awareness of Natech risk seems to be increasing within the countries' competent authorities while there is a tendency to believe that the current level of knowledge on the dynamics of Natech accidents may not be adequate. Consequently, training on Natech risk reduction is needed. There is the perception among the respondents that there is a certain level of Natech awareness in industry, although in almost half of the responding countries industry does not appear to sufficiently take Natech risk into account in industrial risk assessment. In addition, there is a reported lack of Natech-specific scenarios. Low levels of Natech preparedness could therefore have resulted. This highlights the need for better risk communication and the development of methodologies and tools for including Natech risk into conventional industrial risk assessment. Moreover, the development of guidance on Natech risk assessment for industry was indicated as the highest-priority need for effective risk reduction, closely followed by the development of guidance on Natech risk assessment at the community level.

Natech risk reduction measures seem to be widely available although they are often generic due to the absence of data and models on the dynamics of Natech accidents. In fact, currently no specific Natech accident databases exist in the responding countries and Natech events have to be retrieved from conventional chemical-accident databases which lack the level of detail to capture the specifics on Natech accidents. Moreover, chemical-accident prevention and pollution-control regulations, such as the Seveso II Directive, do not provide guidance to the operator on how Natech risk reduction should be achieved, nor to the competent authority on how to evaluate that the risk level is as low as required by regulations. This is a shortcoming that needs to be addressed. Some Natech risk reduction measures that could be considered best practice were reported to exist; most provided examples were, however, targeted towards floods. This finding

suggests that awareness of or the availability of Natech-specific best practices may be limited at present and actions should be directed towards filling this gap, e.g. through a concerted effort to identify existing best practices and to disseminate them widely. Another priority need expressed by the survey respondents is the development of specific Natech risk maps whose availability is very limited. These are required for the identification of Natech-prone areas to inform land-use-planning and emergency-management decisions. In contrast, several countries have developed natural hazard or risk maps for selected natural hazards in certain regions.

The results of this Natech questionnaire survey show that the responding countries have largely recognised natural hazards and disasters as a relevant source of risk to a chemical facility with the potential to trigger a major accident. A framework for Natech risk reduction exists but a strategic Natech risk-reduction initiative appears to be lacking. Moreover, the survey highlighted a number of shortcomings and gaps that need to be addressed to achieve effective risk reduction. Considering the findings of this study the following areas for future work were identified:

- Raising awareness and improving risk communication at all levels of government and in industry;
- The implementation and enforcement of specific regulations for Natech risk reduction;
- The preparation of specific technical codes and of guidelines for risk assessment in industry that address the characteristics of Natech risk;
- The development of guidance on Natech risk assessment at the community level;
- The development of methods and tools for Natech risk assessment;
- The preparation of dedicated Natech emergency management plans which consider the characteristics of Natech accidents (e.g. a possible lack of utilities);
- Identification of best practices for Natech risk reduction and wide dissemination of existing practices;
- The development of Natech risk maps to support effective land-use planning and emergency management;
- Land-use planning that explicitly addresses Natech risk;
- Training of competent authorities on Natech risk reduction both for officials in charge of chemical-accident prevention and those in charge of natural-disaster management;
- Research into the impact of climate change on future Natech risk.

In order to support the process of improving Natech risk reduction, lessons learned from the analysis of past Natech accidents should be formulated and disseminated. These lessons should address failure modes and hazardous-substance release paths as a function of natural-hazard severity, as well as identify risk-reduction measures and possible best practices. As this requires the systematic collection of data on the causes and dynamics of Natech events the JRC has set up a specific Natech accident database which is public to allow the widest possible access to the accident data. Moreover, indicators for measuring the effectiveness and adequacy of Natech risk-reduction measures should be developed.

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1 Introduction

The last decade has seen a growing body of research on chemical accidents triggered by natural hazards and disasters (so-called Natech accidents), and awareness of Natech risk as an emerging risk is growing in Europe. However, there is little information on the actual status of Natech risk reduction in the Member States of the European Union. Therefore, the European Commission's Joint Research Centre (JRC) launched a questionnaire survey to assess Natech risk management practices and awareness of Natech accidents, collect case histories and lessons learned, and identify needs and/or limitations in implementing Natech risk reduction strategies in the EU. The results of the survey are intended to lead to better designed and targeted Natech risk reduction strategies. A similar survey was performed by the JRC within the frame of the OECD Working Group on Chemical Accidents for OECD Member Countries, the results of which have been published in Krausmann and Baranzini (2009)[1].

In March 2009 the JRC questionnaire was sent to the members of the EU Seveso Committee of the Competent Authorities with a request to complete the questionnaire and involve other stakeholders outside government and administration in the respective Member States as far as practicable. The deadline for submitting the survey responses was June, 2009, although a number of filled-in questionnaires arrived after the deadline and in 2010. Overall, 14 EU Member States returned the completed questionnaire. These countries are (in alphabetical order): Austria (2009), Cyprus (2010), Czech Republic (2009), France (2009), Germany (2009), Italy (2009), Lithuania (2009), Luxemburg (2009), Netherlands (2009), Poland (2009), Romania (2010), Slovakia[2] (2010), Sweden (2009) and the United Kingdom (2009). The numbers in brackets indicate the year in which the data was provided and hence represent the Natech risk management status at the time of questionnaire submission. It is possible that in some cases part of the provided information, in particular legal acts, may have been superseded at the time of publication of this report. The responses to the questionnaire were analysed and the results are discussed in the following. The questionnaire template used in the survey is presented in Annex F.

2 Sample description

This analysis is based on 14 responses and therefore captures only about half of the 27 EU Member States. However, the 14 responding countries are home to over 76% of chemical facilities that fall under the provisions of the EU Seveso II Directive[3,4], which motivates the assessment of their status in terms of Natech risk reduction. Where basic descriptive statistics was used in the analysis, the interpretation of the quantitative results is subject to some uncertainty due to the small sample size. In order to increase the robustness of our interpretation, special attention was given to the survey respondents' individual comments or explanatory remarks. However, due to the incompleteness of the data the main purpose of this study is to paint a

[1] E. Krausmann, D. Baranzini (2009) Natech risk reduction in OECD Member Countries: Results of a questionnaire survey, JRC 54120, European Commission, Joint Research Centre.
[2] The questionnaire response from Slovakia was prepared by the University of Žilina and does not represent the official reply of the Slovak Government.
[3] Seveso Plant Information Retrieval System (SPIRS), September 2010.
[4] European Union (1997) Council Directive 96/82/EC of 9 December 1996 on the control of major-accident hazards involving dangerous substances, Official J of the European Communities L10.

qualitative picture of the Natech risk management situation in the responding Member States rather than carrying out a detailed quantitative study.

All responding organisations belong to the public sector with 12 responses from competent authorities in the respective countries and 2 responses from academia. The organisations' main responsibilities are shown in Figure 1. Environment with 29% is leading the classification, followed by civil protection with 21%. All responding organisations operate at national level.

The survey was answered mainly based on the respondent's own professional expertise and experience and by discussion with colleagues (Table 1).

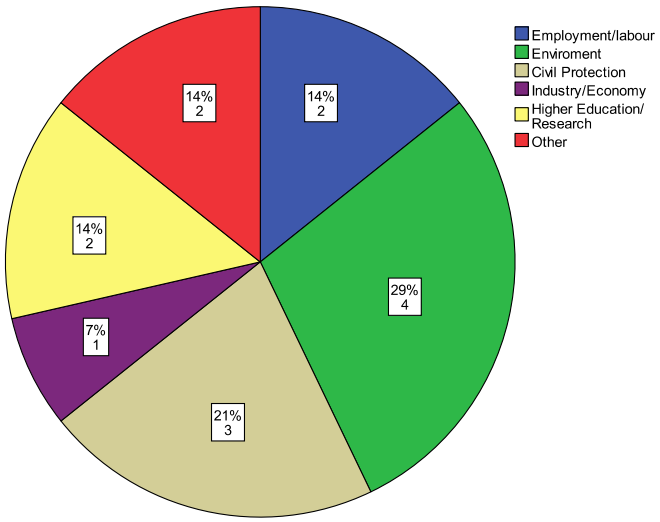

Figure 1: Main responsibilities of responding organisations (number and percentage of replies).

Process used	Number of replies (%)
Participant's own knowledge	9 (64)
Discussion with participant's colleagues	9 (64)
Participant's records	4 (27)
Meeting	3 (21)

Table 1: Process used by the survey respondents for questionnaire completion.

3 Regulations for the prevention and mitigation of Natech accidents

3.1 Regulations and guidelines for chemical-accident prevention and mitigation

The first part of the survey aimed at identifying existing regulations for chemical-accident prevention and natural-disaster management, as well as technical codes and standards that

consider the impact of natural hazards. The government institution(s) overseeing chemical-accident prevention and mitigation, and the rules, codes or guidelines used in the respective country to regulate or guide hazardous-substances handling are summarised in Tables A1 and A2 in Annex A.

The Seveso Directive requires external hazards (including natural events) to be considered in the Safety Report of hazardous installations. Out of the 13 respondents to the question, 10 (77%) indicated that the rules, codes or guidelines indicated in Table A2 implicitly or explicitly address the natural hazards their respective country is subject to, while 3 (23%) replied in the negative (Figure 2). The survey participants were requested to provide details on the specific document, the natural hazard(s) considered, as well as the impact on hazardous-substances handling for the cases where chemical accident prevention legislation considers natural hazards. This information is listed in Table B1 in Annex B. The cited documents influence the handling of hazardous materials e.g. by requiring the preparation of a safety document that considers the potential impact of a selected natural hazard, a site-specific risk assessment, or in some cases the restriction of industrial development in areas prone to selected natural hazards.

With respect to specific *technical* codes, standards or guidelines for the design, construction and operation of buildings and other structures in industry that consider natural hazards, 9 responding organisations (69%) indicated that these were available in their respective countries (Figure 2). Details on these documents and the natural hazard(s) considered can be found in Table B2 in Annex B. A closer look at the provided information revealed that in many cases only selected natural hazards that a country is subject to are considered while others are neglected. In addition, while technical standards and guidelines are designed to protect buildings and other structures during natural events to ensure the safety of human life, they may not give appropriate consideration to installations housing hazardous substances. Therefore, the prevention of hazardous-substances releases may not necessarily be guaranteed and secondary risks to human life and the environment due to these releases may not be addressed. In 4 cases (31%) organisations replied that no such technical codes or guidelines exist in their countries.

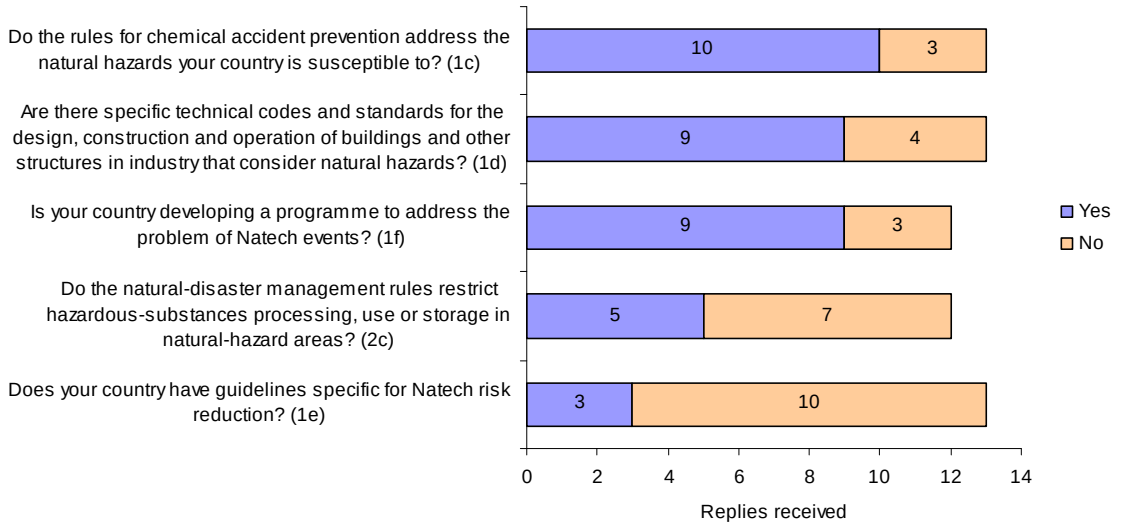

Figure 2: Survey replies to Questions 1c - 1f and 2c on regulations, codes and standards for the prevention and mitigation of Natech accidents.

Guidelines *specific* for Natech risk reduction exist in only 3 (23%) countries while the vast majority of the respondents (77%) replied in the negative. These guidelines, however, address only selected natural hazards a country is subject to. Details on these guidelines including the title and year of documents, as well as the natural hazard(s) considered are provided in Table B3 in Annex B.

The question on whether the country or organisation is developing a strategy or programme to address the problem of Natech accidents was answered by 12 countries. Out of these, 9 (75%) are working on this topic while 3 respondents (25%) replied in the negative (Figure 2). For the 9 countries which are developing a strategy or programme to address Natech accidents, the considered natural hazards are summarised in Table 2. The fact that the majority of the responding countries are in the process of developing specific Natech risk reduction programmes suggests that Natech risk has been recognised as an emerging risk. It also indicates that while a general legislative framework for Natech risk reduction seems to be in place, the countries acknowledge the need to address the lack of detailed knowledge on Natech risk which may have resulted in gaps in Natech accident prevention.

Country	**Natural hazard considered**
Czech Republic	Mainly floods
France	Floods, earthquakes, lightning, landslides (focus on soil/structure interaction)
Germany	Precipitation, floods, storms, earthquakes
Italy	Hydro-geological events, earthquakes, winds, rain, lightning, wildfires
Lithuania	Floods
Netherlands	All-hazards approach
Romania	Floods, landslides, earthquakes
Slovakia	Floods
UK	Mainly floods

Table 2: Natural hazards considered in EU Member State programmes that address Natech risk.

3.2 Regulations and guidelines for natural-disaster management

The government institution(s) overseeing natural-disaster management, as well as the rules, codes or guidelines used in the respective country to address natural-disaster management are listed in Tables C1 and C2 in Annex C.

In 7 cases (58%) out of a total sample size of 12 for this particular question, respondents indicated that natural-disaster management rules, codes or guidelines in their respective countries do not restrict hazardous-substances processing, use or storage in areas subject to natural hazards (Figure 2). In 5 cases (42%) restrictions were reported. These restrictions apply for some or all natural hazards and include siting objections for new installations in hazard-prone areas or site-specific prevention measures including a dedicated risk assessment. Details on the specific documents, the natural hazard(s) considered and the impact on hazardous-substances handling are listed in Table D1 in Annex D.

3.3 Effectiveness of regulations

We asked survey participants if they thought that their country's approach to chemical-accident prevention and natural-disaster management had been effective in preventing Natech accidents. Their opinion had to be ranked on a scale from 1 (low effectiveness) to 5 (highly effective). The ranking of the individual answers is shown in Figure 3. Additional information by some respondents who commented their answer to this question is shown in Table 3[5].

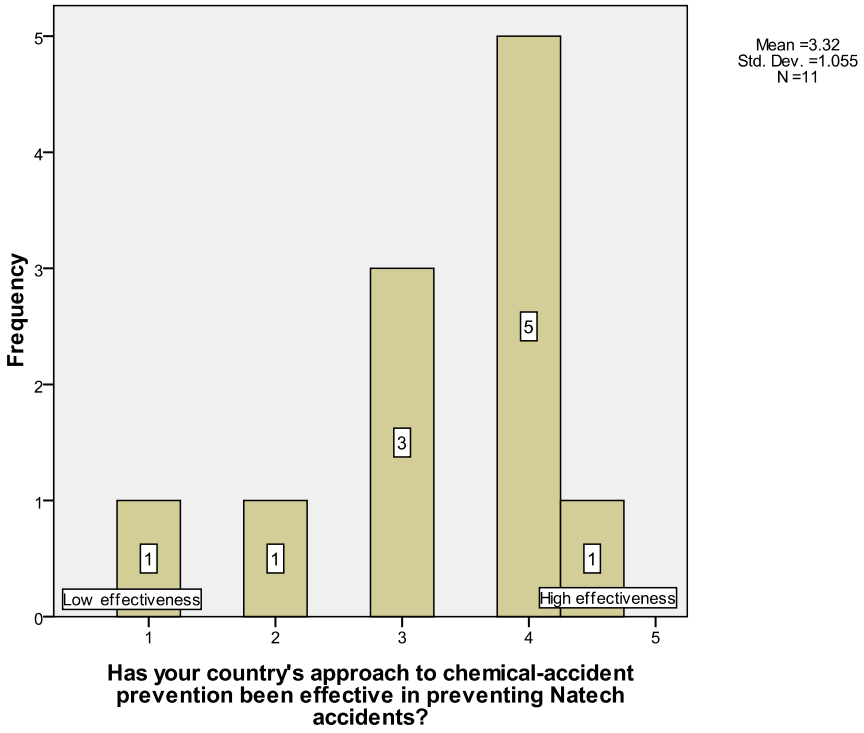

Figure 3: Ranking of the effectiveness of a country's approach to chemical-accident prevention in reducing Natech risk.

The resulting mean value of effectiveness is about 3.3 based on a sample size of 11 countries which answered this question. This mean value indicates that there seems to be a slightly positive tendency towards considering the countries' approach to chemical-accident prevention and natural-disaster management to some extent effective in preventing Natech events. A detailed analysis of the replies to this question in conjunction with the individual responses to Questions 1c to 1e (Figure 2) indicates that there does not seem to be a relationship between the perceived effectiveness and the availability of regulations, technical codes and guidelines that consider natural hazards. In fact, in some countries which considered the effectiveness to be medium-high or high, this judgement seems to be based on the absence of Natech accidents rather than the existence of specific regulations. However, the non-occurrence of accidents is not necessarily an adequate indicator of effectiveness. In some cases, the existence of regulations and their enforcement, or the drawing up of action plans on prevention, preparedness and response is

[5] The numbering in this and the following tables is arbitrary. Identical numbering in tables does not necessarily indicate responses from the same country.

considered an indicator of effectiveness. However, it is unclear what the state of implementation and monitoring is.

With this insight the conclusion drawn from the replies to this question is that it is inconclusive from this survey whether the current approach for chemical-accident prevention and natural-disaster management in EU Member States is sufficient to prevent Natech accidents. The fact that some countries have experienced Natech events and have launched dedicated Natech risk-reduction strategies and research activities (see the following sections) suggests that it may not be.

	Comment on the effectiveness of regulations
1	Most scenarios developed under our country's national safety strategy are covered in current policies and regulation.
2	It is very difficult to evaluate which accidents were prevented.
3	The situation of Natech mitigation in my country is rather satisfactory. An asset in terms of mitigation is the existence of numerous regulatory texts, with appropriate State services for enforcing them. In addition, regularly updated maps help identify those natural hazards industrial facilities may be confronted with.
4	The main threat is caused by flooding where an effective prevention tradition exists and no major accident (spill etc.) happened during the last events. Some hazard types are not relevant as there are no sites within the consequence area (avalanches).
5	Some Natechs due to flood events but not serious damage.
6	There are no specific (technical) regulations for Natech hazards, and there are no standards for risk assessment criteria for technological installations influenced by natural hazards.
7	My country is susceptible to quite a narrow range of natural disasters. The Law on Civil Protection establishes the legal and organisational framework for the organisation and functioning of the civil protection and rescue system, describes the activities comprising the preparedness of state and municipal institutions, all economic entities, public organizations and residents for an emergency, actions in the event of occurrence thereof and response thereto, also the use of all resources of the State for the survival of residents, maintaining the viability of the national economy, protection of the property and the environment against the effects of the emergency, with the citizens actively participating in the processes. Emergency here shall mean a situation caused by natural, technical, ecological or social factors or military actions and posing a sudden and grave hazard to human life or to health, property, nature or causing death and mutilation or property losses. The Law requires the head of an economic entity or an institution to project emergencies and plan preventive measures and to draw up and approve plans of civil protection preparedness for an emergency. State institutions, counties and municipalities shall draw up plans of action in the event of a radiation accident at the Nuclear Power Plant and prepare means of protection of residents and measures aimed at responding to the effects of the disaster outside the territory of hazardous establishments and included in plans of civil protection preparedness for an emergency (external emergency plans). The procedure for preventing, responding to and investigating industrial accidents is laid down by the Regulations on Prevention of, Response to and Investigation of Industrial Accidents, approved by the Government. Considering what is stated we can maintain that the national approach to chemical-accident prevention and natural-disaster management has been quite effective in preventing Natech accidents.
8	Prevention on Natechs is implemented only in the area of floods and major accidents.

	But there are no strict obligations or methods which are able to prevent this type of risk. It is important to implement more obligations (or stricter obligations) in laws of operators of plants to analyse the influence of floods.

Table 3: Respondents' comments on the effectiveness of regulations in preventing Natech accidents.

As conclusion to the questionnaire section on regulations for Natech accident prevention and mitigation we asked the participating countries if they felt that there were gaps or shortcomings in their country's rules or codes that needed to be addressed to ensure effective Natech risk reduction. Table 4 collects the opinions of the 7 respondents on what improvements could or should be made to current regulations, codes and/or guidelines. From the table it is evident that there is a perceived need for improving current regulations and filling existing gaps to fully address the Natech risk a country or region may be subject to. The main proposals for improvements include:

- The implementation and enforcement of specific regulations for Natech risk reduction;
- The preparation of guidelines for industry and specific technical codes that address Natech risk;
- The development of methods for Natech risk assessment and the identification of Natech scenarios which are to date missing or insufficient;
- Land-use planning that explicitly addresses Natech risk;
- Better preparedness and training for the mitigation phase if a Natech accident occurs;
- The development of best practices for Natech risk reduction.

	Improvement of current regulations, codes and/or guidelines
1	+ Guidelines for the consideration of natural hazards in plant design, operation and maintenance, hazard analysis, safety documents and emergency plans of operators. + A guideline for the consideration of natural hazards in inspecting establishments according to the Seveso-Directive. + Special Technical Codes for the structural engineering of plants containing hazardous substances. + Drafting and communication of integrated natural hazard risk maps. + Implementation of a special concept for the risk and crisis communication of natural hazards.
2	+ Methods of Natech risk assessment are in the state of development only. + Insufficient Natech evaluation procedure for land use planning. + No special preparedness/training for mitigation in the case of Natechs.
3	Some weaknesses exist. These include: + Relatively poor perception of Natech risks by staff of industrial facilities. + Lack of good practices for Natech mitigation with approval by the State and industry.
4	Earthquake impact may be underestimated but this a personal assumption.
5	Even if there are many legal acts for the prevention of and response to emergency situations there is no legal act which would clearly address the Natech problem. Natech risk is reduced by implementing the wide range of different legal requirements which often duplicate or conflict with each other or bring confusion due to different titles of the same document.
6	+ There is no uniform approach regarding the risk identification for the chemical

	operators. + Operators should be supported (through economic policies) to adopt the most reliable technical solutions to reduce risk. + Studies evaluating the effects of Natech risk should be developed, which will represent the basis for the development of compulsory security measures on-site.
7	We have no rules for the mitigation and prevention of natural risks other than floods. Other very important natural hazards in our country are landslides, wildfires, storms, and so on.

Table 4: Gaps in regulations and codes and proposals for improvements.

3.4 Conclusions on regulations for the prevention and mitigation of Natech accidents

From the analysis of the questionnaire responses we conclude the following:

1. In 77% of the responding countries natural hazards are addressed either implicitly or explicitly in the existing regulations for chemical-accident prevention. In the remaining 23% of the cases natural hazards are not addressed in the context of these regulations.
2. In 69% of the responding countries technical codes, standards or guidelines for the design, construction and operation of buildings and other structures in industry that consider natural hazards exist. However, in many cases only selected natural hazards that a country is subject to are considered. Moreover, these technical codes, standards and guidelines are designed to protect buildings or other structures from natural hazards but may not give appropriate consideration to installations housing hazardous substances.
3. Only 23% of the responding countries have guidelines specific for Natech risk reduction. These guidelines address, however, only selected natural hazards in a country.
4. 75% of the responding countries report that they are developing a strategy to address Natech risk. This suggests that Natech risk has been recognised as an emerging risk. It also indicates that while a general legislative framework for Natech risk reduction seems to be in place the countries acknowledge the need to address the lack of detailed knowledge on Natech risk which may have resulted in gaps in Natech accident prevention.
5. In 42% of the responding countries natural-disaster management rules, codes or guidelines restrict hazardous-materials handling in hazard-prone areas.
6. The effectiveness of regulations in preventing Natechs is considered slightly positive. This assessment is partly based on the absence of Natech accidents which may not be adequate as an indicator of effectiveness.
7. It is inconclusive from the survey if current regulations are sufficient to prevent Natech accidents. The occurrence of Natechs in some countries indicates that they may not be.
8. There is a perceived need for improving current regulations and filling existing gaps to fully address the Natech risk a country may be subject to. The main proposed improvements are according to the survey: the implementation and enforcement of specific regulations for Natech risk reduction, the preparation of guidelines for industry and specific technical codes that address Natech risk, the development of methods for Natech risk assessment and identification of Natech scenarios which are to date missing or insufficient, land-use planning

that explicitly addresses Natech risk, better preparedness and training for the mitigation phase, as well as the development of best practices for Natech risk reduction.

4 Natech events data collection and retrieval

A typical problem of the analysis of Natech accidents is data unavailability. Therefore we asked the questionnaire participants whether their country or organisation maintains a database for recording/retrieving information on chemical accidents, and if not whether there was any other type of record of these accidents. Of the 13 respondents to this question, 10 indicated to have a database for chemical accidents, while 3 keep written records only. With respect to maintaining a database specific for Natech accidents all 13 respondents replied in the negative.

Although the big majority of the questionnaire respondents does not maintain a Natech-specific accident database, the 11 of them who answered the question indicate that their conventional chemical-accident databases or their written accident documentation can be used to identify and retrieve information on Natech events. In these databases Natech accidents are recorded as normal chemical accidents with a natural triggering event. This may not always allow the capturing of the specific characteristics of a Natech accident as opposed to a conventional chemical accident.

4.1 Conclusions on Natech events data collection and retrieval

The conclusions from the responses to this section of the questionnaire are:

1. 77% of the responding countries maintain a database which can be used to record and retrieve information on conventional chemical accidents; the rest keep written records.
2. There are no specific Natech accident databases.
3. Conventional chemical-accident databases can be used to retrieve Natech accidents. The taxonomy needs to be clarified, however, to ascertain that chemical accidents with a natural-hazard trigger are consistently and reliably classified.

5 Learning from Natech accidents: Case histories

Of 13 total responses, 7 (54%) report that Natech accidents have occurred in the respective countries in the period between 1990 and 2009. The remaining 6 respondents (46%) indicate that they have not experienced Natech events in the requested time period (Figure 4). It should be noted that Natech accidents tend to be underreported and that responses to this survey may reflect this tendency.

In the frame of the Natech survey 5 responding countries provided information on a total of 72 Natech accidents that occurred in their countries. These accidents are included in tabular form in Annex E. Releases of hazardous materials were reported in 68 accidents, while in 2 cases only structural damage without release occurred and in another 2 cases non-structural damage. One near miss was also reported. The analysis of the submitted Natech accidents showed that the most frequent causes were lightning, river floods and low temperature, accounting for about 65% of the reported cases. Figure 5 shows the natural-event triggers reported for this study.

Interestingly, most of the natural hazards that triggered a Natech accident are explicitly or implicitly considered in the respective countries' rules, codes and guidelines for chemical-accident prevention (Annex B, Table B1). However, often only natural hazards with a severity above a defined reference event are taken into account. Moreover, the above rules may be very general and usually technical codes, standards or guidelines are used for risk-assessment or lay-out purposes (Table B2). In fact, in several responding countries Natech accidents were triggered by natural hazards that are in principle considered in these codes. However, as discussed in Section 3.1 technical codes may not address the specific hazards and secondary risks arising from hazardous-substances processing and handling at industrial installations. This is, for instance, supported by the high incidence of reported Natech accidents triggered by lightning, a natural hazard which is typically addressed in the technical codes and standards for building protection. Despite the existence in some countries of dedicated guidance on Natech risk reduction for selected natural hazards (Table B3) it has not kept Natech accidents from occurring. Therefore, the preparation of guidance informed by lessons learned from past Natech accidents should be encouraged.

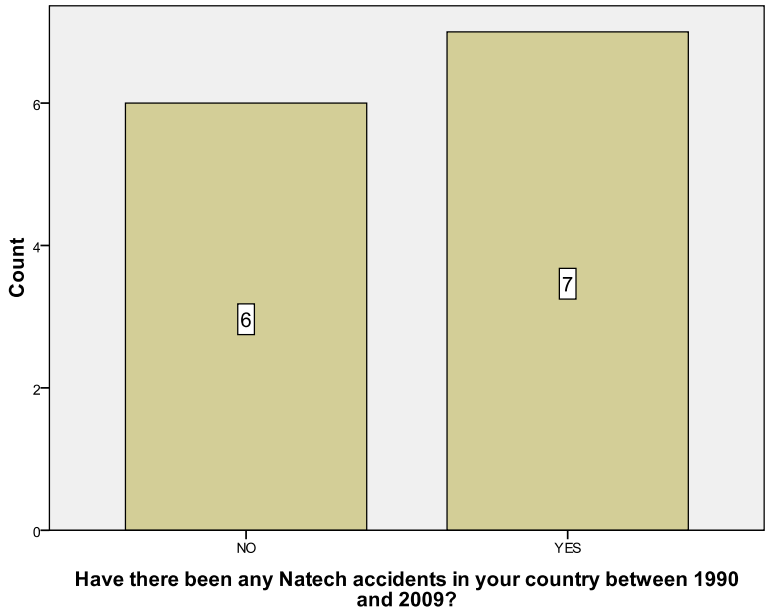

Figure 4: Number of Yes/No counts for Question 6.

In terms of consequences, atmospheric releases (26), liquid spills (23) and fires (20) were the most frequently observed final scenarios, followed by explosions (8) and solid releases (2). Quantitative data on on- and off-site consequences was included in 7 Natech events which resulted in a total of 2 fatalities and 79 injuries.

Some of the Natech accident descriptions in Annex E include information on the failure mode(s) and lessons learned from the accident. The typical observed failure modes with hazardous-substance releases due to the three most frequently reported Natech triggers were e.g. vapour ignition and explosions at floating roof tanks or process upset caused by lightning strikes, failure of containment dykes, tank floating with rupture of pipes and connections or overloading of drainage capacity in the case of floods, and freezing and bursting of pipes for low temperatures.

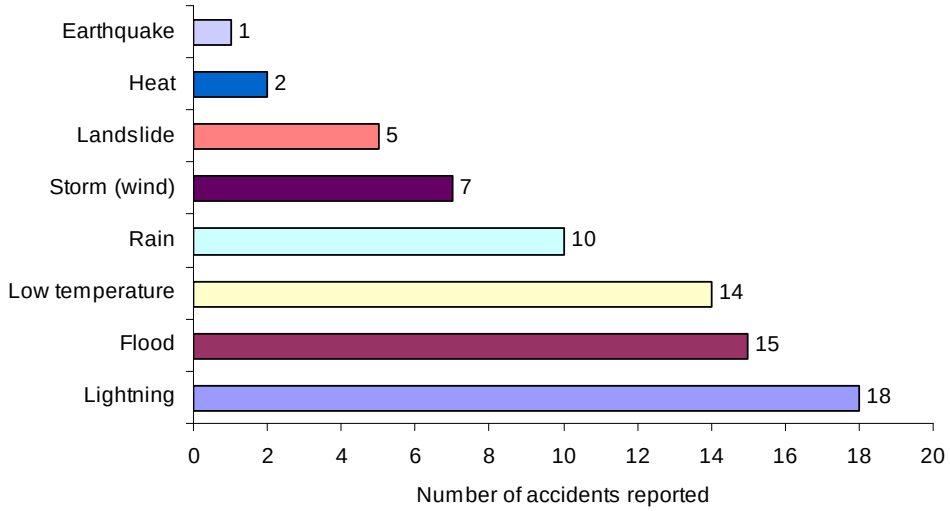

Figure 5: Natural-event triggers in the Natech accidents reported by the responding countries in the frame of this study.

The lessons learned and recommendations provided with the reported Natech cases address organisational aspects but also technical issues. Examples of technical recommendations for preventing the occurrence of a Natech accident induced by freezing are, for instance, choosing the appropriate pipe geometry or heating the vulnerable pipe segments. In the case of floods the construction of floodwalls or the installation of retention ponds under tanks were indicated as measures to prevent or mitigate the consequences of a flood-triggered Natech accident. General lessons learned draw attention to the importance of safety during start-up of a plant after having been in stand-by mode due to a natural hazard or disaster. The importance of standalone emergency lifelines was also highlighted.

5.1 Conclusions on learning from Natech accidents

The conclusions from this section of the questionnaire are:

1. Chemical accidents triggered by natural hazards and disasters have occurred in 54% of the responding countries between 1990 and 2009, making Natech events a relevant source of risk.
2. The most frequent natural-hazard triggers in the reported accidents are lightning, floods and low temperature.
3. The main final scenarios reported are atmospheric releases, liquid spills and fires. Explosions and solid releases occurred to a lesser extent.
4. Some of the Natech accidents reported in the frame of the survey resulted in fatalities and injuries.
5. Lessons learned from past Natech accidents are often available and should be widely and systematically disseminated.

6 Natech awareness and risk reduction

In order to assess the level of awareness and knowledge of Natech risk and its reduction we asked respondents to answer 10 targeted questions by ranking their answers from 1 (Disagree strongly) to 5 (Agree strongly). A ranking of 3 was considered neutral and was interpreted as possibly indicating a lack of adequate information to judge the situation. These questions were answered by 13 survey participants out of 14. The first question referred to the Natech awareness of the survey respondents (Figure 6). The mean value of the 13 replies is 4.5 and therefore quite high, indicating that the respondents have heard about the concept of Natechs.

The situation looks different for the question if risk managers and safety professionals in industry in the respective countries are aware of the concept of Natechs. The sample mean of the answers to this question is 3.1 and indicates an overall neutral opinion. However, 6 respondents (46%) believe that there is some level of Natech awareness in industry (Figure 7). Three respondents (23%) disagree with this statement.

Overall, there is slight agreement among the respondents that Natech accidents are discussed among those in charge of chemical-accident prevention and mitigation in their countries, as indicated by a sample mean of 3.6 (Figure 8). In fact, 7 countries (54%) show slight or strong agreement with this statement. A mean value of 3.9 and therefore stronger agreement is obtained for the answers to the question if Natech events are discussed among those in charge of natural-disaster management in the respective countries (Figure 9). This accounts for slight to strong agreement of 9 responding countries (69%). In our experience this assessment may be optimistic as past Natech accidents indicate that authorities and first responders to natural disasters may not be adequately prepared for situations where a simultaneous response to a chemical accident is required.

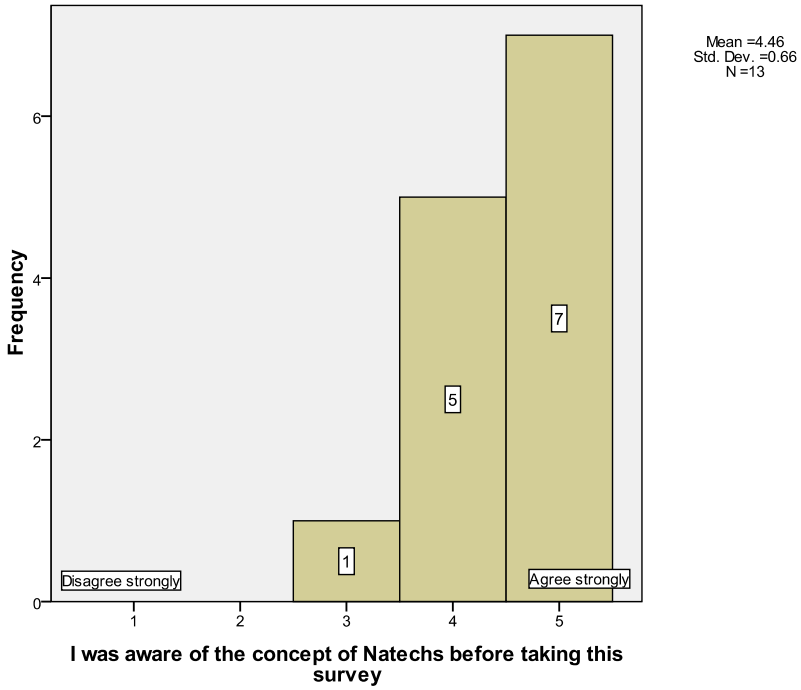

Figure 6: Ranking of responses to Question 8a of the Natech survey.

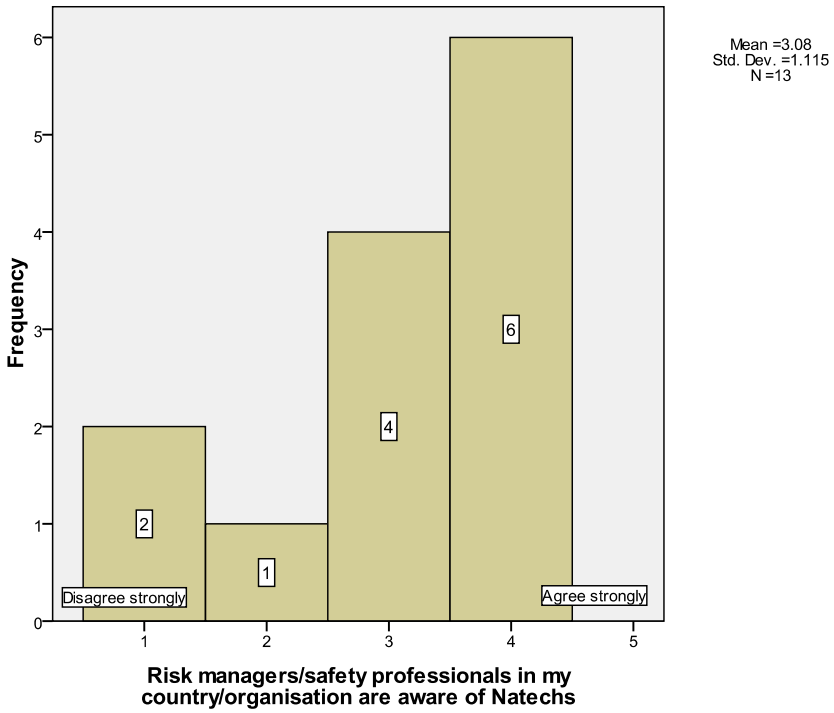

Figure 7: Ranking of responses to Question 8b.

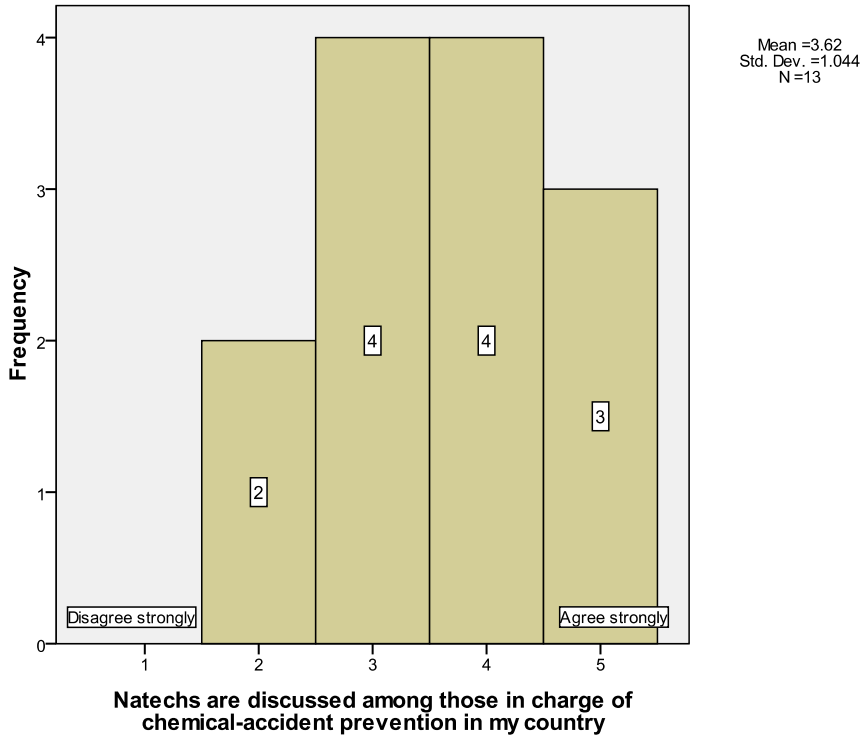

Figure 8: Ranking of responses to Question 8c.

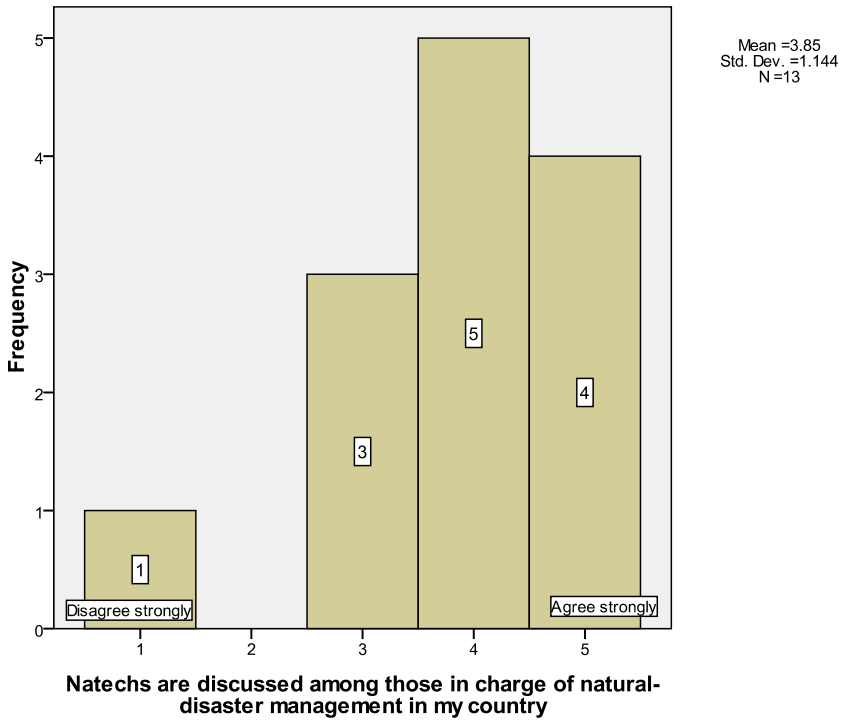

Figure 9: Ranking of responses to Question 8d.

The survey participants expressed a neutral opinion (sample mean = 3) to the question if there is enough emphasis on Natech risk reduction in the laws and regulations for chemical-accident prevention and mitigation in their countries, with almost as many respondents disagreeing (39%) and agreeing (46%) (Figure 10). There is slight disagreement (39%) to a neutral opinion (39%) that there is adequate knowledge on the dynamics on Natechs among the respective country's competent authorities (Figure 11) with a sample mean of 2.9. The existence of adequate training in Natech risk reduction of a country's competent authorities is overall judged neutral to slightly positive with a sample mean of 3.2 (Figure 12). Six countries (46%) slightly agree that this training is adequate.

Overall, the respondents indicate slight agreement (sample mean 3.4) that current practices for chemical-accident prevention and mitigation in the respective countries provide for adequate protection of citizens against possible Natech events. Of the 13 replies received, 8 (62%) expressed slight agreement (Figure 13). This trend follows the one observed in the previous question on the effectiveness of regulations in preventing Natech accidents (Figure 3).

The responses to the question on whether current industry risk assessment methods adequately take into consideration Natech events indicate that the survey participants are almost equally divided into two groups: those who agree with the statement (54%) and those who disagree with it (46%). This is shown in Figure 14. The observed dichotomy in the replies may be due to different practices in the responding countries that put a higher or lower emphasis on Natech risk. As a result, however, Natech events seem not to be taken adequately into account in the current industrial risk assessment process in 46% of the responding countries. This could have resulted in low levels of preparedness for potential Natech accidents.

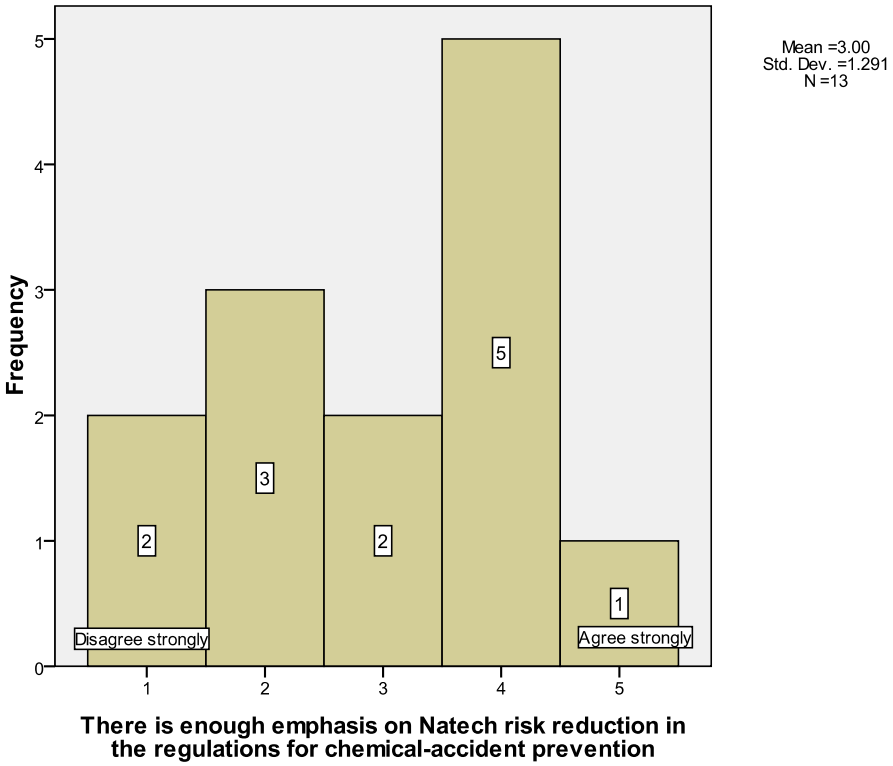

Figure 10: Ranking of responses to Question 8e.

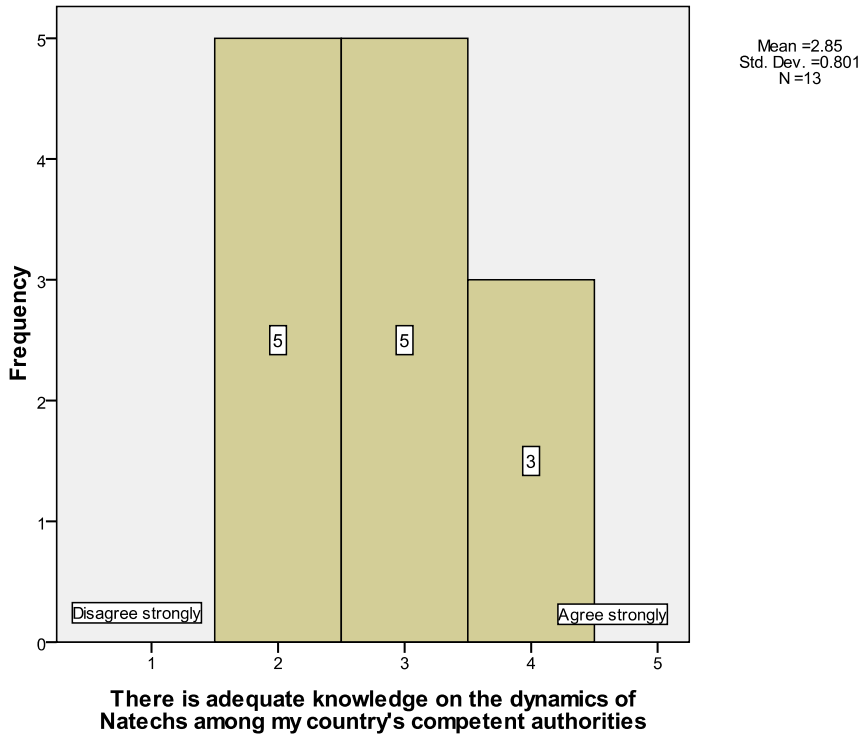

Figure 11: Ranking of responses to Question 8f.

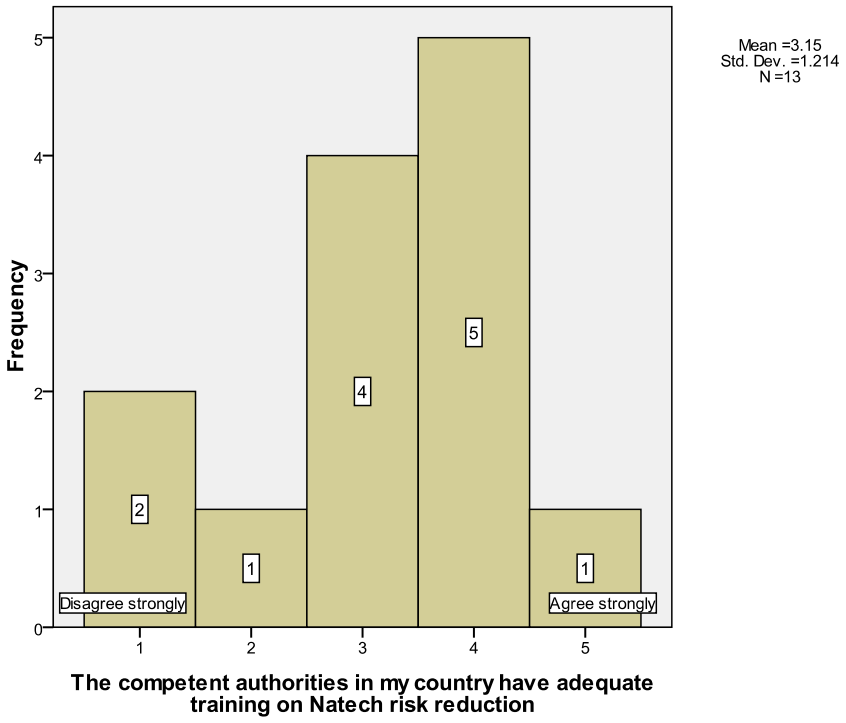

Figure 12: Ranking of responses to Question 8g.

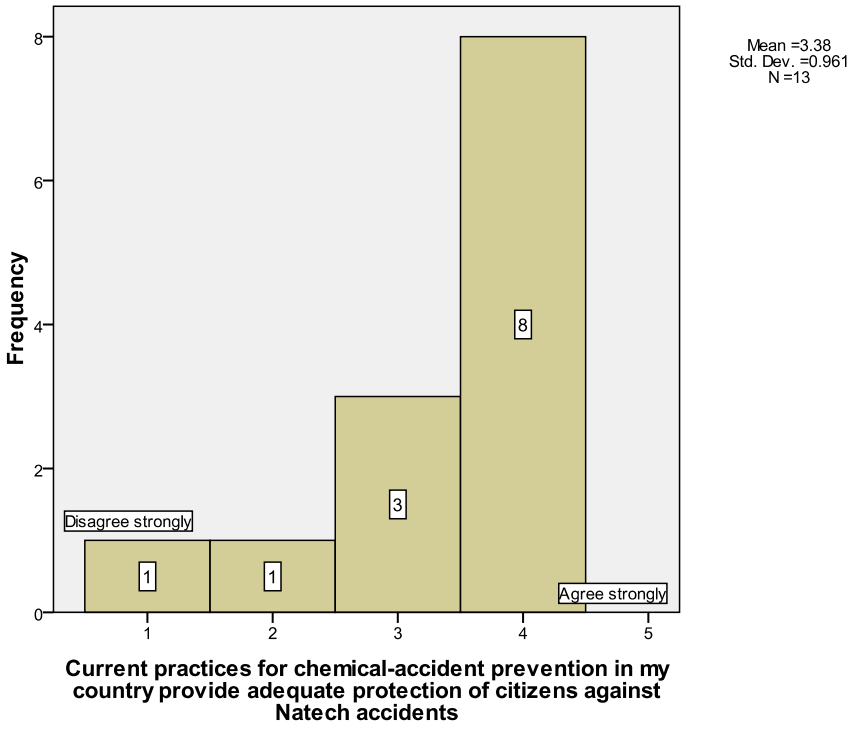

Figure 13: Ranking of responses to Question 8h.

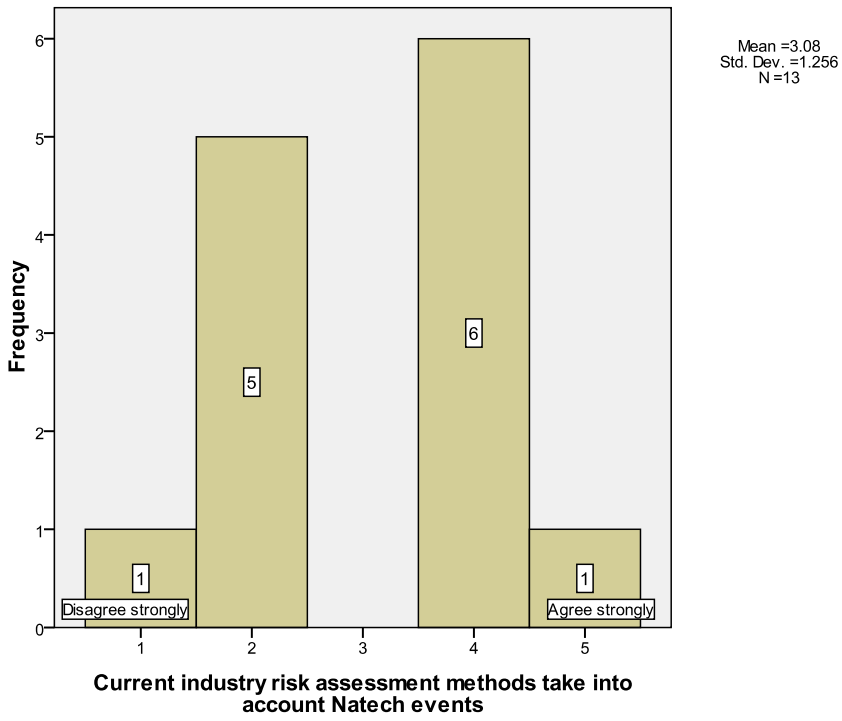

Figure 14: Ranking of responses to Question 8i.

The replies to the question on whether design and construction of buildings and other structures in industry according to the adopted building codes in the respective country provide sufficient protection against Natech accidents result in a mean value of 3.4 (Figure 15). This suggests a positive trend towards agreement with ca. 62% of the respondents indicating that they concur with the question's statement either slightly or strongly. However, as already discussed in Section 3.1 the primary objective of building codes is to ensure life safety, but not necessarily to prevent hazardous-substances releases. It is therefore uncertain if current building codes provide protection against Natech accidents.

In Figure 16 the responses to Questions 8a-8j are summarised to allow for an easier comparison of the replies that describe the state of awareness and knowledge on Natech risk reduction. The subcategories strong and slight (dis)agreement were combined under the categories "Agree" and "Disagree". Overall, the survey participants believe that awareness on Natech risk exists both in the chemical-accident prevention and natural-disaster management communities. They are, however, uncertain about whether there is enough emphasis on Natech risk reduction in the regulations on chemical-accident prevention. Natech awareness in industry is considered significantly lower than for competent authorities and almost half of the responding countries feel that Natech risk is not adequately taken into account in the industrial risk assessment process. The existence of adequate knowledge on the dynamics of Natech accidents among competent authorities ranks lowest. These issues point towards a need for better awareness raising and risk communication, and the development of specific methodologies and tools for including Natech in industrial risk assessment.

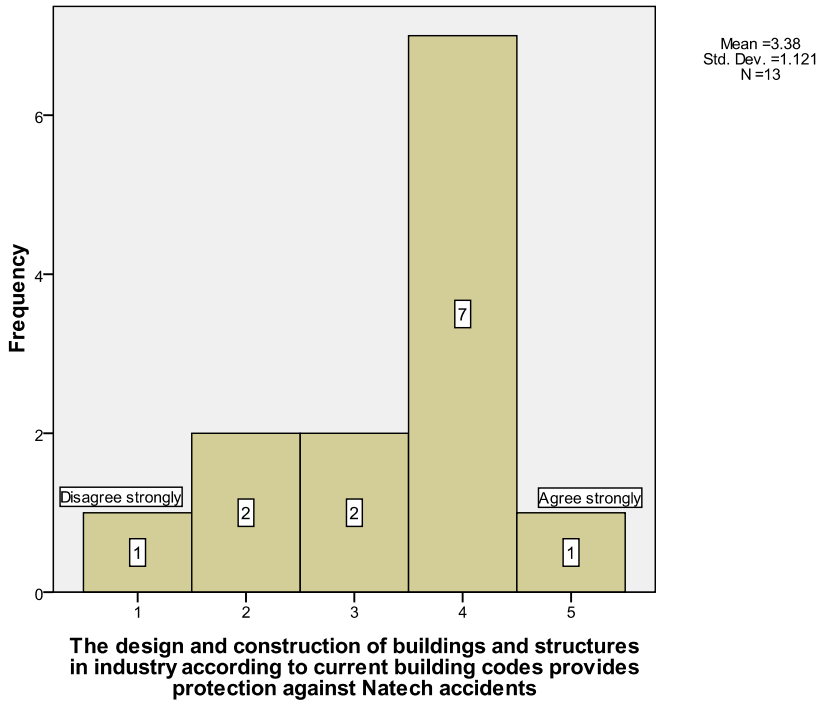

Figure 15: Ranking of responses to Question 8j.

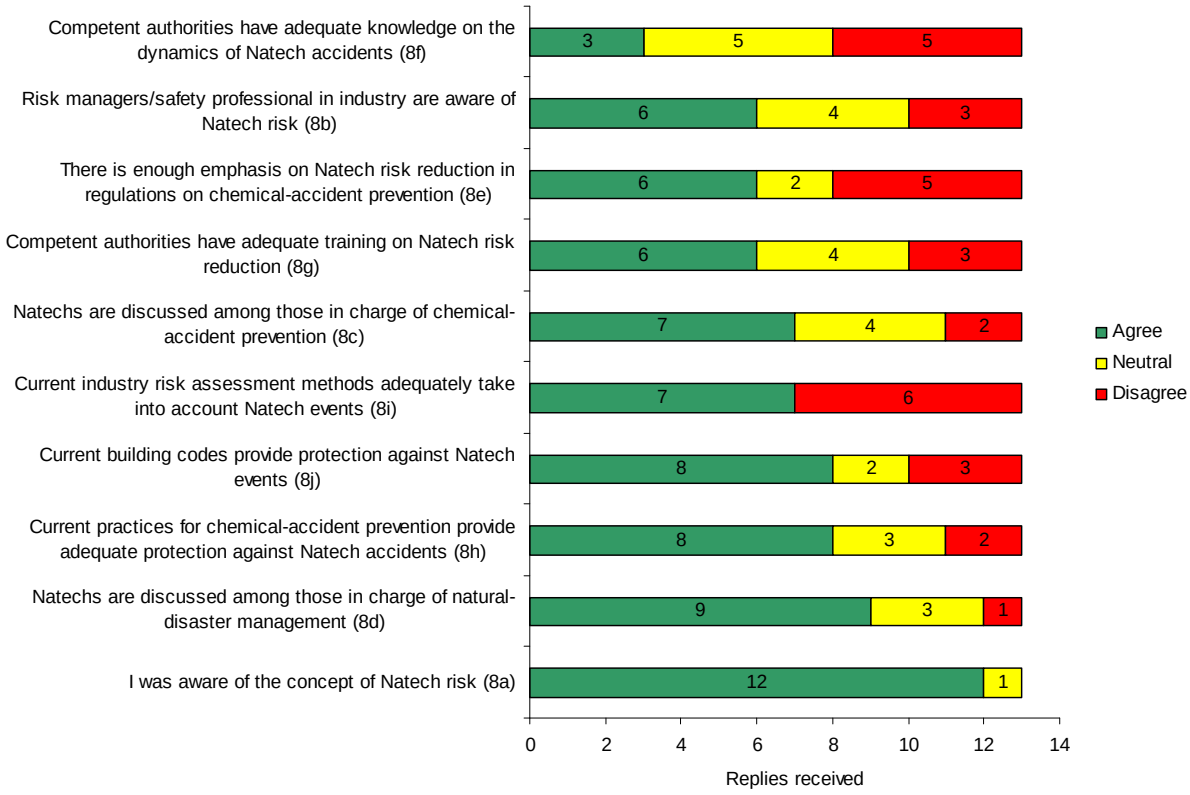

Figure 16: Summary graph of the responses to Questions 8a-8j of the Natech survey.

The survey respondents' opinion on how susceptible their respective countries are to a natural event causing a chemical accident was ranked from 1 (low susceptibility) to 5 (high susceptibility) and resulted in a sample mean of 2.8 based on 13 received replies (Figure 17). This suggests an overall trend towards moderate perceived susceptibility. In fact, 8 countries (62%) indicated a moderate susceptibility to the occurrence of a Natech accident.

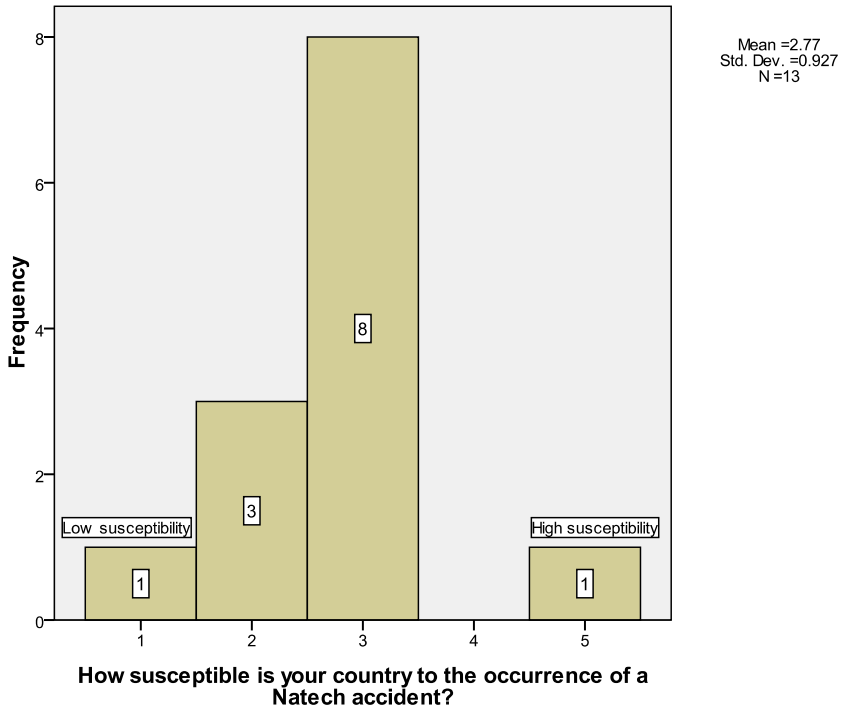

Figure 17: Ranking of responses to Question 9a.

We also asked survey participants which type(s) of natural hazard(s) they would in their perception be most concerned about with respect to triggering a Natech accident in their respective country. In this context we had categorised natural hazards into geological and weather-related events with further subcategories for both hazard groups. A detailed break-down of the natural-hazard categories of most concern is presented in Figure 18 which is based on 14 responses. The first 5 natural hazards believed to be of concern for triggering a Natech accidents are river floods, storms, followed by heavy rain, flash floods and lightning. The first geological hazard of concern is earthquakes which ranks in 7th place together with storm surge, landslides and wildfires.

Combining Figures 5 and 18 provides a comparison of the ranking of natural events that have caused the Natech accidents reported in the frame of the survey and those that are perceived to be of the biggest concern for causing a Natech accident in the respondents' countries (Figure 19). The comparison shows that the perceived risk from lightning and in particular low temperatures seem to be underestimated while the risk from high winds and earthquakes is overestimated. While caution needs to be exercised in the interpretation of Figure 19 as the spatial distribution of natural hazards between countries may not be uniform. The hazards lightning, floods, low temperature and high winds are, however, common in all responding countries.

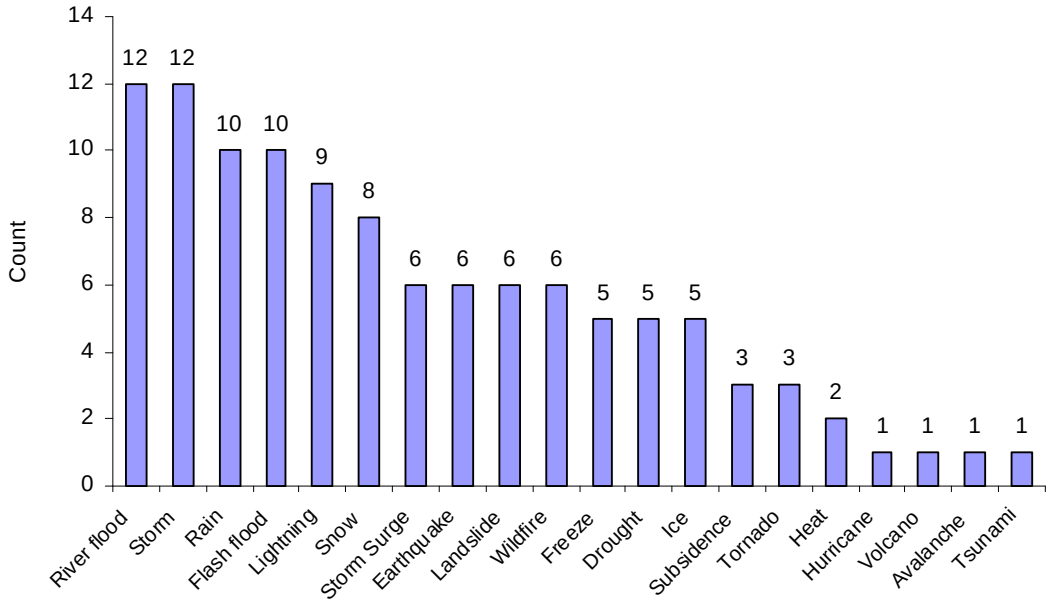

Figure 18: Ranking of natural hazards perceived to be of concern for causing a possible Natech accident in the survey countries. The numbers indicate how many countries expressed concern with respect to a particular natural hazard. Not all hazards can occur or are of equal relevance in all the responding countries.

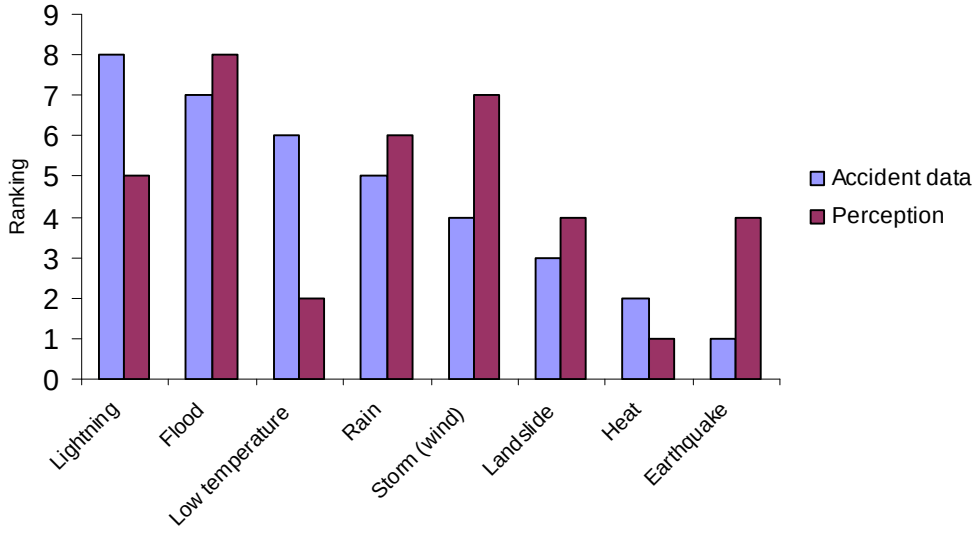

Figure 19: Ranking of natural-event triggers that caused Natech accidents (frequency of cause) and those that are perceived to be of biggest concern for triggering a Natech accident (risk perception).

The level of satisfaction with the steps taken by a country or organisation to reduce the possibility of occurrence of a Natech accident is shown in Figure 20. The analysis was based on 13

responses and yielded a sample mean of 3.5 which indicates a tendency towards satisfaction. A more detailed analysis showed that 12 countries (92%) expressed moderate to high satisfaction.

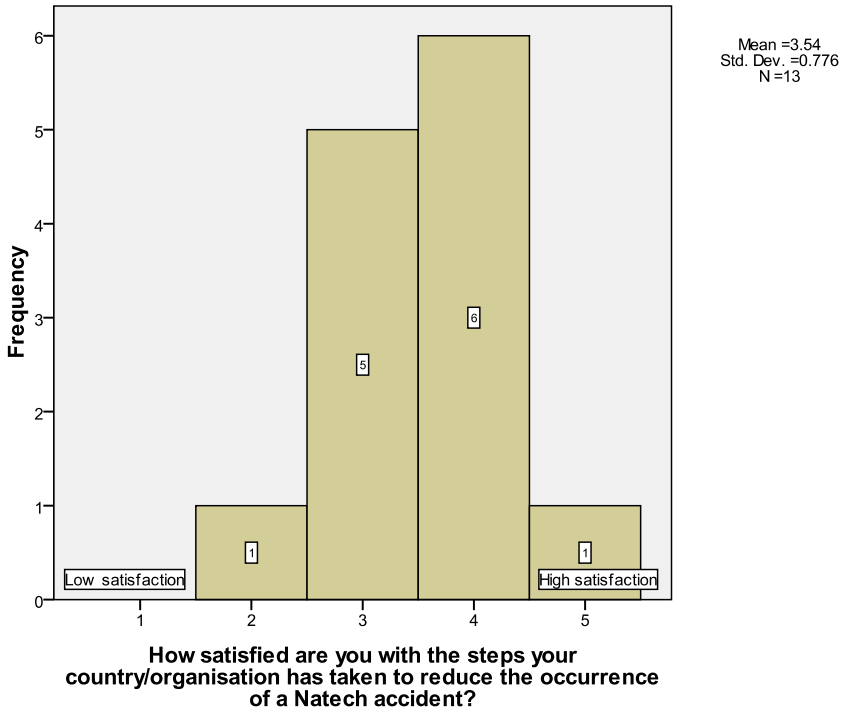

Figure 20: Ranking of the survey responses to Question 9c.

The respondents were asked to explain why they were satisfied with the Natech risk reduction steps taken in their countries or organisations, or when their satisfaction was low why not. Eight survey participants provided further comments which are shown in Table 5. In general, satisfaction was attributed to the existence of legislation or codes and standards, as well as natural-hazard maps in some countries. Government incentives as a means to promote preventative measures for Natech risk reduction also increased satisfaction. Despite indicating some satisfaction with the steps taken to reduce Natech risk, improvements with respect to the development of dedicated guidelines and technical standards were suggested.

	Why are you or why are you not satisfied with your country's Natech risk reduction steps?
1	There are chances for further improvement, such as: + Guidelines for the consideration of natural hazards in plant design, operation and maintenance, hazard analysis, safety documents and emergency plans of operators. + A guideline for the consideration of natural hazards in inspecting establishments according to the Seveso-Directive. + Special Technical Codes for the structural engineering of plants containing hazardous substances. + Drafting and communication of integrated natural hazard risk maps. + Implementation of a special concept for the risk and crisis communication of natural hazards.
2	Good knowledge of hazard-related physical processes; appropriate mapping/zoning;

	relatively efficient warning systems; pretty well-enforced regulation (e.g. land-use planning); efficient emergency response.
3	Mapping of areas exposed to landslides and flooding is performed. Governmental subsidy is given to preventive measures in certain areas.
4	Need for more human and technical resources.
5	Compliance with Seveso II Directive.
6	According to the Law on Planned Economic Activity Environment Impact Assessment new planned establishments have to take into account possible natural hazards. These hazards and their possible consequences can influence the decision of permission for such an economic activity. For the existing establishments the requirement to prepare plans of civil protection preparedness for an emergency and/or internal plans is imposed. The plans should consider natural hazards and foresee preventive measures. Also, the actions and coordination with special services in case of an emergency should be described in the plans. My country is susceptible to quite a narrow range of natural disasters. Nevertheless, there are no legal acts, rules or guidelines which clearly address even the existing range of natural hazards and their possible impact on industrial plants.
7	The implementation of the Seveso II Directive required the identification and analysis of Natech risk, even at the operator level. The authorities with competences in the field of risk prevention and management developed response scenarios. Based on existing data, the probabilities of Natech risk occurrence were estimated.
8	I am quite satisfied with risk mapping, which is now in progress, but I see that our country is very slow in this. Our country will be able to publish flood risk maps in 2013. This year (2010) there were huge floods in our country, highlighting that his problem is very important.

Table 5: Reasons for (dis)satisfaction with a country's measures to reduce Natech risk.

Surprisingly many respondents (7 out of 13) indicated that their country had developed Natech risk maps for all or parts of its territory (Figure 21). This result was at first surprising as it is our experience that true Natech risk maps hardly exist. A closer look at the additional remarks provided by the respondents with respect to this question clarified, however, that while many countries have natural hazard/risk maps for some natural hazards, hardly any of them have specific Natech risk maps (Table 6). Where these Natech risk maps exist they are usually a simple overlaying of natural and technological hazard maps. While this gives an indication of possible Natech hot spots it may not allow a realistic assessment of the Natech risk. The conclusion from this question would therefore have to be that there is a lack of Natech-specific risk maps in the responding EU Member States.

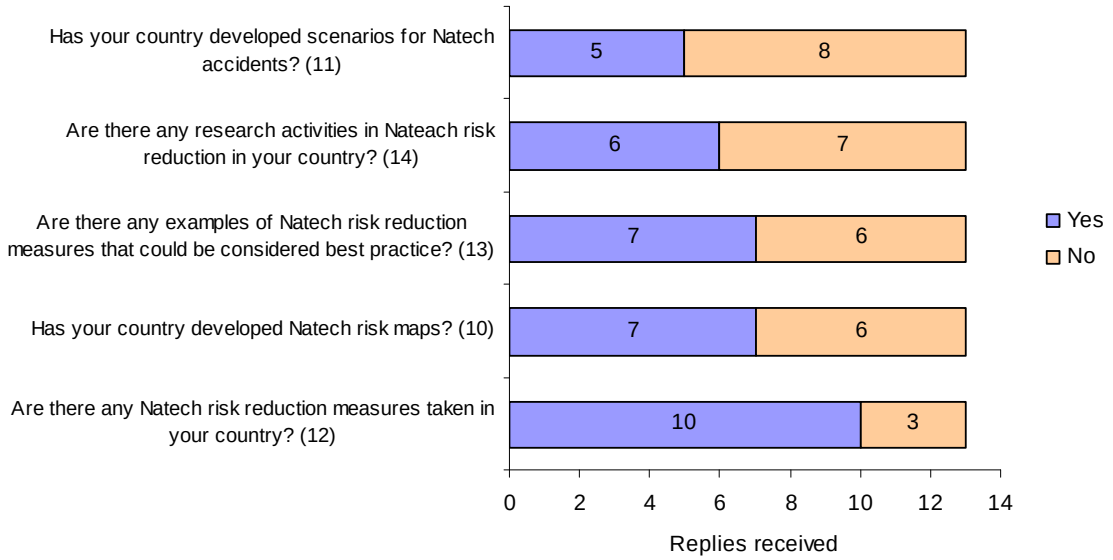

Figure 21: Number of Yes/No counts for Questions 10-14.

	For which natural hazards do you have Natech risk maps?
1	There are maps on possible impacts by rain, snow, wind, earthquakes, flood plains and flood risks on the regional or local level, but there are no special Natech risk maps.
2	All possible risks can be retrieved from websites, e.g. for flooding. Linking these maps to chemical plants however hasn't been a major element of designing these maps; it is more a collection of all kinds of possible risks.
3	Floodable areas with Seveso installation overlapping. Landslide risk maps with Seveso installation overlapping.
4	Flood risk maps (for coastal and river flooding) are available for the parts of our territory.
5	Only natural risk maps: Hazard mapping for earthquake (PGA; site effects); flooding (based on historical observation and/or modeling); subsidence; avalanche; hurricane (on-the-spot modeling of hurricane path/expected landing area).
6	Mapping of areas exposed to flooding and landslides. These maps are, however, not specific for chemical installations at risk.
7	In some cases there are Natech risk maps drawn up by local authorities. Generally Natech maps can be produced on request by analysis of the overlapping of Seveso plants locations with natural risk areas using geographic information systems available to central and local authorities.
8	Floods (in progress), landslides

Table 6: Natural hazards for which Natech risk maps were specified to exist in the responding countries.

With respect to the question if specific Natech scenarios had been developed, only 5 countries (38%) out of 13 replies answered in the positive, while 8 countries (62%) have no specific Natech scenarios (Figure 21). The absence of scenarios could have resulted in a low preparedness level

for possible Natech accidents in the majority of the responding countries. A description of the reported scenarios is provided in Table 7.

	Description of the developed Natech scenarios
1	Difficult to answer: free scenario construction (What-if-based) seems to be better then pre-prepared scenarios.
2	As part of safety reports, it is compulsory for industrial facilities to: + Identify those accident sequences that are potentially triggered/initiated by natural hazards. + Demonstrate an appropriate level of control of those accident risks.
3	In the Safety Reports Natech events must be included by operators and evaluated by competent authorities. For example in an industrial park the competent authorities assessed a scenario of an overflow from artificial basin (induced by heavy rain) interesting a chemical plant.
4	An earthquake may cause leakage.
5	Scenarios can be found in safety reports and emergency plans (eg. ammonia tank damage as a result of an earthquake, accidental pollution by flood).

Table 7: Existing specific Natech scenarios reported in the frame of the survey.

Natech risk reduction measures appear to be more widespread than specific Natech scenarios in the responding countries, with 10 (77%) out of 13 countries indicating that specific measures exist in their countries (Figure 21). A description of these measures is given in Table 8. A more detailed analysis of the comments in Table 8 suggests that the discussed Natech risk reduction measures lie within the frame of the Seveso II Directive on the control of major accident hazards involving dangerous substances or other legislation on pollution control. It is, however, not clear how detailed these requirements are in addressing Natech risk reduction. The Seveso II Directive, for example, requires that external hazards be considered when preparing the safety document. It does, however, not provide any guidance on how this should be accomplished, nor does it propose any methodologies to be used in this context.

	Describe the Natech risk reduction measures in your country/organisation
1	+ Consideration of natural hazards in safety documents and emergency plans of operators. + Requirements for installations for handling of substances hazardous to water in flood plains. + Consideration of establishments in flood risk maps. + Avoiding sites of establishments in coal mining areas.
2	Natural disaster response plans of chemical companies and governments.
3	In the framework of Seveso II fulfillment.
4	Use of flood warning provision and flood management plans.
5	+ Consideration of natural hazard in operators' safety report. + Fire forces and other emergency-related organizations are increasingly considering Natech situations when designing emergency response or contingency plans: - Monitoring, detection and warning dissemination; - Number and profile of staff involved; - Equipment and procedures; - Lessons learned approach.

6	+ Oil storage sites often describe potential effects of lightning. + Large sites in the southern part of our country describe risks involving winds. + Risks of dam breaking due to heavy rains are considered. + Risks of the spreading of polluted surface water due to flooding are considered within areas with polluted ground.
7	Case by case at local level.
8	According to the Regulations on Prevention of, Response to and Investigation of Industrial Accidents the operator is required to prepare the Safety report. The Safety report must contain the information on the possible natural hazards and describe the measures which are taken in case of Natech events. Also according to the Law on Civil Protection all legal entities are required to prepare plans of civil protection preparedness for an emergency. These plans also should consider the possible natural hazards.
9	+ Risk analysis contained in the safety reports; accident scenarios analysed in the on-site plans for Seveso units. + Considering the natural disasters starting with the design phase of the technological installations; elaboration and review of security reports; elaboration, verification and review of action plans in case of emergencies.
10	+ Short analysis in the prevention of major accidents; + Flood plans for regions and plan to protect the population (under the responsibility of civil protection).

Table 8: Natech risk reduction measures in the surveyed countries.

With respect to Natech risk reduction measures that could serve as best practice 7 (54%) out of 13 countries replied positively (Figure 21). The examples that were provided in the frame of the survey as best practices are summarised in Table 9. Some of these examples are of a general nature, while a few best practices dedicated mainly to flood events are Natech-specific. This suggests that while the availability of best practices may currently be limited in some countries or restricted to a few natural hazards, some knowledge exists that could be transferred. The identification of best practices for Natech risk reduction is a priority area for future work.

	Examples of Natech risk reduction measures that could be best practice
1	For examples see: H.-J. Warm, K.-E. Köppke: Protection of existing and planned establishments and installations against hazardous environmental impacts, especially flood. UBA-Texte 42/2007; Chapter 4.4.3 and 7 (http://www.umweltdaten.de/publikationen/fpdf-l/3326.pdf)
2	These examples are of a more general nature, e.g. when flooding is foreseen train carriages with chemicals will be transferred to safer locations.
3	Environment Agency's flood mapping and warning system.
4	+ Consideration of natural hazard in operators' safety report. + Fire forces and other emergency-related organizations are increasingly considering Natech situations when designing emergency response or contingency plans: - Monitoring, detection and warning dissemination; - Number and profile of staff involved; - Equipment and procedures; - Lessons learned approach.
5	There is one site with a large amount of hazardous substances on site which is located

	close to the drinking water supply for a major city. The entire area is known as sensitive to landslides. Specific stabilizing measures have been taken to prevent what could be very serious scenarios. Within the licensing process for hazardous installations it is very common to give an assignment to the operator to investigate possible consequences on the establishment of climate change. There are some additional guidelines on prevention of natural hazards which are not however focused on Natechs.
6	EUROSOT 2005: An emergency response exercise concerning the consequences of a major earthquake involving a wide industrial area, was carried out in Eastern Sicily in 2005 (http://eurosot.protezionecivile.it).
7	+ Risk analysis contained in the safety reports; accident scenarios analysed in the on-site plans for Seveso units. + Establishment and enforcement of policies to prevent major accidents at facilities involving dangerous substances. + Elaboration of security reports, risk analysis and on-site emergency plans. + + Drawing up plans for risk analysis and coverage.

Table 9: Natech risk reduction measures that were provided as examples of best practices.

About 46% of the respondents (6 out of 13 countries) indicated that there are ongoing research activities or projects on Natech risk reduction in their respective countries (Figure 21). This is an interesting result as it shows that there is awareness about Natech risk coupled with the realisation that there is a lack of knowledge and therefore research is needed for effective Natech risk reduction. The Natech research activities and projects, as well as the countries they are performed in are listed in Table 10.

Country	**Natech research activity or project**
Czech Republic	Project of the Ministry of Environment: SPII 1a10 45/07 "Complex interaction between industry and nature events with respect to major accidents" – Better understanding of Natechs; the highest priority are floods/chemical installations interactions.
France	Selected references: + Ministry of Environment: Program on NaTech risks and technical support to competent authorities. + INERIS: Research program on NaTech risk assessment, mitigation and lessons learned. + CETE-Méditerranée: Vulnerability reduction of industrial facilities to natural hazards.
Germany	K.-E. Köppke *et al*.: safety arrangements and measures due to hazards by precipitation and floods, Umweltbundesamt (ongoing).
Italy	Research activities reported in the scientific literature but not implemented in national programmes or systems.
Netherlands	In the framework of the National Safety Strategy research is executed.

Table 10: Information of Natech-specific research activities and projects in some of the survey countries.

6.1 Conclusions on Natech awareness and risk reduction

Our conclusions from the analysis of this questionnaire section are as follows:

1. Awareness of Natech risk exists among the respondents.
2. The respondents tend to believe that there exists some degree of Natech awareness in industry but less than among competent authorities.
3. The survey participants indicate that Natechs are discussed among authorities for both chemical-accident prevention and natural-disaster management. In our opinion the latter may be an optimistic assessment as past Natech accidents indicate that authorities and first responders to natural disasters may not be adequately prepared for situations where a simultaneous response to a chemical accident is required.
4. On average the respondents seem to be undecided on whether there is enough emphasis on Natech risk in current regulations on the prevention of chemical accidents.
5. The respondents show a slight tendency to believe that competent authorities do not have adequate knowledge on the dynamics of Natech accidents.
6. The existence of adequate training in Natech risk reduction of a country's competent authorities is overall judged neutral to slightly positive.
7. There is a slightly positive tendency to believe that current practices for chemical-accident prevention sufficiently protect from possible Natech accidents.
8. In almost half of the responding countries Natech risk seems not to be adequately taken into account in industrial risk assessment.
9. There is a slightly positive tendency to believe that the design and construction of buildings and other structures in industry according to buildings codes provides sufficient protection against Natech accidents. In addition, the respondents' moderate to high satisfaction with the steps taken in their countries to reduce Natech risk is attributed to the existence of legislation, technical codes or natural hazard maps. This overlooks the fact that the objective of codes and standards is to achieve life safety but not necessarily prevent secondary hazards, such as the possible release of hazardous substances.
10. The respondents expressed an overall moderate susceptibility of their countries to the occurrence of a Natech accident.
11. The responding EU Member States appear to be mainly concerned with river floods, storms, heavy rain and flash floods as potential triggers for Natech accidents. However, the most frequent accident triggers in the Natech events provided in the frame of the survey were lightning, floods and low temperatures.
12. There is a lack of specific Natech risk maps in the responding EU Member States. Natural hazard/risk maps for selected natural hazards exist in some regions.
13. There are few Natech-specific scenarios. This means that the preparedness level for possible Natech accidents may be low in the majority of the responding countries.
14. The majority of the respondents (77%) indicate that Natech risk reduction measures exist in their countries. These are, however, usually anchored in chemical-accident prevention or pollution control regulations which do not provide guidance on how Natech risk reduction should be undertaken nor do they recommend methodologies for Natech risk assessment.

15. Over half of the responding countries provided examples of Natech risk reduction measures that could be considered best practice. These are, however, mainly related to floods.
16. The threat of Natech accidents has been recognised, as well as the lack of specific data, models and tools, and almost half of the responding countries have ongoing or have launched research activities into Natech risk reduction.

7 Identifying needs and limitations

In order to identify the main reasons that limit a country or organisation from including Natech prevention strategies in their planning we asked the survey participants' opinion on 8 questions concerning factors that could influence the implementation of Natech risk reduction measures. These questions were answered by 12 survey participants who indicated their views on a 5-level scale from 1 (Disagree strongly) to 3 (Neutral) to 5 (Agree strongly).

The first question referred to lack of awareness as limiting factor, and the break-down of the individual answers is shown in Figure 22. The majority of respondents (58%) indicate slight or strong disagreement that awareness is a limiting factor in Natech risk reduction. This is also highlighted by a sample mean of 2.6. A different picture presents itself for the limiting factor lack of knowledge (Figure 23) where the respondents who disagree and those who agree are distributed in equal number (42%) around the central neutral value.

With respect to a lack of adequately trained personnel as factor influencing Natech risk reduction the respondents are equally divided (Figure 24) with an equal number (33%) of countries agreeing, disagreeing or expressing a neutral opinion.

Seven countries (58%) indicate slight or strong agreement that the lack of adequate resources hampers the inclusion of Natech risk reduction into countries' and organisations' planning (Figure 25). Three countries (25%) disagree slightly or strongly with this statement, resulting in a sample mean of 3.5. A slightly higher overall agreement (sample mean 3.7) is found for budget constraints as factor influencing Natech risk reduction as shown in Figure 26. This may be indicative of the perception that the costs of considering Natech risk reduction may outweigh the gains.

Over 58% of respondents (7 countries) disagree that the implementation of Natech risk reduction is adversely influenced by an organisation not feeling responsible for it (sample mean 2.4). The exact breakdown of replies is shown in Figure 27. The same number of respondents disagree that the problem originates in the fact that the responsibility of an organisation with regard to Natech risk reduction may not be defined (Figure 28). A similar trend is observed for liability and/or legal issues where 6 respondents (50%) disagree that this factor hampers Natech risk reduction (Figure 29). In contrast, 4 countries (33%) indicate slight agreement which points towards different practices in the responding EU Member States.

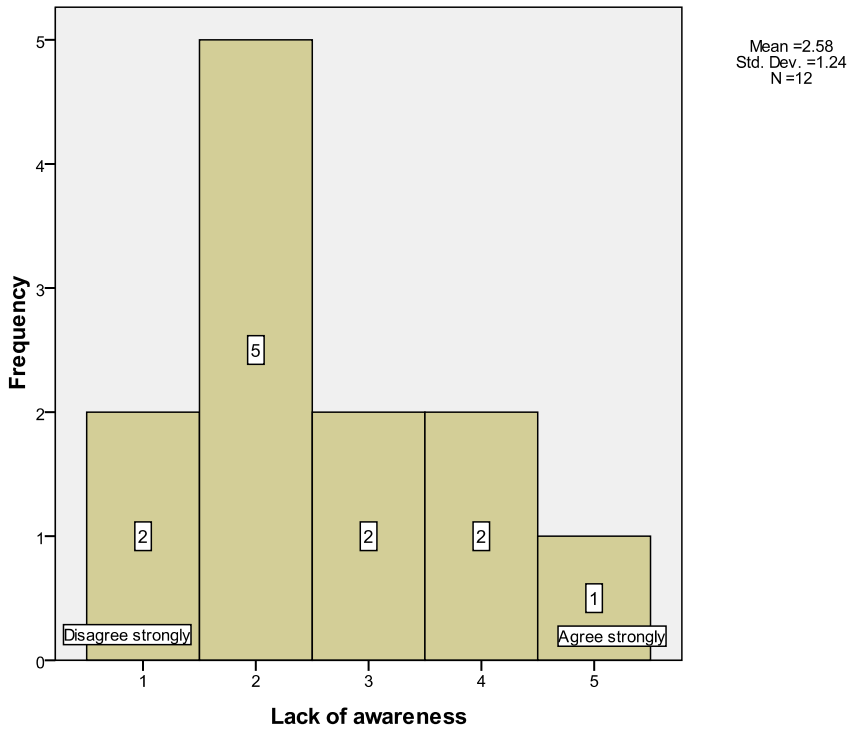

Figure 22: Ranking of survey responses to Question 15a.

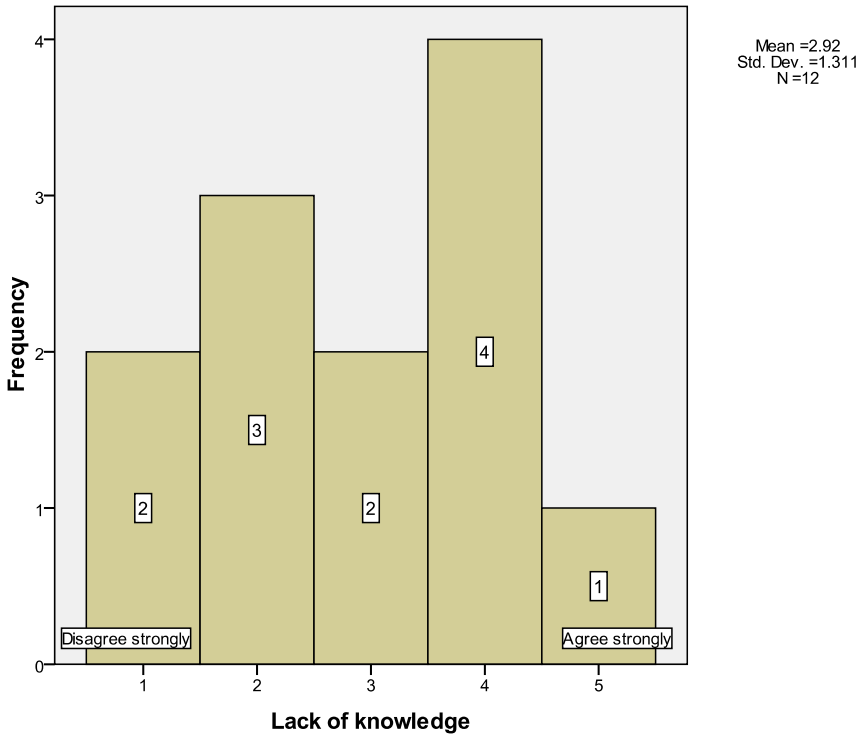

Figure 23: Ranking of survey responses to Question 15b.

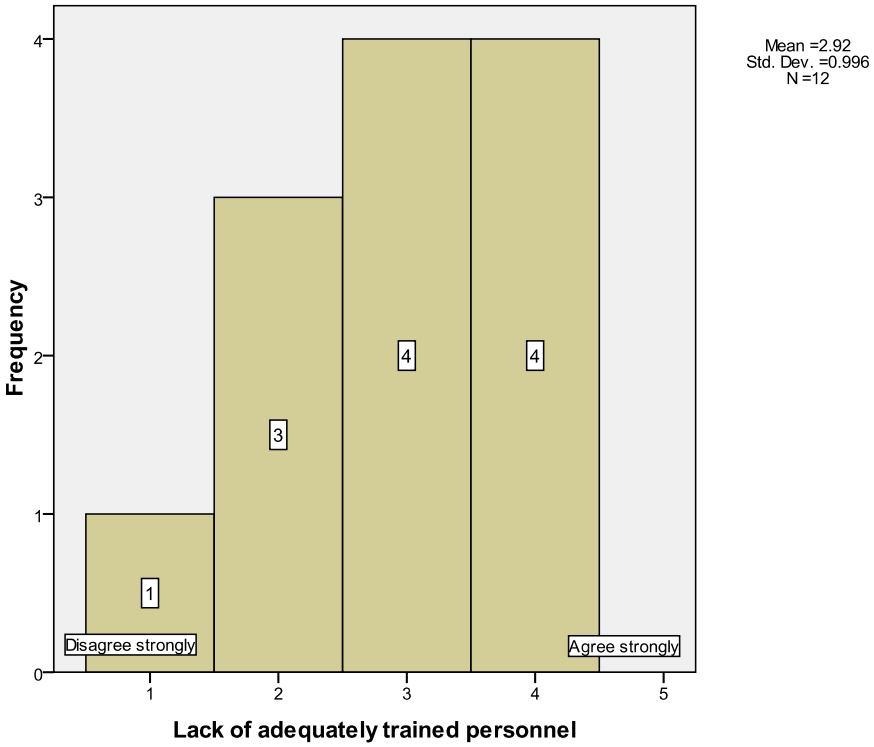

Figure 24: Ranking of survey responses to Question 15c.

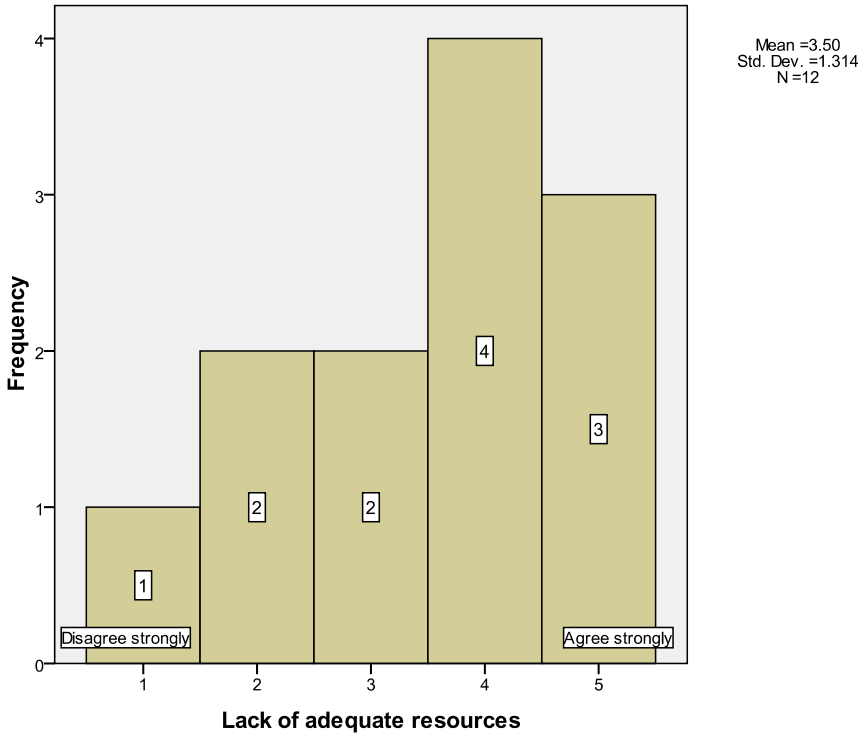

Figure 25: Ranking of survey responses to Question 15d.

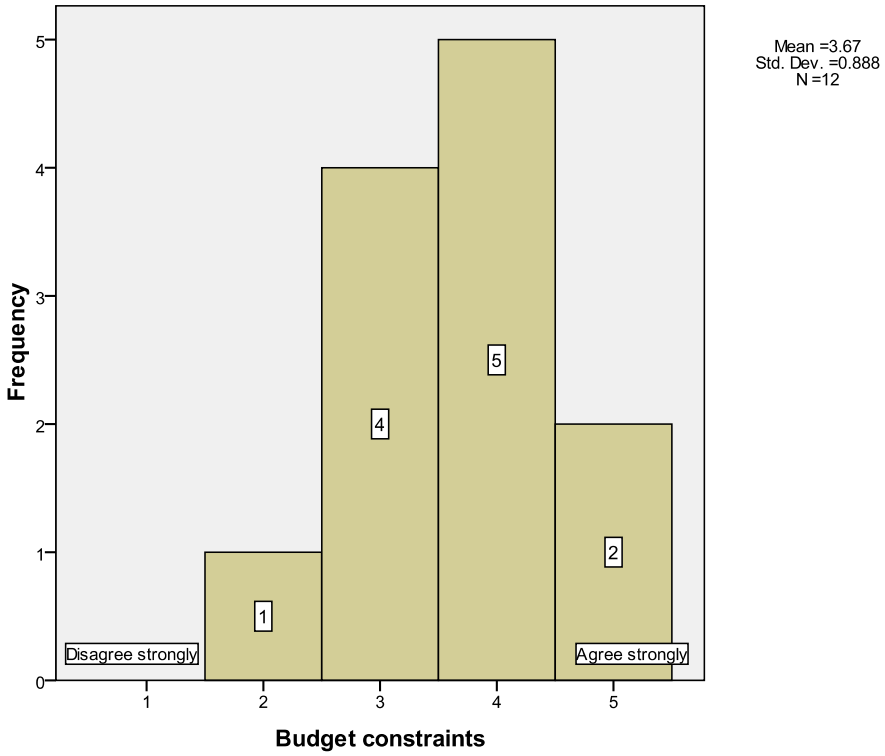

Figure 26: Ranking of survey responses to Question 15e.

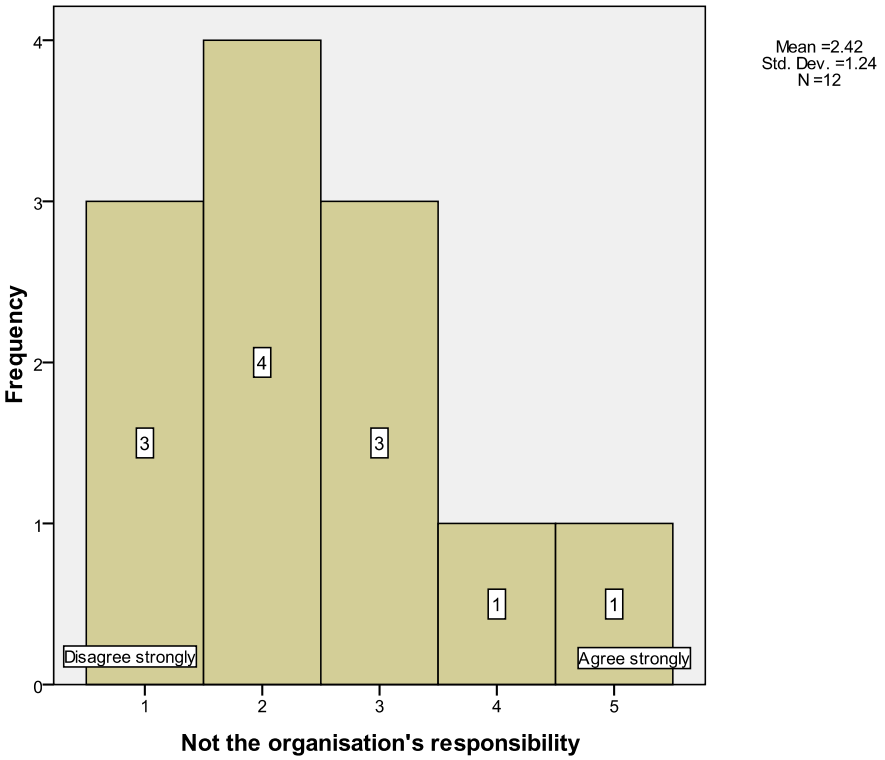

Figure 27: Ranking of survey responses to Question 15f.

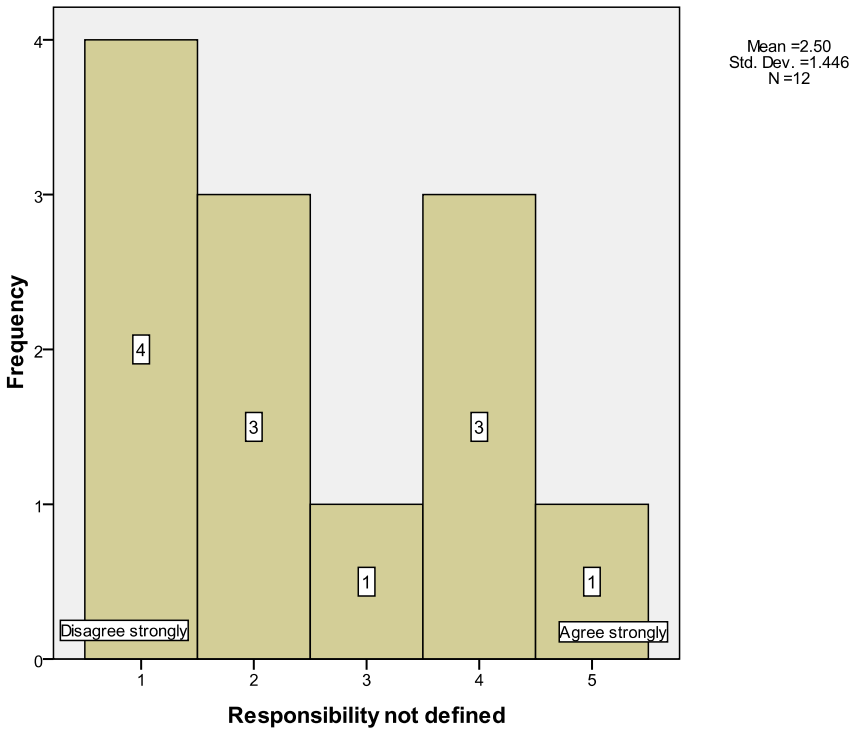

Figure 28: Ranking of survey responses to Question 15g.

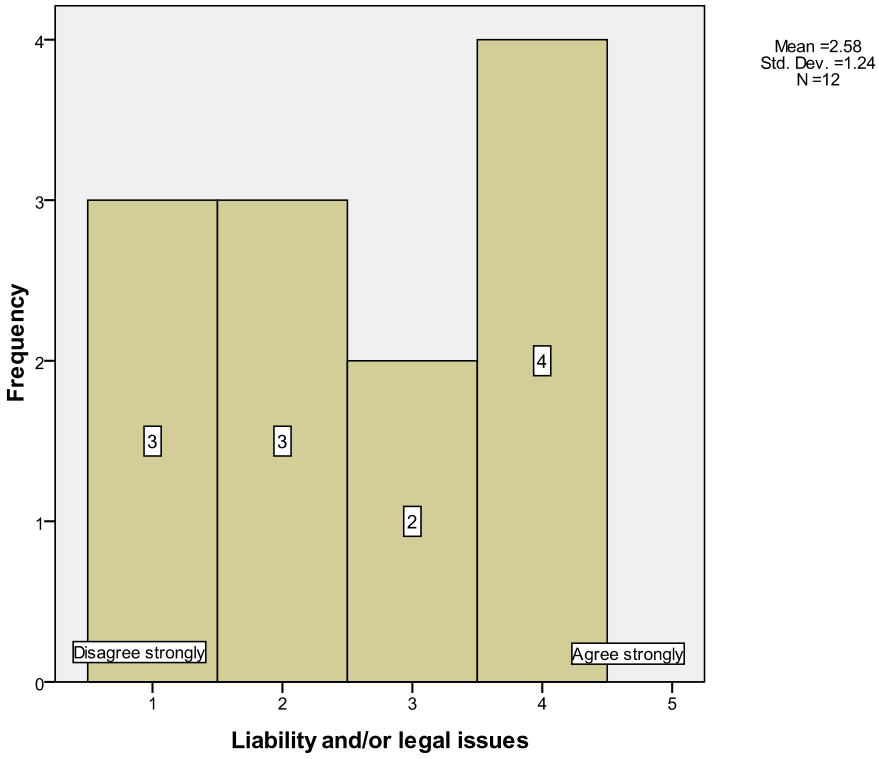

Figure 29: Ranking of survey responses to Question 15h.

The survey participants' responses to Questions 15a-h are summarised in Figure 30. The main factors limiting the inclusion of Natech risk reduction practices and measures in an organisation's planning appear to be budget constraints or a lack of adequate resources. The factors that influence the implementation of Natech risk reduction the least are awareness, responsibility or liability issues.

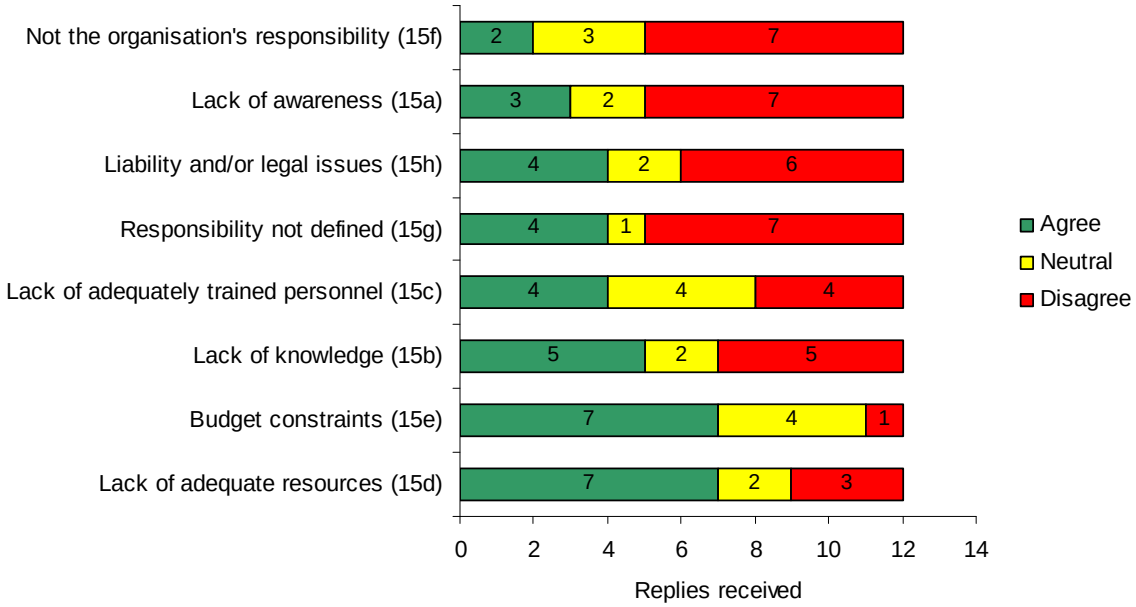

Figure 30: Summary graph of the responses to Questions 15a-h of the Natech survey on the main factors hampering the implementation of Natech risk reduction.

In the next question we collected the survey participants' opinion on what they felt was needed to guarantee effective Natech risk reduction in their respective country or organisation. To this effect the respondents' view on 5 dedicated suggestions was solicited, and they gave their ranking again on a 5-level scale from 1 (Disagree strongly) to 5 (Agree strongly). Overall, 13 countries replied to this section of the questionnaire. The first suggestion referred to whether training of officials in charge of chemical-accident prevention on Natech risk reduction was needed. Six countries (46%) slightly or strongly agreed with this (Figure 31), which is somewhat surprising as only 4 respondents (33%) indicated that the lack of adequately trained personnel was a limiting factor for Natech risk reduction (Figure 24). A stronger correlation between the two answers would have been expected. On the other hand, 5 countries (39%) slightly disagree that training of officials in charge of natural-disaster management on Natech risk reduction is needed (Figure 32). This indicates a tendency to believe that those dealing on a daily basis with natural-disaster management may be better informed about the existence and the dynamics of Natech accidents and therefore need less training than those dealing with chemical-accident prevention. This perception may be erroneous as it neglects the fact that a Natech event is a chemical accident whose trigger is, however, an external rather than an internal event.

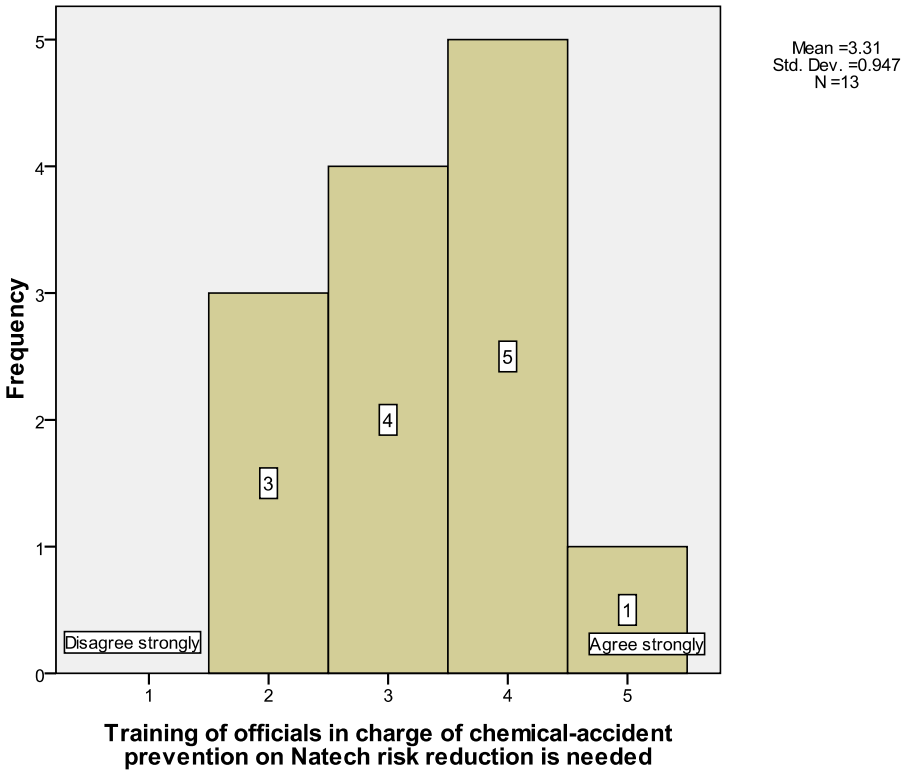

Figure 31: Ranking of survey responses to Question 16a.

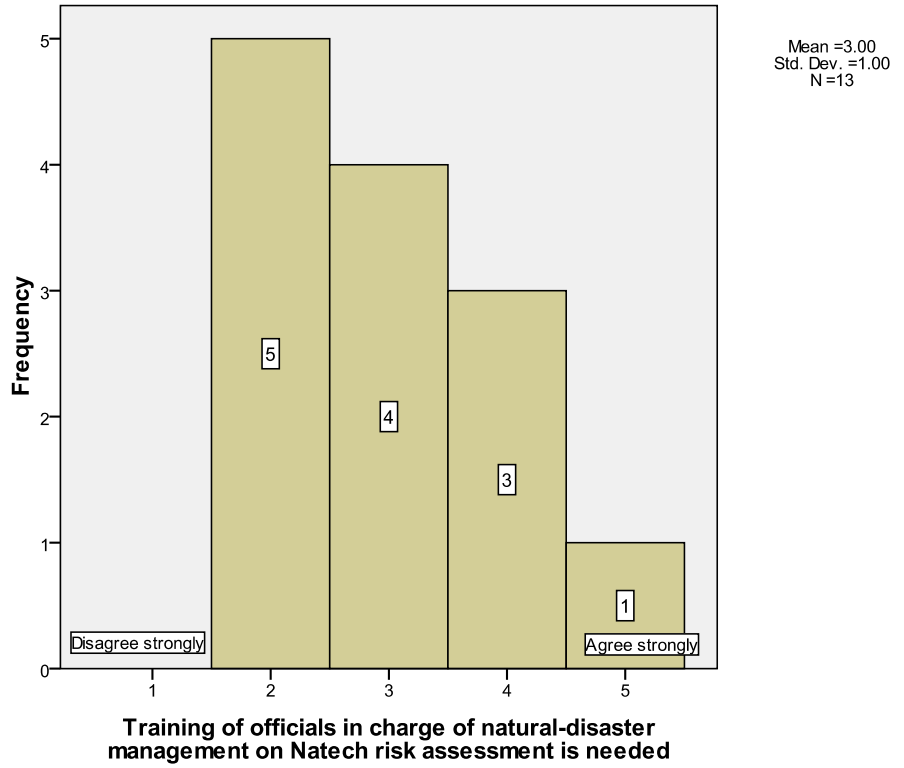

Figure 32: Ranking of survey responses to Question 16b.

A very clear trend toward strong agreement was observed when analysing the responses to the question on whether guidance on Natech risk assessment, prevention and mitigation is needed for operators of industrial establishments. Eleven respondents (84%) agreed slightly or strongly with this statement (Figure 33). As indicated before, the Seveso Directive, for example, does not offer any guidance to industry other than saying that external factors should be considered in the safety document. The same tendency was observed for the suggestion that guidance on Natech risk assessment at the community level is needed, where 62% of respondents showed slight or strong agreement (Figure 34). At the community level, guidance is needed for local emergency management to be able to prepare for a simultaneous natural disaster and chemical accident.

The respondents also agree (62%) that Natech risk maps to inform land-use planning decisions and emergency planning are needed (Figure 35).

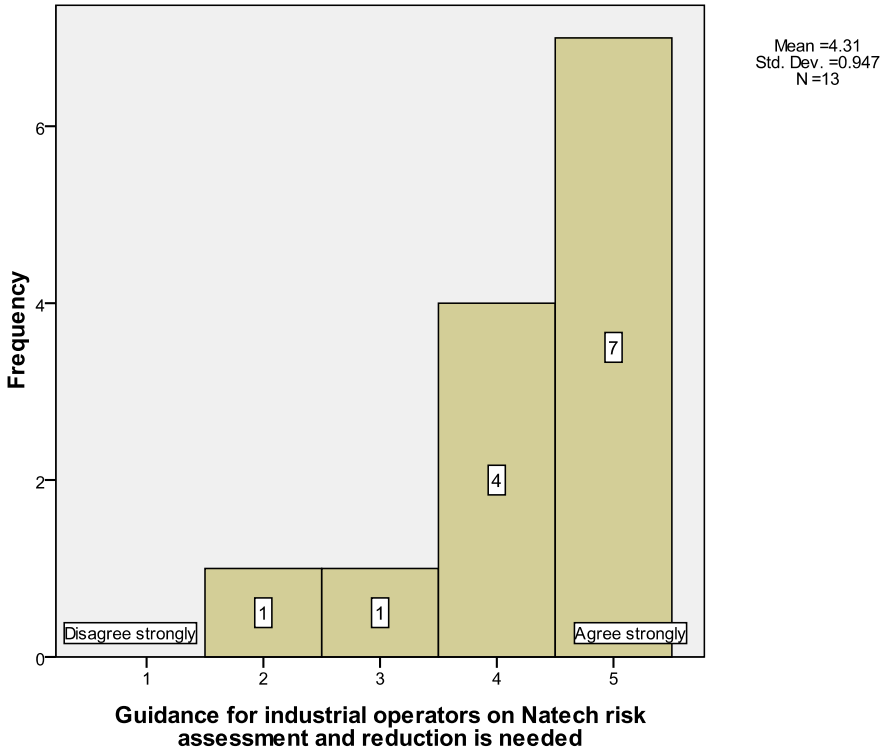

Figure 33: Ranking of survey responses to Question 16c.

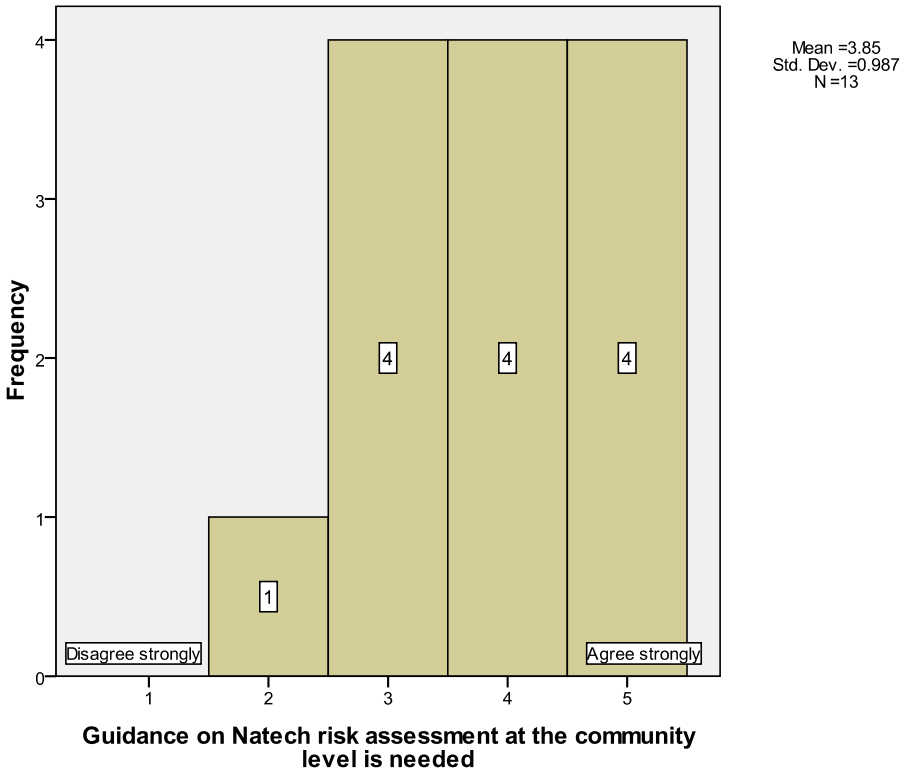

Figure 34: Ranking of survey responses to Question 16d.

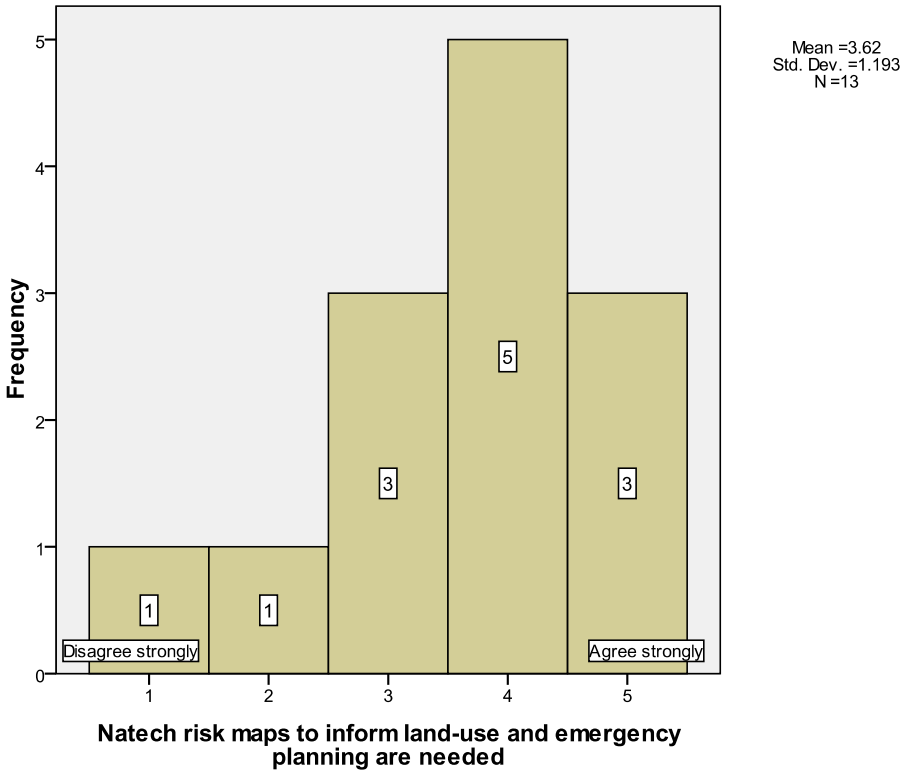

Figure 35: Ranking of survey responses to Question 16e.

Figure 36 gives and overview of the survey responses to Questions 16a-e which indicate the priority needs to be addressed to guarantee effective Natech risk reduction. The survey participants expressed a clear need for guidance on Natech risk assessment for industry. This is closely followed by the need for Natech risk maps and guidance on Natech risk assessment at the community level.

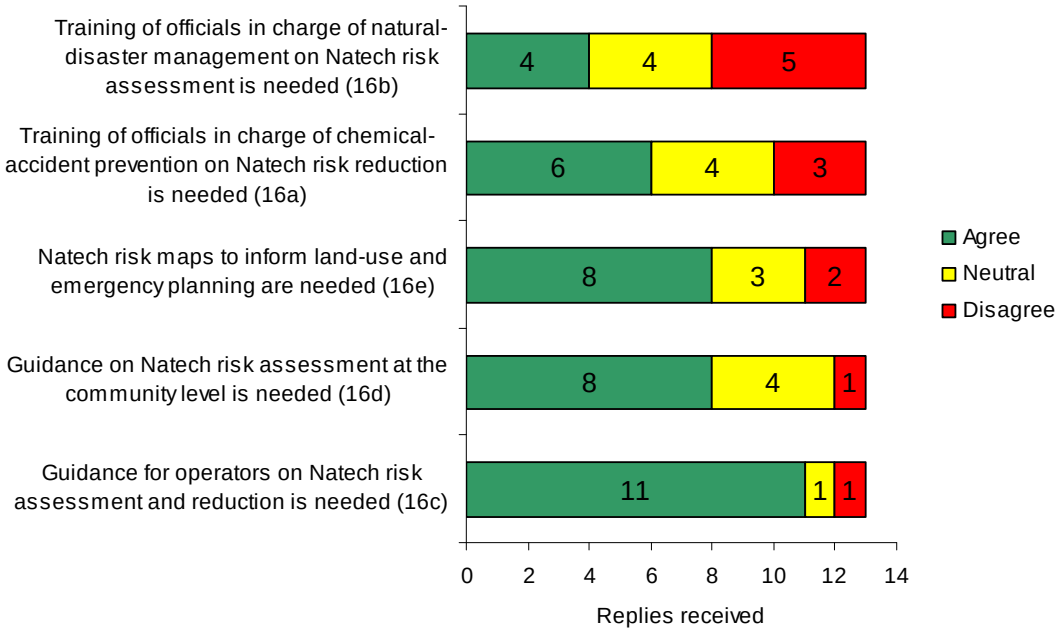

Figure 36: Summary graph of survey responses to Questions 16a-e.

Other issues that the survey participants would like to see addressed to improve Natech risk reduction in their respective countries or organisations are summarised in Table 11. In addition to the proposed improvements to current regulations discussed also in Section 3.3 and Table 4, the respondents mention issues such as research into the impact of climate change on future Natech risk, the preparation of integrated natural-hazard maps, the development of emergency-management plans that consider Natech risk, and the improvement of risk communication on natural risk as important.

	Which other issues would you like to see addressed to improve Natech risk reduction?
1	+ Guidelines for the consideration of natural hazards in plant design, operation and maintenance, hazard analysis, safety documents and emergency plans of operators and in inspections. + Elaboration of Technical Codes for the structural engineering of plants containing hazardous substances. + Consideration of Natech risks in land-use-planning, off site emergency plans and disaster management. + Integrated natural hazard risk maps i.e. maps considering all relevant kinds of natural hazards and displaying them in the same way. + Improvement of forecast (and “nowcast”) systems for natural hazards e.g. for heavy precipitation, flash floods, tornados. + Improvement of risk communication on natural hazards, including warning and

	alarm systems. + Research on the consequences of climate change on natural hazards e.g. the relevance of tornados and wildfires for the safety of establishments.
2	Some emergency response services - with a focus on fire forces - have expressed an interest to understand better complex emergencies such as Natechs, in order to prepare for them.
3	Dedicated personnel.

Table 11: Issues to be addressed to improve Natech risk reduction in the responding countries.

With respect to coordination between institutions 13 (93%) respondents out of 14 replied that the organisations or agencies in charge of chemical-accident prevention and mitigation work in coordination with organisations in charge of natural-disaster management in their countries. In addition, the majority of respondents (91% out of a sample of 11 countries which replied to this question) believes that there is no overlap of responsibilities between organisations and other agencies that would affect the effective planning for and mitigation of Natech accidents in their respective countries. The detailed responses to both questions are shown in Figure 37. Some countries have commented their answers which lead us to conclude that there may not necessarily be a problem of overlapping responsibilities but rather one of a lack of coordination between organisations and of co-operation (Table 12).

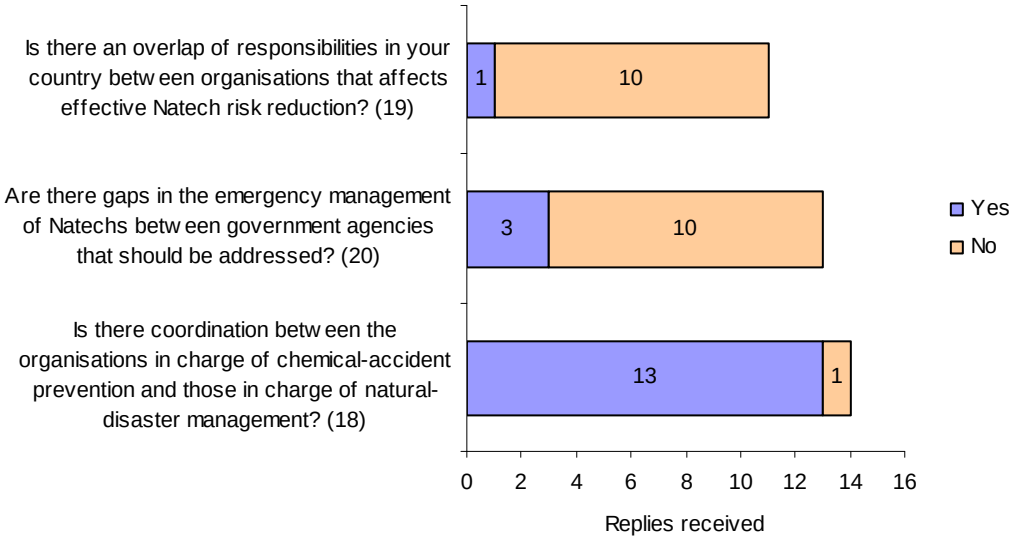

Figure 37: Number of Yes/No counts for Questions 18-20.

	Is there an overlap of responsibilities between organisations in your country?
1	There is no overlap. Cooperation should be improved.
2	Sometimes the same work is done by other agencies/organizations. Coordination is not always optimal.
3	Integration and/or co-ordination of approaches (risk assessment/mapping; design of emergency scenarios; planning of resources etc.) could still be improved at community level and/or at risk basin level.
4	Responsibilities are divided geographically and by extent but not in competence.
5	The Fire and Rescue Department is a constituent part of the civil protection and

	rescue system directing the activities of the civil protection and rescue system, organising the prevention of emergencies, coordinating the activities of state institutions and economic entities in the sphere of civil protection and planning the national preparedness for the implementation of civil protection tasks in the event of an emergency in time of peace and in wartime. The Fire and Rescue Department is also the competent authority for the implementation of Council directive 96/82/EC of 9 December 1996 on the control of major-accident hazards involving dangerous substances.
6	These organizations are the same for both areas.

Table 12: Details on a possible overlap of responsibilities between organisations in charge of accident and disaster management.

With respect to possible gaps in the emergency management of Natechs between organisations or agencies in charge of chemical-accident prevention and those in charge of natural-disaster management 10 (77%) of the 13 countries responding to this question feel that there are no gaps that need addressing (Figure 37). Explaining remarks to the respondents' answers are summarised in Table 13. One respondent pointed out that coordination of approaches could be improved at the local/regional level. Other gaps that were highlighted include the lack of pertinent information on natural hazards for authorities in charge of chemical-accident prevention, as well as the insufficient consideration of natural hazards in safety documents and operator emergency plans. Interestingly, one respondent indicated that gaps could result from the fact that natural events may not be recognised as possibly important for causing chemical accidents.

	Are there gaps in the emergency management of Natechs between government agencies that should be addressed?
1	+ No suitable information on natural hazards for authorities in charge for chemical accident prevention and operators of installations. + No suitable consideration of risks caused by natural hazards in safety documents and emergency plans of operators which have to be supplied to the authorities in charge for emergency management.
2	Fire and Rescue Brigade officers are always members of Seveso II inspection teams, so they are well-informed and may directly influence emergency management both on- and off-site. For small hazard sources, the situation is more complicated, no similar mechanism is present.
3	Work is being taken forward, as appropriate, by the Competent Authority and the civil protection authorities to implement the recommendations of the Incident Investigation Board of a recent major accident on 'emergency preparedness for, response to and recovery from incidents' to ensure robust and fit-for-purpose emergency response arrangements across government.
4	Integration and/or co-ordination of approaches (risk assessment/mapping; design of emergency scenarios; planning of resources etc.) could still be improved at community level and/or at risk basin level.
5	Some impact types are not yet seen critically or are not seen linked to chemical accidents.

Table 13: Details on possible gaps in the management of Natech accidents between government agencies and organisations.

The last question in the survey concerned strategies or recommendations to reduce Natech risk. We asked the survey participants to share their top three recommendations, which 10 respondents provided. This information is shown in Table 14. Several countries indicate that there is a need for improved risk communication, as well as for strengthening Natech awareness among industry and authorities. Moreover, the improvement or development of natural-hazard and Natech risk maps which can be used for land-use and emergency planning was mentioned as a crucial Natech risk reduction strategy. A number of countries also feels that specific guidelines for industry on Natech risk reduction need to be developed. This requires research and methodological development in Natech hazard and risk assessment. Other top Natech risk reduction strategies mentioned are the identification of best practices, as well as knowledge transfer, e.g. by the dissemination of lessons learned to industry and to the various levels of government (national, regional, local).

	What are your top three Natech risk reduction strategies or recommendations?
1	1. Development of guidelines, e.g. for the consideration of natural hazards in plant design, operation and maintenance, hazard analysis, safety documents and emergency plans of operators and in inspections; 2. Improvement of risk communication on natural hazards e.g. improvement of risk maps, warning and alarm systems; 3. Research on the consequences of climate change on natural hazards.
2	1. Development of tools, methods and techniques for evaluation of Natech hazard; 2. Preparation of a tool kit of best practices for Natech management, including experience exchange; 3. Natech communication campaign targeted to both industrials and responsible authorities at all levels.
3	1. Improve understanding of Natech-specific accident sequences, based on post-event investigation; 2. Improve Natech awareness by disseminating lessons learned to industry, municipalities and State; 3. Improve co-operation among the above-listed stakeholders: before, during and after Natech events.
4	1. Strengthen awareness at the local level; 2. Enhance risk communication policies in general; 3. Mapping.
5	1. Mapping of areas exposed to natural hazards; 2. Control of Land use planning; 3. Awareness among operators of chemical installations.
6	1. Framework rules to address all kinds of Natech events; 2. More funds made available to the competent authorities to improve studies and actions; 3.Guideline documents to operators.
7	1. Community involvement; 2. Awareness; 3. Dedicated personnel.
8	1. Natech risk maps to inform land-use-planning decisions and emergency planning are needed; 2. Early warning and exchange of information about the coming natural events; 3. Guidance documents for operators of industrial establishments/installations on Natech risk assessment, prevention and mitigation are needed for improved Natech risk reduction.

9	1. Improving urban development law; 2. Elaboration of Natech risk and other natural disaster maps; 3. Developing a BAT guide for prevention Natech risk.
10	1. Natech risk mapping; 2. Strict obligations in rules, laws, etc. and monitoring; 3. Uniform methodologies.

Table 14: Survey respondents' top recommendations to reduce Natech risk.

7.1 Conclusions on identifying needs and limitations

The conclusions from the replies received for this questionnaire section are:

1. The survey respondents agree that several gaps in Natech risk reduction exist that have to be addressed to guarantee effective Natech risk management.
2. A lack of awareness is not perceived to be a strong limiting factor for Natech risk reduction.
3. The respondents are divided on whether a lack of knowledge or of adequately trained personnel limits Natech risk reduction.
4. A lack of adequate resources and budget constraints are given as the main factors that could limit a country/organisation from addressing Natech risk reduction. This means that there seems to be the perception that the costs of considering Natech risk reduction outweigh the gains.
5. Responsibility, liability and/or legal issues are not perceived to be a limiting factor in reducing Natech risk.
6. There is a perceived need for training of chemical-prevention officials on Natech risk reduction. Officials in charge of natural-disaster management are believed to be slightly better trained on Natech risk reduction. In our experience this perception may, however, be erroneous.
7. There is strong agreement that guidance on Natech risk assessment for industry and at the community level is needed.
8. There is a strong perceived need for Natech risk maps to inform land-use-planning and emergency-management decisions.
9. The survey participants indicate that the following issues should be addressed to reduce Natech risk: Elaboration of guidelines on the consideration of Natech risk for operators, as well as specific technical codes, natural hazard and Natech risk mapping, improvement of risk communication, consideration of Natech risk in land-use planning and offsite emergency planning, as well as research into climate change and its impact on future Natech risk.
10. There is coordination between organisations in charge of chemical-accident prevention and those in charge of natural-disaster management. The cooperation and coordination in the emergency management of Natechs is mostly well established.
11. The majority of responses indicate that there is no overlap of responsibilities between organisations that could affect Natech risk reduction.

12. The top Natech risk reduction strategies are according to the survey: raising awareness at all government levels and in industry and improving risk communication, preparing integrated risk maps, developing specific guidelines for industry and identifying best practices for Natech risk reduction including their dissemination, and developing methodologies and tools for Natech risk assessment.

8 Conclusions

A study on the status of Natech risk reduction in EU Member States was performed by means of a questionnaire survey. The results of the analysis are based on 14 country responses which is too small a population size for drawing robust statistical conclusions. As a consequence, the quantitative results of this study and their interpretation may be subject to some uncertainty. However, a clear tendency towards recognising natural hazards as an important external risk source for chemical facilities could be established. In addition, more than half of the responding countries declared to have suffered one or more Natech accidents with the release of toxic substances, fires and/or explosions and sometimes fatalities and injuries. The natural events that triggered these Natech accidents were not necessarily the ones that were believed to be of major concern so there is a discrepancy between actual causes and risk perception.

A legal framework for Natech risk reduction exists via the responding countries' chemical-accident prevention programmes, but the effectiveness of these programmes in mitigating Natech risk is largely inconclusive. The occurrence of Natech accidents indicates that there may be gaps in legislation, implementation and/or its monitoring that should be addressed to ensure effective Natech risk reduction. In over half the responding countries Natech risk is not addressed in natural-disaster management regulations. Existing technical codes and standards for the design, construction and operation of buildings and structures in industry consider certain natural hazards but their ultimate goal is the safety of human life. Therefore, the prevention of hazardous-substance releases may not be guaranteed and secondary risks due to these releases may not be taken into account. Additionally, some of these technical codes and standards may not be suitable for controlling risks due to hazardous substances. Specific guidelines for Natech risk reduction to support legislation are scarce. Therefore, the development of specific technical codes and guidelines would be required to fully address Natech risk in the EU Member States.

Awareness of Natech risk seems to be increasing within the countries' competent authorities while there is a tendency to believe that the current level of knowledge on the dynamics of Natech accidents may not be adequate. Consequently, training on Natech risk reduction is needed. There is the perception among the respondents that there is a certain level of Natech awareness in industry, although in almost half of the responding countries industry does not appear to sufficiently take Natech risk into account in industrial risk assessment. In addition, there is a reported lack of Natech-specific scenarios. Low levels of Natech preparedness could therefore have resulted. This highlights the need for better risk communication and the development of methodologies and tools for including Natech risk into conventional industrial risk assessment. Moreover, the development of guidance on Natech risk assessment for industry was indicated as the highest-priority need for effective risk reduction, closely followed by the development of guidance on Natech risk assessment at the community level.

Natech risk reduction measures seem to be widely available although they are often generic due to the absence of data and models on the dynamics of Natech accidents. In fact, currently no specific Natech accident databases exist in the responding countries and Natech events have to be

retrieved from conventional chemical-accident databases which lack the level of detail to capture the specifics on Natech accidents. Moreover, chemical-accident prevention and pollution-control regulations, such as the Seveso II Directive, do not provide guidance to the operator on how Natech risk reduction should be achieved, nor to the competent authority on how to evaluate that the risk level is as low as required by regulations. This is a shortcoming that needs to be addressed. Some Natech risk reduction measures that could be considered best practice were reported to exist; most provided examples were, however, targeted towards floods. This finding suggests that awareness of or the availability of Natech-specific best practices may be limited at present and actions should be directed towards filling this gap, e.g. through a concerted effort to identify existing best practices and to disseminate them widely. Another priority need expressed by the survey respondents is the development of specific Natech risk maps whose availability is very limited. These are required for the identification of Natech-prone areas to inform land-use-planning and emergency-management decisions. In contrast, several countries have developed natural hazard or risk maps for selected natural hazards in certain regions.

The results of this Natech questionnaire survey show that the responding countries have largely recognised natural hazards and disasters as a relevant source of risk to a chemical facility with the potential to trigger a major accident. A framework for Natech risk reduction exists but a strategic Natech risk-reduction initiative appears to be lacking. Moreover, the survey highlighted a number of shortcomings and gaps that need to be addressed to achieve effective risk reduction. Considering the findings of this study the following areas for future work were identified:

- Raising awareness and improving risk communication at all levels of government and in industry;
- The implementation and enforcement of specific regulations for Natech risk reduction;
- The preparation of specific technical codes and of guidelines for risk assessment in industry that address the characteristics of Natech risk;
- The development of guidance on Natech risk assessment at the community level;
- The development of methods and tools for Natech risk assessment;
- The preparation of dedicated Natech emergency management plans which consider the characteristics of Natech accidents (e.g. a possible lack of utilities);
- Identification of best practices for Natech risk reduction and wide dissemination of existing practices;
- The development of Natech risk maps to support effective land-use planning and emergency management;
- Land-use planning that explicitly addresses Natech risk;
- Training of competent authorities on Natech risk reduction both for officials in charge of chemical-accident prevention and those in charge of natural-disaster management;
- Research into the impact of climate change on future Natech risk.

In order to support the process of improving Natech risk reduction, lessons learned from the analysis of past Natech accidents should be formulated and disseminated. These lessons should address failure modes and hazardous-substance release paths as a function of natural-hazard severity, as well as identify risk-reduction measures and possible best practices. As this requires the systematic collection of data on the causes and dynamics of Natech events the JRC has set up a specific Natech accident database[6] which is public to allow the widest possible access to the accident data. Moreover, indicators for measuring the effectiveness and adequacy of Natech risk-reduction measures should be developed.

[6] http://enatech.jrc.ec.europa.eu/

Acknowledgements

The author would like to acknowledge A.M. Cruz for her contribution to the preparation of the questionnaire during her stay at the JRC, and M. Wood, Z. Gyenes and L. van Wijk of the JRC for helpful discussions on surveying practices and valuable comments on the report, respectively. Last but not least we thank the respondents to the questionnaire for their availability to participate in this survey.

ANNEX A – Government institutions overseeing chemical-accident prevention, and rules, codes and guidelines for hazardous-substances handling

Table A1: List of government institution(s) overseeing chemical-accident prevention and mitigation in the participating EU Member States.

Country	**Which government institution oversees chemical-accident prevention and mitigation?**
Austria	+ Fed. Ministry for Economics (legislation for industrial activities on major accidents + mining including enforcement); + Fed. Ministry for Agriculture (legislation for waste activities and water-related impacts on major accidents); + Fed. Ministry for Interior (coordination for mitigation affecting more than one region and transboundary); + Fed. Ministry for Infrastructure (pipeline-related accidents legislation); + Federal Chancellor (political coordination body); + 9 regional administrations (Länder) for regional legislation and enforcement, as far as no federal competency is concerned + contact points for alarm + legislative framework for fire brigades; + 84 district authorities (Bezirkshauptmannschaften) for emergency response coordination; + 2357 Communities and 15 cities (Statutarstädte) for local emergency response and local fire brigade organization.
Cyprus	+ Department of Labour Inspection + Civil Defense + Cyprus Fire Service + Department of Town Planning and Housing
Czech Republic	+ Competent authority for the prevention of chemical accidents at government level is the Ministry of Environment; + Responsible body for disaster preparedness (and prevention in general) is the Ministry of Interior; + Several bodies, including county office, environment inspection, fire brigade, occupation health and safety, public health service (and in the case of explosive mining authority) are involved in inspection of classified (Seveso II) installations.
France	+ Drafting regulation : Environment Ministry / General department of risks preventions/Department for technological risks; + Enforcing regulation / Reviewing and approval of safety documents / Licensing hazardous industrial activities : local competent authorities and services from Environment ministry (inspectors); + Setting design and building codes or standards : appropriate national and international bodies; + Assessing accident risk in Natech-prone facilities: engineering firms; consultancy; audit etc.; + Drafting of safety reports for NaTech-prone facilities : experienced engineering/consultancy firms.
Germany	+ Legislation: - Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (Federal Ministry for Environment, Nature Conservation and Nuclear Safety); - Bundesministerium für Arbeit und Soziales. + Enforcement: - Umweltministerien der Länder (Ministries for the Environment of the

	Länder); - Ministerium für Arbeit, Gesundheit und Soziales der Länder (Ministry of Labour, Health, Social Affairs of the Länder).
Italy	+ Central Authorities <u>- Ministry of Environment and Land/Sea Protection (MATTM)</u> The MATTM carries out the control of Seveso establishments and is responsible for the information system and exchanges with the European Commission, the other Member States and with international organizations. Its main tool is the national inventory of Seveso establishments and related information (position, hazardous substances and their quantities, reference persons in the plants, status of authorizations, accidents that occurred, etc.). The MATTM also coordinates the activities of the other central and local authorities regarding the Italian National Digital Mapping Portal. The project provides wide access to environmental and geographic data; <u>- Ministry of Interior</u> It is competent for public security, and operates through Police, Prefectures and National and Regional Fire Brigades. It provides methodological regulation for the technical activities of the Fire brigades; <u>- Ministry of Health</u> It is competent for public health, and operates through: National Health Service, National Institute of Occupational Safety and Prevention (ISPESL), and National Institute of Health (ISS). It provides methodological regulations for the technical activities of its institutes; <u>- Ministry of Infrastructure and Transport</u> It is competent for the realization of major civil infrastructures and national transport plans. It directs the general choices and provides the criteria for land use planning. + Local Authorities <u>- Regions</u> At the end of the devolution process (art 18 D.Lgs. 334/99 and art. 72 D.Lgs. 112/98 – so-called “Bassanini law”), they will carry out the control of the Seveso establishments, currently carried out by the MATT and the CTR. At present, devolution is starting as regards environmental issues and in particular industrial risks. The Regions are moreover responsible for territory management, and they take part in the control procedures of the land use planning, where Seveso establishments are located; <u>- Municipalities</u> For Seveso establishment the Municipality ensures that information on safety measures and on the requisite behaviour in the event of an accident is supplied to the public (art. 22 D.Lgs. 334/99); it also contributes to land use planning, in agreement with the technical conclusions of the CTR, both for the procedures of building authorizations and for town planning. + Technical bodies <u>- National Fire Brigade (CNVVF)</u> Depends on the Ministry of Interior and it has Local Structures of Public Emergency Services (Regional Fire Departments and Provincial Commands).

	- Regional Technical Committee - (CTR) The CTR is the local technical Authority, at regional level, composed of members of the Regional Fire Departments and of other local Authorities, such as the Regional Agency for Environmental protection (ARPA); it assesses the Safety Report (SR) containing the risk analysis elaborated by the operator of Seveso establishment and it assures the safety conditions carried out in the establishment by the operator. The tools available to the CTR include the technical guidelines from the competent Ministries, notably those for fire prevention that also indicate specific criteria for the reduction of the potential impacts that floods, and other events, can have on the industrial structures. - System of Agencies for Environmental Protection (ISPRA/ARPA) The system consists of ISPRA-National Institute Of Environmental Protection and Research (former APAT), under the control of the Ministry of the Environment, which coordinates the Regional Agencies (ARPA), under the control of the Regions. The Agencies carry out technical-scientific functions concerning environmental protection and the prevention of industrial risks. ISPRA does: • provide technical support to MATTM; • promote and coordinates technical activities of interest for local environmental agencies (ARPA), which do their own evaluations for the specific problem. • contribute to risk evaluation when requested; • together with a network including other subjects feed the information base of the SINA (Environmental National Informative System - Sistema Informativo Nazionale Ambientale). ISPRA is the National Focal Point (NFP) for EIONET. - National Institute of Occupational Safety and Prevention (ISPESL) The ISPESL is a technical-scientific organ of the National Health Service, under the authority of the Minister of the Health. - National Institute of Health (ISS) The National Institute of Health is a technical-scientific organ of the National Health Service, which carries out research, experimentation, control, advising, and other activities in matters of public health.
Lithuania	The Fire and Rescue Department under the Ministry of Interior of the Republic of Lithuania is the competent authority for implementing Council directive 96/82/EC of 9 December 1996 on the control of major-accident hazards involving dangerous substances. It is also responsible for setting up measures to ensure the smooth transfer of public institutions, economic entities and the population from ordinary living (working) conditions to an emergency at the smallest losses possible, to the effect that public order is preserved, and human lives, property, as well as the environment is protected against emergencies; laying down and publishing civil protection methodical recommendations; coordinating the preparation of civil protection contingency plans for counties and municipalities; warning and informing state institutions, economic entities and population about a nationwide disaster that threatens human lives, health, property and environment in the event of an emergency; organising localisation of large-scale emergencies, rescue of people and property as well as response to emergencies at national level; carrying out planned and overall check-up of the population warning system and its management units; compiling and

	administering the register of establishments of the state significance and dangerous objects; other.
Luxemburg	+ Inspection du Travail et des Mines; + Administration de l'Environnement.
Netherlands	Ministry of Housing, Spatial Planning and the Environment for chemical prevention and accidents, while the Ministry of Labour is responsible for labour related chemical prevention and accidents.
Poland	In Poland competent authorities for SEVESO II plants are the State Fire Service (SFS) and Environmental Protection Inspection (EPI) handling responsibilities for both lower and upper tier industrial plants mainly focussing on: + assessment and approval of documentation (MAPP's, safety reports, SMS's and internal emergency rescue plans (only SFS)); + inspections; + preparedness of external emergency plans (only SFS); + establishment of group of Domino effects plants (SFS in collaboration with EPI); + land-use planning for SEVESO plants.
Romania	+ Ministry of Administration and Interior through the General Inspectorate for Emergency Situations Responsibilities: - Monitors specific risks and their negative consequences; - Informs, advises and warns; - Plans and prepares resources and services; - Neutralizes the effects of hazardous materials; - Provides transport of forces and means of intervention, human and other resources; - Manages decontamination; - Coordinates the training for the prevention and reduction of chemical accidents at national level - Implementing international, European and regional strategies and programs for the prevention and reduction of Natech accidents; - Develops research, forecasting and statistical analysis of risk types, regarding their nature and frequency, in order to propose measures for adequate emergency intervention; - Verifies the compliance with the laws and regulations regarding the protection against fire and civil protection in the design, implementation, operation and usage of constructions, installations and facilities; - Verifies the activity of detecting potential hazards during construction and operation of installations and facilities; - Controls the activities that present a danger of major accidents, involving dangerous substances; - Organizes and develops specific prevention and mitigation measures of chemical accidents - Participates in the identification, recording and assessing of risk factors; - Exercising the coordination, technical guidance and control of activities for the emergencies prevention and management; - Provides technical assistance on the emergencies management;

	- Verifies the application of regulations regarding the emergency situations management, emergency plans and cooperation plans specific for each risk type; - Assures the adequate transmission of decisions, dispositions and regulations; - Verifies the communication links between the operational centers and the dispatching centers involved in the emergency situations management; - Collects the requests for the resources necessary for the implementation of the emergency situations activities; - Manages the database related to emergency situations; - Executes other duties and tasks in the management of emergency situations, provided by law or institutions. + Ministry of Economy Responsibilities: - Monitors specific risks and their negative consequences - Minimizes the consequences of accidents involving hazardous substances - Provides transport of forces and means of intervention, people and other resources - Manages decontamination - Establishes and assures the implementation of emergency situations management and civil protection measures in their domain, as well as the implementation of measures for the identification and protection of critical national and European infrastructure objectives. + Ministry of Transport Responsibilities: - Monitors specific risks and their negative consequences - It is the regulatory and certification institution in compliance with the European Agreement regarding the transport of dangerous goods. + Ministry of Regional Development and Tourism through the State Inspectorate in Construction Responsibilities: - Exerts state control regarding the compliance with the existing regulations and laws in the field of land-use and urban planning; - Verifies the legality of the building permits, according to the existing regulations, within the local public administration departments; - Requests the execution of technical experts reports on buildings, regardless of their owenrship and destination; - Proposes the cessation of building use, after the occurrence of technical accidents or natural disasters. + Ministry of Environment and Sustainable Development: Responsibilities: - Monitor specific risks and their negative consequences; - Informs, advises and warns; - Neutralizes the consequences of hazardous materials; - Manages decontamination; - Through the risk secretariat, it elaborates specific procedures in the field of risk management and control of activities involving dangerous substances; - Participates in the environmental impact assessment procedure for all

	the phases included in the current legislation; - Participates in the final decision on approval / rejection of the environment certificate; - Ensures the implementation of Regulation (EC). 1272-2008 of the European Parliament and the EC from 2008 regarding the classification, labeling and packaging of substances and mixtures in cooperation with the European Agency for chemical substances; - Verifies the implementation of measures for accidents prevention and consequences reduction; - Applies the regulations for the activities involving dangerous substances; - Verifies the compliance with the regulations in the Environmental Permit/Certificate; - Controls the activities involving dangerous substances. + ISCIR-State Inspection for the Control of Boilers, under pressure Containers and Lifting installations - it is an inspection institution for the technical supervision and the control in functioning; - elaborates technical prescriptions in its field; - controls the market in its field.
Slovakia	+ Ministry of Environment Prevention of chemical accidents, major accidents, labelling of hazardous materials etc. Next are the regional departments of environment (all of this under prevention) + Ministry of Interior (Reaction in case of an accident) Fire prevention and civil protection and their regional departments.
Sweden	+ The Swedish Civil Contingencies Agency (MSB) is responsible for the supervision of the Seveso II Directive at national level as far as consequences for the environment and the public are concerned. The 21 county administrations carry out inspections and enforcement at a regional level. + Swedish Work Environment Authority (SWEA) is responsible for the supervision of internal aspects of the Seveso II Directive at national level. The SWEA's inspection offices around the country carry out inspections and enforcement at a regional level. + Swedish Environmental Protection Agency (SEPA) –the issuing of permits for upper tier Seveso establishments is handled under the Environmental Code (1998:808). The environmental courts and county administrative boards issue the permits. + 21 County Administrative Boards – responsible for inspections according to regulations on measures to prevent chemical accidents. + National Board on Housing, Building and Planning is responsible for land-use planning issues at national level.
UK	+ At Seveso installations: - a competent authority comprising the Health and Safety Executive (HSE) and the Environment Agency (EA) in England and Wales, and HSE and the Scottish Environment Protection Agency (SEPA) in Scotland; - the Health and Safety Executive Northern Ireland and the Northern Ireland Environment Heritage Service; and - in each case the environment agencies lead on environmental aspects.

	+ At IPPC installations: - UK environment agencies. + Land-use planning controls are the responsibility of: - Communities and Local Government (England); - Scottish Government; - Welsh Assembly Government; - Department of the Environment's Planning Service (Northern Ireland); and - Hazardous Substances Authorities (usually Local Authorities) grant consent to hold substances at or above specified controlled quantities.

Table A2: List of rules, codes or guidelines used to regulate or guide hazardous-substances production, use or storage in the participating countries.

Country	**Which rules, codes or guidelines are used to regulate or guide hazardous-substances production, use or storage?**
Austria	There are about 45 pieces of legislation (laws or ordinances) spread amongst some of the institutions listed above that deal basically with the transposition of the Seveso-Directive or EIA as far as accident prevention/mitigation is concerned.
Cyprus	National legislation in compliance with the Seveso II Directive
Czech Republic	All relevant European directives such as Seveso II, REACH, IPPC, Water Framework Directive or EIA are implemented in Czech legislation, as well as other agreements and conventions (Stockholm Convention on POPs, UNECE Convention on Transboundary Accidents etc.). Czech national legislation demands the prevention and preparedness for water accidents even for small sources.
France	Selected references: + EC Directives "Seveso" I and II and their transcription into French national legislation; + Regulatory background for industrial safety in France: dates back to 18th century; + 1976 Law on industrial safety; 2003 Law on Environment; + Subsequent regulation for enforcement of 2003 Law, including NaTech-specific dispositions. The regulation indicate that external attacks, therefore the natural risks, must be treated as initiating events in the safety report (also for land use planning and emergency plans); + Sector-specific guidelines of "good practices" (e.g.: petrochemical industry); + Hazard-specific guidelines (e.g.: calculation of impact/effect distances for BLEVE or Boil-Over).
Germany	+ Bundes-Immissionsschutzgesetz (Federal Immission Control Act); + 12. Verordnung zum Bundes-Immissionsschutzgesetz (Störfall-Verordnung) (12th Ordinance on the Implementation of the Federal Immission Control Act (Major Accidents Ordinance – 12. BImSchV); + Technische Regeln Anlagensicherheit und Leitfäden der Kommission für Anlagensicherheit (Codes on Process Safety and Guidelines of the Commission on Process Safety); + Wasserhaushaltsgesetz (Water Management Act);

	+ Verordnungen zum Umgang mit wassergefährdenden Stoffen of the Länder (ordinances on installations for handling of substances hazardous to water of the Länder); + Gesetz über technische Arbeitsmittel und Verbraucherprodukte (Geräte- und Produktsicherheitsgesetz – GPSG); + Verordnung über Sicherheit und Gesundheitsschutz bei der Bereitstellung von Arbeitsmitteln und deren Benutzung bei der Arbeit, über Sicherheit beim Betrieb überwachungsbedürftiger Anlagen und über die Organisation des betrieblichen Arbeitsschutzes (Betriebssicherheitsverordnung – BetrSichV); + Verordnung zum Schutz vor Gefahrstoffen (Gefahrstoffverordnung - GefStoffV); + Gesetz über explosionsgefährliche Stoffe (Sprengstoffgesetz - SprengG); + Zweite Verordnung zum Sprengstoffgesetz (2. SprengV).
Italy	Italy has completely implemented the directives 96/82EC (Seveso II) and 2003/105/CE (Seveso III) in its regulation, integrating it with the pre-existent one (SEVESO I). The Italian reference rules are respectively the legislative decree august 17, 1999, n. 334 and the legislative decree September 21, 2005 n.238 \. The Italian implementation calls for the issuing of a series of enforcement decrees, fixing criteria and procedures to be followed in fulfilling the relevant obligations and in putting into effect the control measures. Specifically, the following enforcement decrees are in force, stating: - criteria for the drawing up of the Major Accident Prevention Policy MAPP and actuation of the Safety Management System SMS (Decree of the Ministry of the Environment august 9, 2000); - criteria for the identification of the modifications increasing the risk (Decree of the Ministry of the Environment august 9, 2000 - not the same); - link with the procedures for fire prevention (Decree of the Ministry of the Environment august 9, 2000); - criteria for land-use planning (Decree of the Ministry of the Infrastructure may 9, 2001); - criteria for the application of the regulation to the industrial ports (Decree of the Ministry of the Environment may 16, 2001 n.293); - criteria for the drawing up of the Safety Reports (DPCM march 31, 1989, issued in accordance to Seveso I but still in force); - criteria for analysis and evaluation of safety reports related to LPG and flammable liquid storages (respectively Decree of Ministry of Environment May 15, 1996 and Decree of Ministry of Environment October 20, 1998); - criteria for the drawing up of the EEP External Emergency Plans (updated criteria to SEVESO II with the new guidelines issued by Civil Protection Department - DPCM February 25, 2005). For the time being, awaiting the near adoption of relevant new decrees on the matter, technical guidelines are provided, indicating the criteria for the inspections on MAPP and SMS, and a reference document providing general criteria for integrated safety studies in the areas with high concentration of establishments (in particular, the Syracuse area).
Lithuania	+ Law on Chemical Substances and Preparations

	+ Law on Waste Handling + Law on Safety and Health at Work + Law on Protection of Environment + Law on Civil Protection + Law on Planned Economic Activity Environment Impact Assessment + Law on Supervision of Potential Dangerous Installations + Regulations on Classification and Labeling of Dangerous Substances and Preparations + Regulations on Internal Audit of Production and Use of Dangerous Substances and Preparations
Luxemburg	+ Loi modifiée du 10 juin 1999 relative aux établissements classes; + Règlement grand-ducal du 14 septembre 2000 concernant les études des risques et les rapports de sécurité; + Règlement grand-ducal du 23 décembre 2005 modifiant le règlement grand-ducal du 17 juillet 2000 concernant la maîtrise des dangers liés aux accidents majeurs impliquant des substances dangereuses.
Netherlands	Relevant legislation on external safety: + General - Environmental Management Act (Wet Milieubeheer) (the most important environmental act); - Decree on the external safety of establishments (Bevi) (came into effect on 27 October 2004 with the exception of a few aspects); - Regulation of the external safety of establishments (Revi) (2004); - Fireworks decrees. + Risks of serious accidents - Seveso II Directive; - Decree on the risks of serious accidents 1999 (BRZO). + Infrastructure investment projects (external safety around roads and railways) - Circular on risk standards for transport of hazardous materials.
Poland	+ SEVESO II Directive implemented in Environmental Protection Act; + Chemical substances and preparations Act; + ADR; + RID; + AND; + Convention on the transboundary effects of industrial accidents; + ATEX Directive implemented into decree of Minister of Economy, Labour and Social Policy on minimum requirements for workers working with explosive atmospheres; + others.
Romania	+ Law no. 31 of 18 May 1994 regarding the Romania's accession to the European Agreement on international road transport of dangerous goods (ADR), signed at Geneva on 30 September 1957; + Law no. 92 of 18 March 2003 for Romania's accession to the Convention on the transboundary effects of industrial accidents, adopted in Helsinki on 17 March 1992; + Law no. 22 of 22 February 2001 to ratify the Convention on environmental impact assessment in transboundary context, adopted at Espoo on 25 February 1991; + Law no. 30 of 26 April 1995 to ratify the Convention on the protection

	and use of transboundary water courses and International Lakes, adopted at Helsinki on 17 March 1992; + Law no. 6 of 25 January 1991 for Romania's accession to the Basel Convention on the control of transboundary frontiers of hazardous wastes and their disposal; + Law no. 14 of 24 February 1995 to ratify the Convention on Cooperation for the Protection and Sustainable Use of Danube River (Convention for the Protection of Danube River), signed at Sofia on 29 June 1994; + Law no. 98 of 16 September 1992 for ratification of the Convention on the Protection of the Black Sea against Pollution, signed in Bucharest on 21 April 1992; + Government Decision no. 1408 of 4 November 2008 concerning the classification, packaging and labeling of dangerous substances; + Government Decision no. 804 of 25 July 2007 on the control of major accident hazards involving dangerous substances; + Regulation 1907/2006 - the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45 and repealing Regulation (EEC) no. 793/93 and Council Regulation (EC). 1488/94 of the Commission and Council Directive 76/769/EEC and Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC of the Commission; + Order of the Minister of Administration and Interior no. 647 of 16 May 2005 approving the Methodological Norms on developing emergency plans in case of accidents involving dangerous substances; + Order of the Minister of Administration and Interior no. 638 of 12 May 2005 and Minister of Environment and Water Management no. 420 of 11 May 2005 approving the Regulation on management of emergencies arising from floods, dangerous meteorological phenomena, accidents at hydro construction and pollution incidents; + Order of the Minister of Economy and Finance no. 1637 in 2007 and Minister of Labor, Family and Equal Opportunities No. 391 of 2007 for approval of the norm of the intervention and rescue units with industrial potential danger of toxic emissions and / or explosive. + HG 642/2005 criteria for the classification of territorial-administrative units, public institutions and economic operators in terms of civil protection, depending on the specific risks. + Law no. 107/1996 – water law with subsequent additions and amendments. + Order no. 1995/1160 of 18 November 2005 approving the Regulation on the prevention and management of emergencies specific to earthquakes and/or landslides. + HG 642/2005 criteria for the classification of territorial-administrative units, public institutions and economic operators in terms of civil protection, depending on the specific risks types.
Slovakia	Law nr.163/2001 Z. z. on chemical substances and preparations, Law nr. 261/2002 Z.z. on prevention of major industrial accidents – implemented SEVESO directive, Law nr. 42/1996 on civil protection
Sweden	+ Act on measures to prevent and limit the consequences of major chemical accidents - Contains necessary definitions, obligations of operators, including the construction of a safety report, a management program for prevention of major accidents and an internal plan for emergency

	preparedness. Addresses information to the public and regular inspections of establishments covered by the legislation. + Ordinance on measures to prevent and limit the consequences of major chemical accidents - Defines for which substances and threshold quantities Act (SFS 1999:381) on measures to prevent and limit the consequences of major chemical accidents should apply. Contains further details on the obligations of operators and on inspections. + Regulations on measures to prevent and limit the consequences of major chemical accidents issued from the Swedish Work Environment Authority and the Swedish Civil Contingencies Agency. + The Civil Protection Act - States the obligation to inform the authorities in neighboring countries when an accident has occurred. + The Civil Protection Ordinance - States that local rescue services are responsible to prepare an external emergency plan for certain establishments covered by Act on measures to prevent and limit the consequences of major chemical accidents. States the obligation of operators to report on accidents to local authorities and to the Swedish Civil Contingencies Agency. + The Environmental Code - Contains regulations on permissions and a deepened safety examination during licensing process for upper tier Seveso operators. + Ordinance on Environmentally Hazardous Activities and Health Protection - Contains regulations on what kind of establishments that need permission according to the Environmental code. + Planning and Building Act - Gives the framework for planning and building and regulates the planning process.
UK	+ Legislation to implement the Seveso Directive – Control of Major Accident Hazards Regulations: COMAH is supported by a wide range of guidance. Key documents include: - A guide to the Control of Major Accident Hazards Regulations; - Emergency planning for major accidents; - Safety Report Assessment Manual; - A range of safety report assessment guides e.g. chemical warehouses. + Legislation to implement IPPC – the Environmental Permitting Regulations. These are supported by e.g. guidance on containment and accident management plans.

ANNEX B – Natural hazards in regulations, technical codes, standard or guidelines, and Natech-specific risk-reduction guidelines

Table B1: List of rules, codes or guidelines for chemical-accident prevention and mitigation that address the natural hazards a country is susceptible to.

Title and year of document	**Natural hazard(s) considered**	**Impact on hazardous-substances handling**
CZECH REPUBLIC		
Conception of Protection of Citizens (2008)	Floods Wind Storms Snowstorms Extreme temperature	Indirect
Crisis plans (continuously)	Floods Wind Storms Snowstorms Extreme temperature	Indirect
Act 59/2006 Coll. – Seveso II (2006)	External events in general	Prevention demanded as a part of major accident prevention.
FRANCE		
Ministerial order of 10 May 2000 relative to the prevention of majors accidents involving hazardous substances or preparations present in SEVESO installations - Annex IV	Flooding Earthquake Climatic events	In the safety report are not considered the following natural events : + Earthquakes whose intensity is higher than the maximum reference earthquakes (as defined by regulation, see ministerial order of May 10, 1993); + Flooding whose magnitude is higher than the reference flooding (defined by the Natural Risk Prevention Plans, see Question 2); + Climatic events of intensity higher than the historical events known or susceptible to occur that may affect the installation.
Guide for the writing and reading of safety reports for upper tier SEVESO establishments - Circular of 28 December 2006	Earthquake Lightning Flooding Snow Winds	Addresses particular initiating events for accident risk analysis/case of natural hazards: + In the safety report: Reference natural events considered as initiating events in risk analysis, for

		accidental scenarios identification / Identification of reducing risk measures / Justification of compliance with appropriate regulation. + In case of compliance with the appropriate regulation, it is considered that the reducing risk approach is sufficient. + Major accidents, caused by reference natural events, are excluded from the land-use planning process, and only taken into account in emergency plans.
Order of 10 May 1993 laying down the paraseismic rules applicable to certain upper tier SEVESO industrial installations + Circular of 27 May 1994 Note : these regulation will change soon (change of the national earthquake map, rules of design and construction for industrial facilities have been strengthened)	Earthquake	+ Determination of the "maximum earthquakes historically probable" (SMHV) with historical and geological data. + Definition of "safety earthquakes" (SMS) / Intensity SMS = intensity SMHV + 1 (MSK scale). + Study of the behaviour of equipments subject to seismic vibrations at least equal to those corresponding to the response spectrum of the "safety earthquake" (SMS).
Order of 15 January 2008 the protection against lightning of some industrial installations (including SEVESO installations) + Circular of 24 April 2008	Lightning	+ Risk assessment, in accordance with NF EN 62305-2 / Levels of protection required for installations are defined. + A technical study is carried out to define precisely preventive measures and protective devices, their location, and the conditions for their checking and maintenance.
GERMANY		
12. Verordnung zum Bundes-Immissions-	All (in principle)	Natural hazards have to be

schutzgesetz (Störfall-Verordnung) 12th Ordinance on the Implementation of the Federal Immission Control Act (Major Accidents Ordinance – 12. BImSchV)		considered in the layout of plants in establishments and in safety documents of operators.
Verordnungen zum Umgang mit wassergefährdenden Stoffen of the Länder (ordinances on installations for handling of substances hazardous to water)	Floods	Prohibition of and regulations on installations containing substances hazardous to water in flood planes and flood prone areas.
Zweite Verordnung zum Sprengstoffgesetz (2. SprengV)	Groundwater, rain, floods,	Installations for storage of explosives must prevent the intrusion of groundwater and rain and be safe against impacts by floods.
ITALY		
DPCM March 31, 1989 issued in accordance to Seveso I, still in force	Earthquakes (old classification), floods, lightning, winds, heavy rain, sea storms	Mandatory Prevention and protection counter-measures carried out by the operators which involve both technical/equipment and safety management issues.
Criteria for analysis and evaluation of safety reports related to LPG (Decree of Ministry of Environment May 15, 1996)	Earthquakes (old classification), lightning	
Criteria for analysis and evaluation of safety reports related to flammable liquid storages (Decree of Ministry of Environment October 20, 1998)	Earthquakes (old classification), lightning	
Reports on environmental consequences of major accidents	Factors related to seismic hazards implementing the general criteria of the actual seismic classification	Technical reference for prevention and protection counter-measures carried out by the operators which involve both technical/equipment and safety management issues.
LUXEMBURG		
Use of documents of the surrounding countries		
POLAND		
Water Act of 18 July 2001	Floods	Not in detail.
Crisis Management Act of 16 April 2007	Natural disasters like floods, storms, tornadoes, earthquakes	Not in detail.
National Forest Act 28 September 1991	Forest fires	Not in detail.
Fire Protection Act 24 August 1991 and State Fire Service Act of 24 August 1991	Natural hazards like floods, storms,	Not in detail.

	fires,	
ROMANIA		
HG 642/2005 - Criteria for the classification of territorial-administrative units, public institutions and economic operators in terms of civil protection, depending on the specific types of hazards	Earthquakes, floods, landslides, fall of cosmic objects, dangerous meteorological phenomena	Additional safety measures to reduce risks
Law 107 of 1996 - Water law, with subsequent additions	Floods	Prohibiting chemical deposits in areas of flood risk
ORDER no. 638/420 of 12.03.2005 of the Minister of Administration and Interior and the Minister of Environment and Waters to approve the Regulation on management of emergencies arising from floods, dangerous meteorological phenomena, construction accidents and pollution incidents	Floods, dangerous weather phenomena	Additional safety measures to reduce risks of accidental pollution, accidents at hydro construction, linking emergency plans with hazard maps
Order No. 1995/1160 of 18 November 2005 approving the Regulation on the prevention and management of emergencies specific to earthquakes and/or landslides	Earthquakes, landslides	Measures to prevent damage or destruction of buildings
SLOVAKIA		
Decree No. 261/2002 Coll. on prevention of major industrial accidents	Floods, storms, earthquakes, …. (all external influences)	Obligation for operators of plants to analyse external influences, however, the depth of analysis is not specified
SWEDEN		
The Panning and building act	Flooding and erosion	Only land which is suitable for the purpose should be used for a specific activity. This means that land could be considered as unsuitable for activities involving chemicals.
UK		
A guide to the Control of Major Accident Hazards Regulations 1999 (as amended) (revised 2006) Safety Report Assessment Manual (updated 2007)	Consideration of external factors such as seismic evens and extreme environmental conditions such as flooding, wind, snow etc.	Requirement to consider relevant external factors in the Safety Management System. Requirement for top tier operators to demonstrate that risks of a major accident initiated or escalated by natural events are ALARP (as low as reasonably practicable).
IPPC guidance	Flooding	Guidance on flood risk and flood mitigation

Table B2: List of specific technical codes, standards or guidelines for the design, construction and operation of buildings and other structures in industry that consider natural hazards.

Title and year of document	Natural hazard(s) considered
AUSTRIA	
The Eurocodes are transposed into various national standards and regional building laws (it is impossible to list them all); moreover in older standards natural hazards are covered by respective factors as far as avalanches, snow load etc. are relevant.	Earthquake, avalanche, snow load
CZECH REPUBLIC	
Set of construction rules (several documents), no single covering document	Extreme snowfall, wind, floods, lightning etc.
FRANCE	
PS69 code, updated into PS69/82 and PS92	Earthquake
EuroCode 8, 1998 (first edition) and later updates	Earthquake
NV 65/99 amended (DTU P 06 002) et N 84/95 amended (DTU P 06 006) NF EN 1991-1-3 : Eurocode 1 : Actions on structures - Part 1-3 : General actions – Snow loads (April 2004) NF EN 1991-1-4 : Eurocode 1 : Actions on structures - Part 1-4 : General actions - Wind effects (November 2005)	Snow and winds
GERMANY	
Technische Regeln zur Druckbehälterverordnung – Druckbehälter, Reihe 600 Aufstellung der Druckbehälter, BArbBl. 6/1998, S. 74	Floods, Groundwater
Technische Regeln für Dampfkessel Reihe 400 Ausrüstung und Aufstellung: TRB 452 Anlagen zur Lagerung von druckverflüssigtem Ammoniak für Dampfkesselanlagen - Aufstellung, Ausrüstung, Betrieb, Anlage 1, Anlage 2 BArbBl. 12/1996, S. 67	Floods, Groundwater
Technische Regeln für brennbare Flüssigkeiten TRbF 20 Läger, BArbBl. 6/2002, S. 62	Floods, Groundwater
Technische Regeln für brennbare Flüssigkeiten TRbF 40 Tankstellen, BArbBl. 6/2002, S. 62	Floods, Groundwater
Technische Regeln für Acetylenanlagen und Calcium-carbidlager, BArbBl. 10/1988, S. 44 (45)	Floods, Groundwater
Technische Regeln für Gefahrstoffe Reihe 500 Schutzmaßnahmen bei Tätigkeiten mit Gefahrstoffen, TRGS 511 Ammoniumnitrat, BArbBl. 6/2004, S. 43, GMBl. Nr. 64 vom 29.12.2008 S. 1338	„Weather“ e.g. sunlight, floods, rain, fog, snow
Technische Regeln für Gefahrstoffe Reihe 500 Schutzmaßnahmen bei Tätigkeiten mit Gefahrstoffen TRGS 514 Lagern sehr giftiger und giftiger Stoffe in Verpackungen und ortsbeweglichen Behältern, BArbBl. 9/1998, S. 53	Floods

Technische Regeln für Gefahrstoffe Reihe 500 Schutzmaßnahmen bei Tätigkeiten mit Gefahrstoffen TRGS 555 Betriebsanweisung und Unterweisung nach § 20 GefStoffV, GMBl. Nr. 14 vom 25.03.2008 S. 287	Floods
TRFL Technische Regel für Rohrfernleitungsanlagen, BAnz. Nr. 80 vom 28.04.2004 S. 9371	Mining, Landslides, Groundwater
DIN EN 1998-4: Eurocode 8: Auslegung von Bauwerken gegen Erdbeben - Teil 4: Silos, Tankbauwerke und Rohrleitungen; Deutsche Fassung, (Eurocode 8: Design of structures for earthquake resistance - Part 4: Silos, tanks and pipelines; German version EN 1998-4), 2007-01	Earthquakes
DIN EN 1998-6: Eurocode 8: Auslegung von Bauwerken gegen Erdbeben - Teil 6: Türme, Maste und Schornsteine; Deutsche Fassung EN 1998-6 (Eurocode 8: Design of structures for earthquake resistance - Part 6: Towers, masts and chimneys; German version EN 1998-6), 2006-03	Earthquakes
DIN 4149: Bauten in deutschen Erdbebengebieten - Lastannahmen, Bemessung und Ausführung üblicher Hochbauten (Buildings in german earthquake areas - Design loads, analysis and structural design of buildings), 2005-04	Earthquakes
DIN 1055-4: Einwirkungen auf Tragwerke - Teil 4: Windlasten (Action on structures - Part 4: Wind loads), 2005-03	Wind
VDI 6004 Blatt 1: Schutz der Technischen Gebäudeausrüstung - Hochwasser - Gebäude, Anlagen, Einrichtungen (Protection of Building Services - Flood - Buildings, installations, equipment), 2006-06	Floods
VDI 6004 Blatt 2: Schutz der Technischen Gebäudeausrüstung - Blitze und Überspannungen (Protection of building services - Lightning protection systems and surge protection), 2007-07	Lightning
VDI 6200: Standsicherheit von Bauwerken - Regelmäßige Überprüfung (Structural safety of buildings - Periodic inspections), 2008-10	Earthquakes, Wind
ITALY	
Every new construction, industrial plants included, has to comply with the New official Technical Rules issued with the Decree of Ministry of Infrastructure and Transports (January 14, 2008). This Rule is substantially in accordance with EC8. The specific topic of equipment and plant are treated more in detail in the UNI codes	Earthquakes, wind, snow
LITHUANIA	
Standard LST EN 1991-1-2:2004, LST EN 1991-1-2:2004/AC:2009 and LST EN 1991-1-2:2004/P:2004 Eurocode 1: Actions on structures - Part 1-2: General actions - Actions on structures exposed to fire*	Actions on structures exposed to fire
Standard LST EN 1991-1-3:2004 and LST EN 1991-1-3:2004/AC:2009 Eurocode 1 - Actions on structures - Part 1-3: General actions - Snow loads*	Snow loads

Standard LST EN 1991-1-4:2005 Eurocode 1: Actions on structures - Part 1-4: General actions - Wind actions*	Wind actions
Standard LST EN 1991-1-5:2004 Eurocode 1: Actions on structures - Part 1-5: General actions - Thermal actions* * International standard together with national annexes is followed in Lithuania for design, construction and operation of buildings and other structures in industry.	Thermal actions
Standard STR 2.01.06:2003 Lightning Safety of Constructions'. Proactive Protection from Lightning	Lightning
ROMANIA	
Law no. 50 of 29 July 1991 authorizing the execution of construction works, with subsequent amendments	Earthquakes, floods
Regulation of 25/04/2007 on the prevention of explosions for the design, installation, putting into operation, use, repairing and maintenance of technical installations operating in potentially explosive atmospheres	Dangerous meteorological phenomena
H.G. 525 of 1996 approving the general urban planning Regulation	All types of natural disasters
H.G. 925 of 1995 approving the Regulation for the verification of technical expertise and quality of projects and execution of construction works	All types of natural disasters
GT006-97: Guide for the identification and monitoring of landslides	Landslides
GT019-98: Guide of landslide risks maps for the assurance of building stability	Landslides
Law no. 10/1995 on quality construction	All natural disasters
SWEDEN	
Regulations on construction from the National Board of Housing , Building and Planning	Buildings should be able to resist a certain amount of strain. Natural hazards considered are Landslides, wind, snow and water. This is not specific for industry however.

Table B3: List of guidelines specific for Natech risk reduction in the surveyed countries for which responses were received.

Title and year of document	**Natural hazard(s) considered**
FRANCE	
Forest fires and industry, ed. DRIRE Provence Alpes Côte d'Azur	Forest fires
Guide for the analysis of vulnerability to flooding for industrial companies, Bruno Ledoux Consultants - SAGERIS, 2000	Flooding
Flood mitigation for industrial facilities, INERIS, 2004	Flooding
Vulnerability reduction for flood-prone industry, CETE-Mediterranée, 2007	Flooding
Vulnerability reduction for flood-prone industry, ENSMP-Paris, 2008	Flooding
Integration of earthquake hazard in risk analysis for industrial accident,	Earthquake

INERIS, 2006	
Lightning risk, INERIS, 2001	Lightning
GERMANY	
Leitfaden – Der Lastfall Erdbeben im Anlagenbau (Guideline: The load case earthquake in plant engineering) Verband der Chemischen Industrie, Frankfurt, März 2009	Earthquakes
IKSE - Internationale Kommission zum Schutz der Elbe: Empfehlungen für Anforderungen an Anlagen zum Umgang mit wassergefährdenden Stoffen in Hochwassergebieten oder einstaugefährdeten Bereichen, Aug. 2002	Floods
ROMANIA	
Territorial risk plan – revised annually	All types of natural disasters
Risk coverage and analysis plan – revised annually	All types of natural disasters

ANNEX C – Government institutions overseeing natural-disaster management, and rules, codes or guidelines used

Table C1: Government institution(s) overseeing natural-disaster management in the participating EU Member States.

Country	**Which government institution oversees natural-disaster management?**
Austria	+ 9 regional administrations (Länder); + 84 district authorities (Bezirkshauptmannschaften); + 2357 Communities and 15 cities (Statutarstädte); + Fed. Ministry for Interior; + Federal Chancellor.
Cyprus	The main mission of the Civil Defense Force is the performance of various humanitarian tasks intended to protect the civilian population against the dangers, and help it to recover from the immediate effects of hostilities or disaster as well as to provide the conditions necessary for its survival.
Czech Republic	+ Flood warning, extreme weather warning: Czech Hydro-meteorological Institute (belongs to Ministry of Environment); + Floods maps, territory in flood risk mapping, including free internet access (Ministry of Environment); + Emergency preparedness and civil defense (Ministry of Interior); + Regional (district) offices – Crisis plans.
France	+ Natural risks prevention : Environment Ministry The policy consists both in improving knowledge ok risks, organizing how they are to be monitored, informing the population, enforcing the necessary regulations and risks prevention plans, promoting and assisting measures to reduce vulnerability, and enabling wider feedback on disasters. + Hazard monitoring and (early warning): - (flooding) Central Department for hydro-meteorology and support to flood forecasting (SCHAPI), Departments of flood forecasting (SPC), Navigation services, Ministry of Equipment.. - Information with flood warning national maps; - (earthquake) Several geosciences institutions (IRSN) / universities; CEA; - (hydro-meteorological hazards) Meteo-France. + Emergency response: - Ministry of Interior, Civil Protection services; - Municipality services; - Fire protection services; Police.
Germany	+ Legislation and coordination in case of disasters: - Bundesministerium des Inneren (Federal Ministry of the Interior); - Innenministerien der Länder (Ministries of the Interior of the Länder); - Regierungen der Länder (district governments). + Disaster Management: - Kreise und kreisfreie Städte (counties and cities). + Assistance: - Bundesamt für Bevölkerungsschutz und Katastrophenhilfe (Federal Office of Civil Protection and Disaster Assistance (BBK); - Technisches Hilfswerk (Technical Assistance Organisation (THW).
Italy	The Department of Civil Protection (DCP) Under the control of Presidency of the Council the DCP is functional for addressing the activities of central and local authorities, national technical

	bodies and public and private organizations as far as the Civil Protection National System is concerned. In the framework of this system (a star type system) the DCP has competence on promotion and management regarding the core set of information needed to risk assessment and prevention from disaster . DCP also acts as main director in the coordination of the whole activities related to emergency response in case of catastrophic events of national relevance including natural disasters.
Lithuania	The Fire and Rescue Department under the Ministry of Interior of the Republic of Lithuania oversees natural disaster management.
Luxemburg	Administration des Services de Secours.
Netherlands	Local governments organised in future in safety regions are the first to respond to natural disaster management. Based on the scale of the event provinces, waterboards or the national government will be involved.
Poland	Crisis management authorities which are under the jurisdiction of local governments are responsible for natural disaster management with close collaboration with the following institutions mainly: + State Fire Service; + Police; + Inspection of Road Transport; + Building authorities; + Water authorities; + National Forestry; + Institute of Meteorology and Water Management; + NGO's.
Romania	Since 1 January 2005, in Romania, the National System for Emergency Situations Management was organized and functions, in order to assure, in a unitary and professional manner, the protection of population's life and health, environment, material and cultural values, during an emergency situations, as well as to recover rapidly after an emergency situation. It is composed of: **+ Committees for emergency situations** (the national committee, ministerial committees and other public institutions committees for emergency situations, the Bucharest committee, county committees for emergency situations, local committees for emergency situations) **+ General Inspectorate for Emergency Situations** - Professional public services in each community for emergency situations - Operational centers for emergency situations - Emergency response commander. **+ The national committee for emergency situations** is formed within the Ministry of Administration and Interior and it operates under the immediate administration of the minister and of the Prime Minister, having the following main attributions: - considers and proposes for adoption by the National Government, the national insurance plan which includes human material and financial resources, necessary for the emergency situations management, analyzes and submits for approval to the Government, the Framework for the organization, operation and endowment of the committees, centers and operational centers for operational situations emergency, as well as the decision-making information flow;

	- declares, with approval of the Prime Minister, the state of alert at national level or at several counties level, coordinates the management of emergency situations and declares the cessation of the state of alert; - decides, with the approval of the Prime Minister, the implementation of evacuation plans, proposed by the ministerial, county or Bucharest Municipality committees; - proposes to the Government, through the Minister of Administration and Interior, the establishment of the state of emergency in the affected areas by the Romanian President, based on requests received from the county or Bucharest committees, and follows the measures established for this purpose; - proposes to the Government the request / provision of international humanitarian assistance in case of emergency situations with significant impact, based on the analysis elaborated by the General Inspectorate; - coordinates, at national level, the activity of the international work force required for managing emergency situations, especially in reducing the disasters negative consequences; - proposes to the Government to include in the annual state budget funds necessary to manage emergency situations, including the funds necessary for operational structures of the National System to intervene outside state borders, in the specialized structures of international bodies with responsibilities in the field; - establishes the main support functions provided by the ministries, other central agencies and nongovernmental organizations on emergencies prevention and management, which is then approved by the Government; - initiates the elaboration of legislation regarding the emergency situations management and advise on those developed by the Ministerial, county and Bucharest Municipality committees; - establishes cooperation of the National System structures with other National authorities and other bodies of the Romanian state or international authorities in the management of emergency situations and it coordinates public information on the management of emergencies; **+ Committees for emergency situations** have been established and function within ministries and public institutions, having the following main attributions: - inform the National Committee through the General Inspectorate on the potential generating emergency situations and their imminent threat; - develop regulations on the emergency situations management, specific to each risk types in the field of the ministries and other public institutions with responsibilities in the management of emergency situations and presents them for approval to the General Inspectorate and the National Committee; - evaluate emergency situations in the fields of competence, establish specific measures for their management, including the pre-alarming of the emergency services in the field of competence of the ministries, and propose, if necessary, the declaration of the state of alert; - consider and approve their plans for providing human, materials and

	financial resources necessary for the emergencies management; - inform the National Committee. **+ General Inspectorate for Emergency Situations** It is a specialized body of central public administration, with juridical personality, within the Ministry of Administration and Interior, which ensures, at national level, the implementation in an unitary manner of the current legislation regarding human life, human health and environment protection against fires and disasters and the implementation of civil protection and emergency situations management measures. It functions as national contact point in the relations with the government and international organizations and NGOs with responsibilities in emergency situations management and ensures the coordination and control of specialized professional and voluntary services for emergency situations management. It has the following main attributes: - Analyzes, evaluates and monitors the risk types, forecasts on their evolution in order to identify potential generating conditions for emergency situations and also proposes measures to warn the population and reduce the negative consequences. It provides: * Coordination of unitary enforcement throughout the country of the measures and actions for prevention and management of emergencies; * Operative informing of the Minister of Administration and Interior and the institutions concerned on the potential generating emergency situations or occurrence of emergency situations in the territory, through their own information system; * inform the population through the media on the imminent threat or emergency situations and on the measures taken to reduce the consequences; * technical and expert coordination of operational centers and ensures the maintenance of a permanent information flow. It coordinates: * the national training programs for protection against disasters; * the activities of prevention and intervention performed by the professional community services and the formation of groups which will coordinate the operational response in case of emergency situations in the affected areas; * the planning of resources necessary for the management of emergency situations at national level and the development of plan which will ensure human, material and financial resources for such situations; It endorses: * and proposes to the National Committee for approval the plans of intervention, cooperation or technical assistance elaborated in cooperation with other international organizations, in order to improve the emergencies management; * the regulations on emergency situations management, developed by ministerial committees. - Cooperates with the international institutes in the field, on the basis of the conventions in which Romania is party, and verifies the compliance with these conventions during emergency situations;

	- Provides technical assistance to the public central and local authorities regarding the management of emergencies; - Manages the database on emergency situations and provides data and information required for managing emergency situations to interested institutions; - Proposes the participation with means and forces to reducing the consequences of emergency situations outside the country, according to treaties, agreements and international agreements to which Romania is party to the Administration and Interior Minister; - Cooperates with other agencies in managing the emergency situation. **+ Public professional services for emergency situations** These are individual structures which function as county inspectorates and Bucharest Municipality inspectorate, providing coordination, guidance and control activities in order to prevent and manage emergency situations. They are organized on territorial administrative units and accomplish the following tasks. - Organize and perform specific activities to prevent emergency situations; - Participate in the identification, recording and evaluation of risk factors and elaborate risk schemes for their territorial unit, which are approved by the prefect; - Coordinate, guide and control the emergencies prevention and management activities; - Provide technical assistance on the management of emergencies; - Monitor through the operational centers the evolution of emergency situations; - Plan, organize and develop training for response in case of emergencies; - Verify the application of regulations on emergency situations management, intervention and cooperation plans; - Collect resource requirements required to perform support functions during emergency situations. **+ Operational Centers** Operational centers for emergency situations are competent structures for emergency situations management, which, according to the current legislation, are part of the National System of Emergency Situations Management. At the level of ministries and central public institutions, central operational centers are organized, with temporary or permanent activity, depending on their duties in managing emergencies. Operational centers with permanent structures are operational and technical structures, which are formed within ministries and central public institutions. They have responsibilities and complex capacities in emergency situations prevention and management, in order to monitor, assess, alarm and coordinate the interventions in case of emergency situations. Operational centers with temporary activity are technical – administrative structures which fulfill specific duties during the alert state, in case of emergency situations and during exercise and trainings for response preparedness. **+ Emergency response commander** During emergency situations, the unitary coordination on-site of all the

	actions of the intervention units is executed by a person authorized by the National, ministry, county or Bucharest Municipality committee, depending on the event nature, severity and on the size of the involved units. This person is called the emergency response commander. Citizens may request the intervention units from the professional public services to perform the below mentioned missions: - Fire extinguishing - Extrication activities - First-aid - Save or protect people, goods and animals at risk - Reducing the consequences of accidents, natural disasters and calamities - Transport water to the population affected by disasters; - Evacuation of water from the basements of buildings or wells after floods; - Reducing, collecting or removal of polluting products; - Saving from high altitudes; - Deactivation of unexploded ammunition
Slovakia	+ Ministry of Environment and regional departments (prevention) + Ministry of Interior and Ministry of Defense an their regional departments; Fire brigades, Integrated Safety System and Civil Protection and the Military (mitigation)
Sweden	Sweden has created and maintains a national platform for the management of natural hazards in compliance with the UN Hyogo Framework for Action for disaster risk reduction 2005-2015 (HFA). This platform includes a network of agencies which meets 5 times a year to discuss and implement the action programme. Working groups are formed to carry out the tasks. The steering group for the activities is comprised of the Director General for each of the agencies in the network. + National Land Survey of Sweden - Field studies and techniques to produce analog and digital maps that can be used as the basis for emergency planning, preparedness, response and recovery. Responsible for coordinating implementation of the EU INSPIRE directive. + National Railroad of Sweden - Maintains the good conditions of roads, recommends routes for safe transport of dangerous goods. + Swedish Water Power Authority - Hydroelectric power regulation and dam safety. + Swedish Environmental Protection Agency -Perform climate studies and research and propose environmental policy. Much attention is paid to climate adaptation, risks and vulnerability. + Swedish Forest Agency – Forestry management. + Swedish International Development Cooperation Agency - Humanitarian assistance to countries afflicted by natural catastrophes, capacity building projects- Rules and advice related to where businesses and other activities in the municipality should be located, building and city planning advice where natural hazards exist. + Swedish Civil Contingencies Agency (MSB) Support for flood inundation maps and landslide risk maps for developed areas. Support to municipalities at the national, regional and local level. + National Board of Health and Welfare – Supervision and guidance for schools hospital, day care centres, health care centres.

	+ National Board of Housing, Planning and Building – Authority for planning, land management, water resources urban development and building. Authority monitors the function of the legislative system and proposes regulatory changes if necessary. + National Food Administration - Assure that there is drinking water available for all even during and after a natural disaster. VAKA group for drinking water shortages. SAMVA is a co-operation between actors to insure good water quality and water availability to homes, industry, businesses etc. + Swedish Association of Local Authorities and Regions – Ask as a voice for all the Swedish municipalities on various issues including natural disaster management. + Swedish Geotechnical Institute - Technical Field investigations and modeling for slope stability maps in developed areas. Support to municipalities that need to produce landslide risk maps. Risk for erosion has also become a concern. General erosion risk maps. + Swedish Geological Survey - Provide information including digital maps for geological types, soil types and ground water. + Swedish Meteorological and Hydrological Institute - provides services such as general forecast and weather warnings, industry specific services, simulations and analysis, statistics, climate studies and contracted research. Warnings are issued to the public and authorities regarding extreme weather (rainfall, storm, avalanche risk). A warning system for fires and vegetation fire risk has been operation since about 2000. + Swedish Road Administration - planning building and maintaining state roads. Responsible for road transport systems, including impacts on the environment, traffic safety, transport quality, and effective regional development. + Representatives for the County Administrative Boards – assistance to municipalities for risk and vulnerability analysis. Lead emergency operations when it exceeds the capacity of the municipalities.
UK	A number of government instructions have oversight: + in England, the Civil Contingencies Secretariat of the Cabinet Office provides guidance on disaster management; + in Scotland, the Scottish Government's Civil Contingencies Division has overall responsibility for civil protection; + in Wales, the Welsh Assembly Government or Wales office (depending on the subject matter) is represented on key committees and fora within the UK government relating to civil protection; and + in Northern Ireland, the Central Emergency Planning Unit in the Office of the First Minister and the Deputy First Minister promotes and coordinates civil protection arrangements. HSE also has a role in planning for emergencies where it is the Lead Government Department for planning issues relating to civil contingency events involving an industrial site – especially a major hazard chemical, biological or radiological/nuclear site – regardless of whether the event is precipitated by natural disaster.

Table C2: Rules, codes and guidelines that address natural-disaster management in the participating countries.

Country	**Which rules, codes and/or guidelines that address natural-disaster management are used?**
Austria	Not aware of any guidelines etc. that deal with natural-disaster management in connection with chemical accidents – if they exist, this would be on regional basis.
Czech Republic	+ Crisis planning at all levels include as an important part natural disasters management; + Bilateral agreement with all neighboring countries (and many others) exist, as well as multilateral agreement on mutual help in the case of disaster; + UNECE Convention on the Transboundary Effects of Industrial Accidents; + UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes.
France	+ National earthquake map (decree of 14 May 1991), updated in 2009; + Law of 2 February 2005, creation of the Natural Risk Prevention Plans (NRPP); + Law on Domestic Safety and Protection of Citizen, 18 March 2003; + Civil Protection Law, 13 August 2004; + Directive 2007/60/CE on the assessment and management of flood risk, 23 October 2007.
Germany	+ Zivilschutzgesetz des Bundes (Federal civil protection act); + Brand-, Katastrophenschutz- oder Zivilschutzgesetze der Länder ((fire- or disaster management or civil protection legislation of the Länder).
Italy	As far as the emergency response and natural disaster management the Law by Decree 24 February 1992, n. 225 and its amendments is the reference code stating the institution of Civil Protection National System under the coordination of DCP. Many other rules and ordinances regarding the organization of emergency activities, funds distribution to local authorities, natural disaster prevention, as well as the "upgrading" of DCP organisational structure itself have been issued and updated. In the framework of Natech the most important could be considered: - Law 183 of 1989 and Law by Decree 180 of 1998 on soil defence (now included with amendments in the Code of environment, Law by Decree April 3th, 2006 n.152). These measures are designed to achieve advanced knowledge of the land through the mapping of areas at different levels of risk and danger caused by landslides, avalanches and floods, and provide measures to limit land use. The measures also identify main protection actions to reduce or to remove the risk. Actions are identified by Basin Authorities by means the elaboration of dedicated sections (PAI and PFSS) of a more general plans (Basin Plans) and are mandatory for public or private infrastructure located inside risk areas. In some local context (e.g. Po river Authority) specific directives are mandatory for the owners of Seveso Plants located inside flood areas in assessing hydraulic risk. - Decree of Ministry of Infrastructure and Transports (January 14,

	2008). This Rule states that every new construction, industrial plants included, has to comply in design and construction criteria with the New official Technical Rules. The rules take into account seismic hazards calculated on equally spaced points grid on the national territory according to studies carried out by INGV (Substantially in accordance with EC8) - OPCM (20/03/2003) states general (administrative) criteria for new seismic classification of national territory subsequently implemented in the above mentioned 2008 technical rules. The application rule of this code (Decree October 21, 2003 GU n.252 del 29/10/03) identifies in its appendix list B those structures whose collapse may generate severe impacts on the environment in the event of an earthquake. "Seveso" plants, clearly mentioned in list B are identified as priority features for which an assessment of seismic adequacy has to be started.
Lithuania	+ Law on Civil Protection + Regulations on Emergency Situations Prevention in Lithuania Republic + Regulations on Invokement of Material Resources and General and Special Units in the Cases of Emergency Situations and on Compensation Pay for Invokement of Material Resources and General and Special Units and on Rendering the State Assistance for the Incurred Damage and Losses + Order No. 1-415 on Setting the Level for Operational Management of the Fire Prevention and Rescue Service Forces, Performance of Operational Management and Instruction for the Preparation of the Plan for Saturation of the Fire Prevention and Rescue Service Forces to Respond to Emergency Situations, Emergency Incidents and Accidents, issued by the Director of Fire and Rescue Department on 29 December 2008 + Also Lithuania has signed governmental bilateral agreements on cooperation and mutual assistance in case of emergencies and major accidents prevention with Latvia, Poland, Belarus, Germany, Sweden, Hungary, and Ukraine.
Luxemburg	Use of documents of UNECE.
Netherlands	Relevant legislation on external safety: + General: - Environmental Management Act (Wet Milieubeheer) (the most important environmental act); - Decree on the external safety of establishments (Bevi) (came into effect on 27 October 2004 with the exception of a few aspects); - Regulation of the external safety of establishments (Revi) (2004); - Fireworks decrees. + Risks of serious accidents: - Seveso II Directive; - Decree on the risks of serious accidents 1999 (BRZO). + Infrastructure investment projects (external safety around roads and railways) - Circular on risk standards for transport of hazardous materials.
Poland	+ SEVESO II Directive implemented in Environmental Protection Act; + Chemical substances and preparations Act; + ADR; + RID; + AND;

	+ Convention on the transboundary effects of industrial accidents; + ATEX Directive implemented into decree of Minister of Economy, Labour and Social Policy on minimum requirements for workers working with explosive atmospheres.
Romania	+ Government Emergency Ordinance no. 21 of 2004 on the National System of Emergency Situations Management; + Law no. 481/2004 on civil protection; + OMAI 1184 of 2006 for approving the Norms for the organization of evacuation activities during emergency situations; + Norms of 08.07.2004 on the development of protection plans in the event of a disaster caused by earthquakes and/or landslides; + H.G. 2288 of 2004 for the approval of the allocation of support functions assured by the ministries, other central agencies and nongovernmental organizations on prevention and emergencies management; + O.M.A.I. no. 638/420 of 12 May 2005, approving the Regulation on management of emergency situations generated by floods, dangerous meteorological phenomena, construction accidents and pollution accidents; + O.M.A.I. 1475/13 October 2006 approving the Regulation on management of emergencies generated by forest fires; + Order No. 1995/1160 of 18 November 2005 approving the Regulation on the prevention and management of emergencies generated by earthquakes and/or landslides.
Slovakia	Law 7/2010 on protection against floods – implemented directive 2007/60/ES, Law nr. 42/1996 on civil protection, law nr. 364/ 2004 on waters – "water law"
Sweden	+ Guidelines: UN Hyogo Framework for Action for Disaster Risk Reduction 2005-2015. + International agreements: Sweden has agreements with Finland, Denmark and Norway, Estonia, Latvia and Lithuania for assistance with cross- border disasters, and in some cases mutual training activities. + Legislation: The Civil Protection Act of Sweden requires that municipalities develop programs for emergency prevention and emergency response. The municipalities are legally bound to perform risk and vulnerability analysis. + EU instruments: European Community Mechanism enables countries afflicted with a natural disaster to receive support from EU Member States.
UK	The Civil Contingencies Act 2004 provides a single regulatory framework for civil protection in the UK. It is supported by statutory guidance on emergency preparedness and by non-statutory guidance on emergency response and recovery. There are concordats between the UK Government and Scottish Ministers and the Welsh Assembly Government.

ANNEX D – Rules, codes and guidelines for natural-disaster management that restrict hazardous-substances handling

Table D1: List of rules, codes or guidelines for natural-disaster management that directly or indirectly restrict hazardous-substances processing, storage or use in areas subject to natural hazards.

Title and year of document	**Natural hazard(s) considered**	**Impact on hazardous-substances handling**
FRANCE		
The Natural Risks Prevention Plans define rules (prohibitions, restrictions) applicable for all the constructions, including hazardous industrial facilities, located in the different areas exposed to natural hazard.		
General guide, Natural Risks Prevention Plan / Environment Ministry, 1997	All	Selection of measures based on local context.
Methodological guide, Prevention Plan for coastal risk / Environment Ministry, 1997	Coastal risks	
Methodological guide, Prevention Plan for flooding / Environment Ministry, 1999	Flooding	
Prevention Plan for flooding / Prevention measures / Environment Ministry, 2002	Flooding	
Methodological guide, Prevention Plan for landslide / Environment Ministry, 1999	Landslide	
Methodological guide, Prevention Plan for seismic risk / Environment Ministry, 2002	Earthquake	
Methodological guide, Prevention Plan for forest fires / Environment Ministry, 2002	Forest fires	
ITALY		
OPCM (20/03/2003)	Earthquakes	In this rule, for constructions where the consequences of a collapse could be relevant, it is mandatory for the owners to assess seismic adequacy to the new classification.
Decree of Ministry of Infrastructure and Transports (January 14, 2008)	Earthquakes, wind, snow	
Law 183 of 1989 and Law by Decree 180 of 1998 and amendments (now Law by Decree n.152 of 2006)	Floods, landslides	In some local context River Basin Authorities identifies risk areas and issue directives that provide specific measures to verify flood risk for Seveso Plants
ROMANIA		
Order of the Minister of Administration and Interior no. 638 of 12. May 2005 and Minister of Environment and Water Management no. 420 of 11 May 2005 approving the Regulation on	Floods	Additional measures for safety to ponds containing dangerous substances

management of emergencies arising from floods, dangerous meteorological phenomena, accidents at hydro construction and pollution incidents		
Order of MTCT / May 1995 (2005) / 1160 (2006)	Earthquake	For buildings housing hazardous substances the development and implementation of measures to eliminate/reduce risk is required
SLOVAKIA		
Decree No. 7/2010 Coll. on protection against floods	Floods	The obligation of operators in flood areas to realize mitigation against the flood (flood plans etc.); Plan for developing flood risk maps
Decree No. 364/2004 Coll. on waters – "water law"	Floods	
UK		
Planning Policy Statement 25: Development and Flood Risk (published December 2006 by the Department for Communities and Local Government)	Flooding	Requires an objection to new installations requiring hazardous substances consent (and other highly vulnerable activities) within flood plains. If activity is to be considered for areas with a medium risk of flooding then an 'Exception Test', including a flood risk assessment is required. PPS 25 also provides guidance on the flood risk assessment process for new activities.
Management of Flood Risks at Major Installations Policy Number: 105_02 (Published 29/05/02 by the Environment Agency)	Flooding	Details the Environment Agency's approach to proposed developments of major installations within floodplains and the method of assessment of existing activities i.e. Safety Report Assessment.

ANNEX E – List of Natech accidents provided by the survey participants

DATE	LOCATION	TYPE OF INDUSTRY	TYPE OF NATURAL HAZARD/ DISASTER (e.g. flood, earthquake)	TYPE OF RELEASE (e.g., air release, liquid spill, fire, explosion, etc.)	SUBSTANCE RELEASED		FAILURE MODE	LESSONS LEARNED
					Name (e.g., chlorine)	Quantity released		
2006	Kolin, Czech Republic	Cyanide production	Low temperature	Liquid spill	Cyanide	6-9 tons	Failure of passive mitigation systems: containment dikes, enclosure	Importance of safety in stand-by regime and risk analysis completeness.
2002	Neratovice, Czech Republic	Chemical industry	Flood	Atmospheric release; Liquid spill	Chlorine	86 ton	Rupture of pipes and connections	Possibility of floods exceeding 100-yr flood level.
2002	Ostrava, Czech Republic	Aniline production	Low (oscillating) temperature below freezing point	Explosion			Run-away reaction	Importance of safety in stand-by regime.
1997	Ostrava, Czech Republic	Oil refinery	Flood	Liquid spill	Used oil		Failure of passive mitigation systems: containment dikes, enclosure	Risk of chemical release from brownfields.
November 2008	Andrezieux-Boutheron, France	Road transport	Flood	Liquid spill	Used engine oil	Unknown (1ha polluted land)	Flooding of tank storing used engine oil	
November 2008	Saint-Germain	Chemicals	Flood	Liquid spill			Impact includes the loss of	Commissioning of hydraulic study for

	Laprade, France						explosimeter in buildings	impacted area.
November 2008	Grasse, France	Agroindustry	Lightning	Fire			Fire of methane production unit	Audit of lightning protection system.
October 2008	Missirac, France	Urban water treatment plant	Lightning	Liquid spill	PCB		Leak of power transformer	
July 2008	Joncels, France	Railway	Lightning	Liquid spill	PCB		Leak of power transformer	
July 2008	Colmar, France	Gas pipeline	Lightning	Fire			Leak of pipeline	
June 2008	Arette, France	Agriculture	Flood	Liquid spill	LPG		Flotation of LPG tank	
May 2008	Raon-l'Etape, France	Paper mill	Flood	Liquid spill			Breach of protecting floodwall	• Reconstruction of floodwall; • Levee watch procedure.
November 2007	Le Francois, France	Alcohol production	Earthquake	*Non-structural damage*			M7.3 earthquake caused anchor breach at tanks	
July 2007	Mardyck, France	Petrochemical	Lightning	Toxic cloud	Ethylene		Loss of utility (torch)	
June 2007	Vervins, France	Agriculture	Lightning	Liquid spill	PCB	357 kg	Leak of power transformer	
October 2004	Toulouse, France	Battery recycling	Lightning	Fire			Fire of piles of used batteries	Updating of lightning safety report.
July 2004	Saint-Sulpice, France	Printing	Lightning	Gas			Loss of utility (emission cleaning)	Updating of lightning safety report.
January 2004	Auzouer-en-Tourraine, France	Chemicals	Flood	Liquid spill	Acrylic substances		Flooding of site occurred during cleaning of reactors used for mixing of	• Hydraulic study; • Improvement of safety

							chemicals	measures and emergency management procedures.
December 2003	Arles, France	Phytosan	Flood	Liquid spill	Phytosan substances		Flooding of equipment and stocks, despite early measures taken before the flood	Flooding is included as additional accident scenario in the safety report of the facility.
December 2003	Saint-Gilles, France	Agropharmaceutical	Flood	Liquid spill	Agropharma substances		No major pollution thanks to early measures taken by staff before the flood	N.a. (Flooding already considered as potential accident scenario in existing safety report of the facility).
October 2003	Romans sur Isere, France	Metal industry	Lightning	Fire	Magnesium; H_2		Fire of unknown mix of industrial waste	Revision of storage equipment and procedures.
May 2003	Carsix, France	General store	Lightning	Fire; Liquid spill River pollution from polluted fire-fighting water				
October 2000	Tarnos, France	Steel recycling	Storm	Smoke			Strong winds prevent fire extinguishing	Revised list of accident scenarios and management.
May 2000	Petit-Couronne,	Refinery	Storm	Smoke	SO_2		Loss of utilities (electricity)	Updated list of failure modes.

	France							
December 1999	Muret, France	Chemicals	Storm	Fire			Loss of electricity; loss of internal venting capacity	
December 1999	Ambes, France	Oil storage	Storm-rain	Liquid spill	Petrochemicals		Overload of draining capacity	Cleaning and improvement of draining systems.
December 1999	Ambes, France	Alcohol production	Storm-rain	Liquid spill	Sulfuric acid; Chlorohydric acid		Floating of acid tanks and spill	Installation of retention ponds under acid tanks.
December 1999	Ambes, France	LPG storage	Storm-rain	*Non-structural damage*			Loss of electricity	Power supply by emergency generator (diesel engine).
December 1999	Ambes, France	Soda chlorate production	Storm-rain	Liquid spill	NaCl		Flooding of facility	Building of floodwall for local protection.
January 1997	Valdoie, France	Metal industry	Landslide	Liquid spill	Petrochemicals		Freeze-triggered landslide causing pipe breach	Revised mapping of landslide hazards/ geotechnics.
January 1996	Le Croisic, France		Storm-rain	Liquid spill	Engine oil		Flooding of engine oil tank	
8 August 2008	Solingen, Germany	Metal industry, Electroplating	Rain	Air release 7 inj. onsite; 13 inj. offsite	Nitrous gases (NO, NO_2)	20kg	Chemical reaction of rainwater with acid stored in a trough in the open.	• Internal prevention planning; • Worker training. More details in ZEMA: http://www.infosis.bam.de/
1 March	Duisburg,	Iron and steel	Wind	*Structural*			A crane was caught	More details in

2008	Germany	works, port handling		*damage* 1 injured			by a gust of wind and toppled onto slack silos under construction.	ZEMA: http://www.infosis.bam.de/
13 May 2006	Baunatal, Germany	Metal industry, Foundry	Rain, lightning	Explosion; Fire			A probable lighting strike caused magnesium scrap metal to burn. Heavy rain flooded the scrap yard with up to 20cm of water. Reaction of the burning Mg with the rainwater led to the formation of hydrogen with subsequent violent gas explosions.	• New safety concept for scrap yards; • Evaluation of the rain-water drainage system; • Separate and roofed storage of Mg dross. More details in ZEMA: http://www.infosis.bam.de/
2006	Germany	Storage of liquefied gases	Flood	Air release	Liquefied gas		Floating of un-anchored tank due to flooding and subsequent breaking of pipe connections.	Re-evaluate flood-prone areas in the face of climate change. More details in ZEMA: http://www.infosis.bam.de/
28 February 2003	Kaiserslau-tern, Germany	Storage, (un)loading of substances and preparations	Low temperature	Air release 2 injured onsite	Chlorine	50 litres	Freezing and bursting of a feed line that went unnoticed. After thawing of the line the liquid entered a mixing vessel	Rinse feed line and mixing vessel with water before putting them out of operation. More details in ZEMA:

							through the man-hole lid where it reacted with the mixture and generated chlorine gas.	http://www.infosis.bam.de/
5 January 2002	Wismar/Haf-feld, Germany	Plastics and synthetic fibres manufacturing	Low temperatures	Explosion	Pentane	16.2 kg	Weather-related conditions (freeze) caused problems at automatic start-up of vessel filling and necessitated manual start-up. During this period another fault occurred with a gate valve but was resolved. Shortly after this an explosion occurred when a pentane/nitrogen mixture from two leaking hand valves reacted with oxygen. It is unclear if the freeze caused or contributed to the accident.	More details in ZEMA: http://www.infosis.bam.de/
4 January 2002	Spreetal, Germany	Waste disposal	Low temperature	Air release	Nitrogen gas mixture	700 m^3	Tearing open of 3 welded seams on	Ascertain functional

					containing benzene		the roof of a tank containing tar oil mixed with solid materials. A technical failure is suspected as primary cause but the freezing of the pressure-control valve could have caused or contributed to the accident.	reliability of pressure-control valves at low temperatures. More details in ZEMA: http://www.infosis.bam.de/
31 December 2001	Laichingen, Germany	Storage, (un)loading of substances and preparations	Low temperature	Air release; Fire 1 fatality onsite	Oxygen	2,400kg	Release of oxygen into surroundings through an incompletely closed flush valve. The valve was operated with compressed air and probably failed due to the freezing of the compressor bleed air pipe.	• Monitoring of the flush valve final position; • Compressor bleed air pipe cross section lay-out changed to prevent freezing. More details in ZEMA: http://www.infosis.bam.de/
16 June 2001	Mannheim, Germany	Storage, (un)loading of substances and preparations	Lightning	Air release; Fire	Naphtha	3,371 kg	Lightning struck a 42,000m^3 storage tank and ignited product vapor along the perimeter	Implement measures to prevent accidents after a lightning strike or to

							seal of the floating roof. The fire spread over a total length of 40m along the perimeter seal.	mitigate their consequences. More details in ZEMA: http://www.infosis.bam.de/
22 January 2000	Rostock, Germany	Storage, (un)loading of substances and preparations	Low temperature	Air release	Ammonia	700 kg	In a pressurized ammonia storage tank depot ammonia was released from a hand valve. Due to the low temperatures ice had formed inside the hand valve and pushed on the bellows, thereby destroying it.	• Inclusion of the event into the site's valve maintenance planning; • Replacement of the failed armature with one of different design. More details in ZEMA: http://www.infosis.bam.de/
13 November 1998	Leverkusen, Germany	Chemical manufacturing	Low temperature	Air release	Phophortrichloride	12 kg	Condensation of chlorine gas in a pipe bridge due to low temperature and low demand. This liquid chlorine was carried along with the chlorine gas into the phosphorus furnace where it evaporated abruptly.	Installation of a safeguard to stop chlorine feed if necessary. More details in ZEMA: http://www.infosis.bam.de/

24 October 1998	Rostock, Germany	Storage, (un)loading of substances and preparations; Ammonia storage	Storm (depression); Wind	Air release	Ammonia	1,400kg	Due to a short circuit there was limited electrical capacity in the facility to ensure maintaining tank pressure using compressors. The available capacity was exceeded when a passing depression required the operation of additional compressors. This resulted in a black out. The torch was blown out by the high winds.	• Additional heating of 29kV switch unit; • Standalone emergency power supply for torch and the pressure-control instrumentation; • Revision of pressure relief valves. More details in ZEMA: http://www.infosis.bam.de/
22 February 1996	Bitterfeld, Germany	Phosphorus mud pit	Low temperature	Fire	Phosphorus (white, yellow); Phosphorus pentoxide gas from fire		At a former phosphorus production site phosphorus waste was stored in pits covered with water. Due to freeze-up this water had been frozen. Strong sunlight and temporary thawing led to a reduction of the water layer, allowing	More details in ZEMA: http://www.infosis.bam.de/

							phosphorus to reach the surface in an area of max. 40 x 40m where it ignited.	
29 January 1996	Leuna, Germany	Acetylen production	Low temperature	Explosion	Acetylen	0.5 kg	Low temperatures led to the formation of ice on the surface of lime slurry which fell and damaged the agitator in a lime slurry vessel.	• Ensure better aeration of the system; • Addition of heating to prevent freezing and the formation of ice. More details in ZEMA: http://www.infosis.bam.de/
27 December 1995	Rostock, Germany	Storage, (un)loading of substances and preparations; Atmospheric storage		Air release	Ammonia	800 kg	Ammonia was released from a safety valve whose membrane had suffered weather-related cracking and degradation, thereby losing its tightness.	• Replacement of safety-valve membranes; • Revision time reduced by 6 months. More details in ZEMA: http://www.infosis.bam.de/
4 August 1995	Frankfurt/ Main, Germany	Chemical processing	Heat	Fire	Nitrogen oxides (NO, NO_2); p-Nitrosophe-	20,000 kg	Self ignition of p-Nitrosophenol stored outside due to a heat wave.	Storage of p-Nitrosophenol in the basement to ensure that temperatures stay

					nol			below 30 degrees. More details in ZEMA: http://www.infosis.bam.de/
27 November 1994	Germany	Acrylic acid storage	Low temperature	Explosion; Fire 1 fat. onsite 12 inj. onsite	Acrylic acid	10 tons	A black-out in the facility caused the failing of the heater fans and the tank's circulating pump. The building cooled down and acrylic acid froze in the pipes. The acrylic acid started to polymerize and was transferred into the storage tank where the polymerization reaction continued unnoticed for 4 days. Then the tank burst due to the overpressure generated by the reaction, the acrylic acid exploded and ignited a fire.	• Ensure high enough temperature in storage and pipe area that acrylic acid cannot freeze and loose the oxygen required for inhibition; • Fit tanks with adequate pressure-relief systems; • Monitor flow rates in the circulating loop. More details in ZEMA: http://www.infosis.bam.de/
7 September 1994	Bad Breisig, Germany	Plastics and synthetic fibres	Lightning	Fire	Toluylendiiso-cynate (TDI)		Electrostatic charge in connection with a lighting strike.	Inclusion of scenario in safety document. More details in

								ZEMA: http://www.infosis.bam.de/
3 August 1994	Weilburg/ Lahn, Germany	Paint manufacture	Heat	Air release	Hexamethylen-1,6-diisocya-nate (HMDI)	20 kg	Exothermic reaction of HMDI mixed with sawdust for disposal due to heat.	Revision of operating instructions. More details in ZEMA: http://www.infosis.bam.de/
27 June 1994	Gernsheim, Germany	Storage, (un)loading of substances and preparations; Methanol storage	Lightning	Fire; Explosion	Methanol	8,000 kg	Lightning struck a 354,000kg methanol tank, leading to an explosion with fire.	More details in ZEMA: http://www.infosis.bam.de/
4 March 1993	Ludwigsha-fen, Germany	Storage, (un)loading of substances and preparations; Storage of liquefied gases	Low temperature	Air release 1 injured onsite	1,3- Butadiene; Flammable gases		Low temperatures resulted in ice formation and blocking of the pipe between the sphere and the torch which was recognized during hydrotesting by opening the blank flange on the pipe. When closing the flange an ice layer formed between the seal faces, thereby creating an opening from where the	• Avoid hydrotesting during the winter months; • Additional instrumentation to better localize blocked pipe sections. More details in ZEMA: http://www.infosis.bam.de/

							substance was released once the pipe was unfrozen.	
6 January 1993	Ludwigsha-fen, Germany	Chemical manufacturing	Low temperature	Air release	1,3-Butadiene; Benzene	400 kg mixture	A seal failed in a flange connection in a steam cracker due to ice formation.	Better monitoring and heating of pipes. More details in ZEMA: http://www.infosis.bam.de/
30 June 1992	Vogelsang, Germany	Disposal of explosive substances	High winds	Fire	Explosive substances		During the controlled disposal of propellants by burning, sudden high winds caused a conflagration that got out of control and burned surrounding vegetation.	Adapt the amount of material to be disposed of by burning to the weather conditions. More details in ZEMA: http://www.infosis.bam.de/
7 June 1989	Oberhausen, Germany	Chemical manufacturing	Lightning	Air release	Nitrogen dioxide	31 kg	Lightning strike caused process upset which led to the shutdown of the nitric acid plant. During restart incomplete decompression resulted in a release.	Use check valves to avoid unintentional backflow of gases. More details in ZEMA: http://www.infosis.bam.de/
18 January 1985	Wesseling, Germany	Chemical manufacturing	Low temperature	Explosion; Fire; Air release	Hydrocarbon (gas);	500-11,500 kg	Bursting of a pipe due to freeze-up which led to	Prevent freezing by selected pipe geometry or use

				43 injured onsite	Propylene	4,100 kg	propylene release which exploded.	heating. More details in ZEMA: http://www.infosis.bam.de/
26 September 2007	Porto Marghera, Italy	Polymers	Heavy rain	*Structural damage*			Overbalancing of floating roof in tank containing virgin naphtha	
12 October 2002	Brindisi, Italy	Petrochemical	Heavy rain	Liquid spill	Fuel oil	1,500 kg	Overfilling of basin containing rain water with oil	
22 September 2002	Cogoleto, Italy	Chemicals	Flood	Solid release	Chrome salts		Warehouse flooded	
24 July 2002	Porto Marghera, Italy	Polymers	Lightning	Fire	Ethylbenzene		Vapour ignition caused by lightning	
25 January 2001	Rome, Italy	Transport pipeline	Landslide	*Near miss*			Landslide brushed against natural gas pipeline	
14 July 1998	Genoa, Italy	Transport pipeline	Rain	Air release	Methane		Catastrophic rupture of pipe	
20 June 1998	Cuneo, Italy	Storage	Storm	Liquid spill	Gasoline		Catastrophic rupture of tank	
23 January 1996	Naples, Italy	Pipeline	Landslide	Air release	Methane		Catastrophic rupture of pipe	
1 November 1995	Genoa, Italy	Pipeline	Landslide	Liquid spill	Heavy oil	190 m^3	Structural failure of underground pipeline due to electrolytic corrosion caused by the scratching of	

							the pipe tube by the space holders between the pipeline protective packing and the pipe. The space holders were crushed when the pipeline packing was squeezed onto the pipe tube due to subsidence of the terrain.	
6 November 1994	Cuneo, Italy	Pharmaceutical	Flood	Solid release	Toxic materials		River overflowed, warehouse flooded	
14 September 1994	Turin, Italy	Transport pipeline	Lightning	Air release; Fire	Methane		Failure of underground pipeline	
8 October 1993	Livorno, Italy	Chemicals	Flood	Air release	Chlorine		Plant flooded	
16 November 1992	Genoa, Italy	Transport pipeline	Landslide	Liquid spill	Heavy oil	30,000 kg	Pipeline rupture	
9 June 1992	L'Aquila, Italy	Storage	Flood	Air release	LPG	40,000 kg	Storage flooded	
14 July 1991	Verona, Italy	Resins, paints	Lightning	Fire	Resins			
25 January 1991	Arezzo, Italy	Transport pipeline	Landslide	Air release	Methane		Pipeline rupture	
30 October 2000	Sandhurst, Gloucester, UK	Waste treatment	(Severe storm) Flooding	Fire (smoke plume); Explosions	Hydrogen chloride; Phosgene; Others	Mitigation taken during incident	Initial fire occurred during a severe storm. Wind or lightning could	Issues highlighted: • Storage and segregation of incompatible

				Potential pollution of floodwater		prevented significant release	have contributed to or initiated the event Inappropriate storage in floodplain	chemical substances and waste; • Packaging of chemical waste to prevent damage; • Procedures for receipt and classification of waste materials; • The risk of flooding at major hazard sites, many of which are located close to rivers and estuaries. Since the incident there is improved land-use-planning guidance in relation to new developments in floodplains.

ANNEX F – Questionnaire used in the frame of the Natech survey

SURVEY OF NATURAL HAZARD-INDUCED CHEMICAL ACCIDENTS ALSO KNOWN AS "NATECHS" (NATURAL-HAZARD TRIGGERED TECHNOLOGICAL ACCIDENTS)[7]

The purpose of this survey is to assess Natech risk management practices and awareness of Natechs, identify case histories and lessons learned, and identify needs and/or limitations in implementing Natech risk reduction strategies in European Union Member States. The results of the survey will lead to better designed and targeted Natech risk reduction strategies.

Needless to say, the success of this survey depends on your contribution. Thus, it is important that you answer each question in as complete a way as possible. We understand that sometimes the information may not be available or not in the level of detail required by the question. In this case, please answer the question to the best of your ability. With this questionnaire we want to obtain an overview of the state of Natech risk reduction; some questions are therefore very general. If you want to provide additional information or need more space to explain your answers please feel free to add as much information as you need.

Should you have any question about this survey of Natech accidents, please contact *Elisabeth Krausmann* at the JRC (elisabeth.krausmann@jrc.it)

Please send the completed questionnaire back to the JRC (elisabeth.krausmann@jrc.it) **by 19 June 2009.**

[7] This questionnaire was prepared by A.M. Cruz and E. Krausmann.

Please carefully read the following definition for "Natech" and "chemical accident":

DEFINITION

For the purposes of this survey, a "Natech" (natural hazard-triggered technological accident) is defined as a chemical accident caused by a natural hazard or a natural disaster.

Chemical accidents include accidental oil and chemical spills, gas releases, and fires or explosions involving hazardous substances from fixed establishments (e.g. petrochemical, pharmaceutical, pesticide, storage depot), and oil and gas pipelines.

Examples: the sudden release of anhydrous ammonia from a storage tank due to damage caused by an earthquake; chlorine gas release from a broken pipe caused by floating off of a storage tank due to flooding; or heavy rain and high winds during a hurricane cause sinking of the floating roof on a storage tank exposing naphtha fuel to the atmosphere and to lightning strike leading to explosion and fire; etc.

SURVEY OF NATURAL HAZARD-INDUCED CHEMICAL ACCIDENTS ALSO KNOWN AS NATECHS (NATURAL-HAZARD TRIGGERED TECHNOLOGICAL ACCIDENTS)

I. REGULATIONS FOR THE PREVENTION AND MITIGATION OF NATECHS

WE ASK NATIONAL AUTHORITIES TO ANSWER FOR THEIR COUNTRY, AND INDUSTRY, INTERNATIONAL ORGANIZATIONS AND OTHER STAKEHOLDERS FOR THEIR ORGANIZATION WHERE APPLICABLE

1. Regulations and guidelines for chemical-accident prevention and mitigation

   a. Which government institution(s) in your country oversee(s) chemical-accident prevention and mitigation? Please provide a brief description of their responsibilities. *(Note: If there is more than one institution, please list them and their responsibilities.)*

   .....

   .....

   .....

   b. Please indicate which rules, codes or guidelines (incl. international agreements) are used in your country to regulate or guide *hazardous-substances* production, use or storage in order to prevent or mitigate chemical accidents with impacts on the public and/or the environment.

   .....

   .....

   .....

   c. Do any of these rules, codes and/or guidelines address the *natural hazards* your country is susceptible to?

   ☐ **Yes** ☐ **No**

   If yes, please indicate title and year of the applicable document, type of natural hazard(s) considered, and how day-to-day hazardous-substances handling is affected (e.g. no chemical storage facilities in floodplains or seismic zones, etc.):

Title and year of document	Natural hazard(s) considered	Impact on hazardous-substances handling

d. Does your country/organization have specific *technical* codes, standards or guidelines for the design, construction and operation of buildings and other structures in industry that consider natural hazards?

☐ **Yes** ☐ **No**

If yes, please indicate title and year of document and indicate for which natural hazard(s):

Title and year of document	Natural hazard(s) considered

e. Does your country/organization have a document which provides guidelines *specific* for Natech risk reduction?

☐ **Yes** ☐ **No**

If yes, please indicate title and year of document and indicate for which natural hazard(s):

Title and year of document	Natural hazard(s) considered

f. Is your country/organization developing a strategy or program to address the problem of Natech events?

☐ **Yes** ☐ **No**

If yes, for which natural hazard(s): .....

.....

2. Natural-disaster management

a. Which government institution(s) in your country oversee(s) natural-disaster management? Please provide a brief description of their responsibilities. *(Note: If there is more than one institution, please list them and their responsibilities.)*

.....

.....

.....

b. Please indicate which rules, codes and/or guidelines (incl. international agreements) that address natural-disaster management are used in your country if any.

.....

.....

.....

c. Do any of these rules, codes and/or guidelines directly or indirectly restrict *hazardous-substances* processing, use or storage in areas subject to natural hazards?

☐ **Yes** ☐ **No**

If yes, please indicate the title and number of the applicable document, the type of natural hazard(s) considered, and the impact on hazardous-substances handling:

Title and number of document	Natural hazard(s) considered	Impact on hazardous-substances handling

3. Effectiveness of regulations

a. In your opinion has your country's approach to chemical-accident prevention and natural-disaster management been effective in preventing Natech accidents? *Please indicate the level of effectiveness by marking a box below (1, low or not effective, and 5, high effectiveness).*

(low) 1--------2---------3--------4--------5 (high)

☐ ☐ ☐ ☐ ☐

Please explain your answer below. If possible give examples of Natechs that occurred despite of, or that were most likely prevented by the introduction of the rules, codes or guidelines:

.....

.....

b. Are there any gaps or shortcomings in your country's rules or codes that should be addressed to ensure effective Natech risk reduction?

Please explain: .....

.....

II. NATECH EVENTS DATA COLLECTION AND RETRIEVAL

WE ASK NATIONAL AUTHORITIES TO ANSWER FOR THEIR COUNTRY, AND INDUSTRY, INTERNATIONAL ORGANIZATIONS AND OTHER STAKEHOLDERS FOR THEIR ORGANIZATION WHERE APPLICABLE

4. a. Does your country/organization maintain a database which can be used to record and retrieve information on chemical accidents?

☐ **Yes** ☐ **No**

If yes, please describe (name of database, owner, access): .....

b. If no, does your country/organization keep any type of records (e.g. written reports) of chemical accidents?

☐ **Yes** ☐ **No**

5. a. Does your country/organization maintain a Natech-specific database which can be used to record and retrieve information about Natech accidents?

☐ **Yes** ☐ **No**

If yes, please indicate how to access this database (contact person, web link): .....

b. If no, can the chemical accident records and/or the database indicated in your answer to Question II.4 be used to identify and retrieve information about Natech accidents?

☐ **Yes** ☐ **No**

III. LEARNING FROM NATECHS: CASE HISTORIES

WE ASK NATIONAL AUTHORITIES TO ANSWER FOR THEIR COUNTRY, AND INDUSTRY, INTERNATIONAL ORGANIZATIONS AND OTHER STAKEHOLDERS FOR THEIR ORGANIZATION WHERE APPLICABLE

6. *Have there been any Natech accidents in your country/organization in the period between 1990 and the present?*

☐ **Yes** (*If yes, go to next question)* ☐ **No** (*If no, go to section IV.)*

7. *We are interested in learning about Natech events that have occurred in your country/organization, including near-misses where deemed relevant for lessons learning.* ***We would appreciate if you could provide details about each Natech event in the spreadsheet at the end of this questionnaire****.*

   If you prefer you can attach a WORD, EXCEL or PDF file with the description of the Natech events.

IV. NATECH AWARENESS AND RISK REDUCTION

WE ASK NATIONAL AUTHORITIES TO ANSWER FOR THEIR COUNTRY, AND INDUSTRY, INTERNATIONAL ORGANIZATIONS AND OTHER STAKEHOLDERS FOR THEIR ORGANIZATION WHERE APPLICABLE

8. Please answer the items below by writing in the box at the end of each item the letter that best reflects your opinion.

A **Disagree Strongly**	B **Disagree Slightly**	C **Neutral**	D **Agree Slightly**	E **Agree Strongly**

a. I was aware of the concept of Natechs before taking this survey.	
b. Risk managers/ safety professionals in industry in my country/organization are aware of the concept of Natechs.	
c. Natech events are discussed among those in charge of chemical-accident prevention and mitigation in my country/organization.	
d. Natechs events are discussed among those in charge of natural-disaster management in my country.	
e. There is enough emphasis on Natech risk reduction in the laws and regulations for chemical-accident prevention and mitigation.	
f. There is adequate knowledge on the dynamics of Natechs among our country's competent authorities.	
g. The relevant competent authorities in my country have adequate training on Natech risk reduction to enable effective Natech risk management.	
h. Current practices for chemical-accident prevention and mitigation in my country/organization provide for adequate protection of citizens against possible Natech events.	
i. Current industry risk assessment methods adequately take into consideration Natech events.	
j. The design and construction of buildings and other structures in industry according to the adopted building codes in my country provide sufficient protection against Natech accidents.	

9. In the following questions, please rank your country/organization on a scale of 1-5 (1=low, 3=moderate, 5=high):
   a. In your opinion, how susceptible is your country/organization to a natural hazard causing a chemical accident?

(low) 1--------2---------3--------4--------5 (high)

☐ ☐ ☐ ☐ ☐

b. What type(s) of natural hazard(s) would you be most concerned about in this context (*please list all that apply*)?

GEOLOGICAL:

☐ Earthquake ☐ Volcano ☐ Landslide ☐ Tsunami ☐ Subsidence

☐ Other (specify):

WEATHER-RELATED:

High winds: ☐ Storm ☐ Tornado ☐ Hurricane/cyclone/typhoon

☐ Other (specify):

Floods: ☐ Flash flood ☐ River flood ☐ Storm surge ☐ Other (specify):

Extreme temperature and related: ☐ Heat ☐ Freeze ☐ Snow ☐ Ice

☐ Drought ☐ Other (specify):

Others: ☐ Heavy rain ☐ Lightning ☐ Wildfire ☐ Other (specify):

c. How satisfied are you with the steps your country/organization has taken to reduce the possibility of occurrence of a Natech accident?

(low) 1--------2---------3--------4--------5 (high)

☐ ☐ ☐ ☐ ☐

Please explain: why, or why not? .....

.....

10. Has your country developed Natech risk maps for some or all parts of its territory?

☐ **Yes** ☐ **No**

If yes, please tell us for which natural hazard(s): .....

.....

11. Has your country/organization developed scenarios for natural hazard-triggered chemical accidents?

☐ **Yes** ☐ **No**

If yes, please describe these Natech scenarios or one of the worst-case Natech scenarios:

.....

.....

12. Are there any Natech risk reduction measures taken in your country/organisation (e.g. consideration of natural hazards in operators' safety documents or emergency plans, in inspections, etc.):

☐ **Yes** ☐ **No**

If yes, please describe them: .....

.....

.....

13. Are there any examples of Natech risk reduction measures (prevention, preparedness and response) in your country/organization that could be "best practice"?

☐ **Yes** ☐ **No**

If yes, please provide details: .....

.....

14. Are there any research activities or projects on Natech risk reduction in your country/organization?

☐ **Yes** ☐ **No**

If yes, please provide a short description of the project and the natural hazard(s) considered:

.....

.....

V. IDENTIFYING NEEDS AND LIMITATIONS

WE ASK NATIONAL AUTHORITIES TO ANSWER FOR THEIR COUNTRY, AND INDUSTRY, INTERNATIONAL ORGANIZATIONS AND OTHER STAKEHOLDERS FOR THEIR ORGANIZATION WHERE APPLICABLE

15. Please indicate which factors (list all that apply) limit your country/organization from including Natech prevention strategies in your planning. Please write in the box at the end of each item the letter that best reflects your opinion.

A **Disagree Strongly**	B **Disagree Slightly**	C **Neutral**	D **Agree Slightly**	E **Agree Strongly**

a. Lack of awareness	
b. Lack of knowledge	
c. Lack of adequately trained personnel	
d. Lack of adequate resources	
e. Budget constraints	
f. Not the organization's responsibility	
g. Responsibility not defined	
h. Liability and/or legal issues	
i. Other (Specify):	

16. Please indicate below what is needed to guarantee effective Natech risk reduction in your country/organization. Please write in the box at the end of each item the letter that best reflects your opinion.

A **Disagree Strongly**	B **Disagree Slightly**	C **Neutral**	D **Agree Slightly**	E **Agree Strongly**

a. Training of officials in charge of chemical-accident prevention and mitigation on Natech risk reduction is needed.	
b. Training of officials in charge of natural disaster management on Natech risk assessment is needed.	
c. Guidance documents for operators of industrial establishments/installations on Natech risk assessment, prevention and mitigation are needed for improved Natech risk reduction.	
e. Guidance on Natech risk assessment, prevention and mitigation at the community level is needed for improved Natech risk reduction.	
f. Natech risk maps to inform land-use-planning decisions and emergency planning are needed.	

17. Are there any other issues that you would like to see addressed to improve Natech risk reduction in your country/organization?

.....

.....

18. Do organizations or agencies in charge of chemical-accident prevention and mitigation work in coordination with organizations in charge of natural-disaster management in your country?

☐ **Yes** ☐ **No**

19. In your opinion, is there an overlap of responsibilities between organizations and other agencies that affects effective planning for and mitigating Natech events in your country?

☐ **Yes** ☐ **No**

Please explain: .....

20. In your opinion, are there gaps in the emergency management of Natechs between government agencies in charge of chemical-accident prevention and civil protection authorities in charge of natural-disaster management that should be addressed?

☐ **Yes** ☐ **No**

Please explain: .....

21. In order to further reduce your country's or organization's susceptibility to Natechs, what would be your top <u>three</u> Natech risk reduction strategies/recommendations?

1. .....
2. .....
3. .....

V. BACKGROUND INFORMATION

In order to analyze the data it is important that we have some background information so that we can group opinions together.

22. Contact information of the person filling in the questionnaire:

Name:
Organization:
Country:
Address:
Phone:
Email:

23. Your organization belongs to:

a. Public sector [ ]

Please indicate in which area your organization's responsibilities mainly fall in:

Employment /labor [ ] Environment [ ] Civil protection [ ]
Industry/ Economy [ ] Public Health [ ] Higher education/ research [ ]
International development/aid organization [ ]
Other (please specify): [ ]

Your organization is at which level:

International [ ] National [ ] Regional [ ] Provincial [ ] Local [ ]

b. Private sector [ ]

Please indicate in which area your organization's responsibilities mainly fall in:

Higher education/ research [ ] Industry/ Manufacturing [ ] Engineering [ ]
Environmental Consulting [ ] Services [ ]
Other (please specify): [ ]

24. What process did you use to complete the answers to this survey (please check all that apply)?

[ ] To answer some questions I used my own knowledge from _____ years of work experience.

[ ] I discussed several/all questions with different colleagues individually.

[ ] I had to look through (or had someone look through) our records to answer some of the questions.

[ ] The questions and answers were discussed in a meeting.

[ ] Other (please specify):

Note: In the following lines please list any documents or attachments that you are enclosing with this survey.

.....

.....

.....

SPREADSHEET
HAZARDOUS-SUBSTANCES RELEASES CAUSED BY NATURAL HAZARDS AND DISASTERS

DATE	LOCATION	TYPE OF INDUSTRY	TYPE OF NATURAL HAZARD/ DISASTER (e.g. flood, earthquake)	TYPE OF RELEASE (e.g., air release, liquid spill, fire, explosion, etc.)	SUBSTANCE RELEASED		FAILURE MODE**	LESSONS LEARNED
					Name (e.g., chlorine)	Quantity released (kg)		

**** We have provided some examples of potential failure modes below. The list is not exhaustive!**

EXAMPLE LIST OF POTENTIAL FAILURE MODES

(Please list in the above spreadsheet all that apply)
• Structural failure • Building collapse • Structural failure of passive mitigation systems: containment dikes, enclosure • Failure of active mitigation systems: Sprinklers, water curtains • Failure of restraining straps • Failure of anchoring mechanisms • Rupture of pipes and connections • Loss of water/water pressure • Loss of electricity • Loss of heating/boiler failure • Loss of cooling/refrigeration • Failure of cooling water tower • Failure of control mechanisms • Over-pressurization • Human error • Other (Please Specify)

European Commission

EUR 24661 EN - Joint Research Centre – Institute for the Protection and Security of the Citizen
Title: Analysis of Natech risk reduction in EU Member States using a questionnaire survey
Author(s): E. Krausmann
Luxembourg: Publications Office of the European Union
EUR – Scientific and Technical Research series – ISSN 1018-5593
ISBN **978-92-79-18927-2**
doi:**10.2788/82675**
2010 – 118 pp. – 21 x 29.7 cm

Abstract

A study on the status of Natech risk reduction in EU Member States was performed by means of a questionnaire survey. A clear tendency towards recognising natural hazards as an important external risk source for chemical facilities could be established. In addition, more than half of the responding countries declared to have suffered one or more Natech accidents with the release of toxic substances, fires and/or explosions and sometimes fatalities and injuries. The natural events that triggered these Natech accidents were not necessarily the ones that were believed to be of major concern so there is a discrepancy between actual causes and risk perception.

The results of this Natech questionnaire survey show that the responding countries have largely recognised natural hazards and disasters as a relevant source of risk to a chemical facility with the potential to trigger a major accident. A framework for Natech risk reduction exists but a strategic Natech risk-reduction initiative appears to be lacking. Moreover, the survey highlighted a number of shortcomings and gaps that need to be addressed to achieve effective risk reduction. Considering the findings of this study the following areas for future work were identified:

- Raising awareness and improving risk communication at all levels of government and in industry;
- The implementation and enforcement of specific regulations for Natech risk reduction;
- The preparation of specific technical codes and of guidelines for risk assessment in industry that address the characteristics of Natech risk;
- The development of guidance on Natech risk assessment at the community level;
- The development of methods and tools for Natech risk assessment;
- The preparation of dedicated Natech emergency management plans which consider the characteristics of Natech accidents (e.g. a possible lack of utilities);
- Identification of best practices for Natech risk reduction and wide dissemination of existing practices;
- The development of Natech risk maps to support effective land-use planning and emergency management;
- Land-use planning that explicitly addresses Natech risk;
- Training of competent authorities on Natech risk reduction both for officials in charge of chemical-accident prevention and those in charge of natural-disaster management;
- Research into the impact of climate change on future Natech risk.

In order to support the process of improving Natech risk reduction lessons learned from the analysis of past Natech accidents should be formulated and disseminated widely. These lessons should address failure modes and hazardous-substance release paths as a function of natural-hazard severity, as well as identify risk-reduction measures and possible best practices. As this requires the systematic collection of data on the causes and dynamics of Natech events the JRC has set up a specific Natech accident database which is public to allow the widest possible access to the accident data. Moreover, indicators for measuring the effectiveness and adequacy of Natech risk-reduction measures should be developed.

The mission of the JRC is to provide customer-driven scientific and technical support for the conception, development, implementation and monitoring of EU policies. As a service of the European Commission, the JRC functions as a reference centre of science and technology for the Union. Close to the policy-making process, it serves the common interest of the Member States, while being independent of special interests, whether private or national.

JRC
EUROPEAN COMMISSION

LB-NA-24661-EN-C

Publications Office

ISBN 978-92-79-18927-2