Managing Risks from Natural Hazards to Hazardous Installations (Natech)

A GUIDE FOR SENIOR LEADERS IN INDUSTRY AND PUBLIC AUTHORITIES

Series on Chemical Accidents

A collaboration between OECD, EC JRC and UNECE

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Series on Chemical Accidents

Managing Risks from Natural Hazards to Hazardous Installations (Natech)

A Guide for Senior Leaders in Industry and Public Authorities

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Editorial

There is growing awareness that natural hazards, even common ones such as lightning, can have significant impacts on the safety of hazardous installations. Certain conditions, such as high and low temperatures, thawing of permafrost, landslides, earthquakes or floods can result in accidents with the release of hazardous substances, fires or explosions. These are referred to as Natural Hazard Triggered Technological accidents (or Natech accidents). Recent Natech accidents around the globe have caused major damage to hazardous installations with often disastrous effects on human lives, the environment, infrastructure, regional security and economic development. In 2017, the flooding of a chemical plant handling organic peroxides in the United States following massive rainfall from Hurricane Harvey triggered a blackout and loss of refrigeration, resulting in the exposure of first responders to toxic fumes and necessitating evacuation over a 1.5 mile radius. In 2011, a major earthquake in Japan triggered multiple fires and explosions at a refinery's petroleum gas storage tank farm. Fires burned for 10 days and the refinery returned to full operation only 2 years later. Climate change is particularly relevant in this context as it affects the intensity and frequency of natural hazards with potential unprecedented and unexpected impacts on these installations.

Leaders in industry and public authorities have a critical role to play in ensuring the appropriate delivery and governance of the prevention of, preparedness for, and response to Natech accidents, especially with an increasing level of risk due to climate change. Awareness raising, active engagement and informed decision-making can help ensure more effective Natech risk management. Future changes and adaptations must be anticipated with a multi-disciplinary approach involving meteorologists, geologists, civil, mechanical and chemical engineers, first responders, workers, potentially affected communities, and process safety experts. The involvement of all relevant stakeholders must be supported by well-defined communication and co-operation between relevant authorities at the local, national and transboundary levels, as well as with industry.

For the past 12 years, the OECD Working Party on Chemical Accidents, the Joint Research Centre of the European Commission and the United Nations Economic Commission for Europe secretariat of the Convention on the Transboundary Effects of Industrial Accidents have led efforts in raising awareness of Natech risks and sharing good practices for Natech risk management across countries and their respective constituencies. Most recently, our organisations joined forces to develop this guidance to help inform senior leaders in industry and public authorities of Natech risk and support them in setting direction for implementing respective measures, including the integration of Natech risk management into corporate governance strategies and national policies. We hope that this document will encourage commitment and high standards for the governance of Natech risk amongst leaders in industry and public authorities, thus ensuring long-term sustainable development and the achievement of a higher level of safety at hazardous installations.

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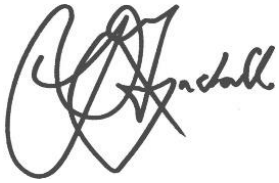

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Background to the guidance

This guidance is complementary to the Third Edition of the OECD Guiding Principles for Chemical Accident Prevention, Preparedness and Response. Its development is based on previous work done by the OECD Programme on Chemical Accidents, in particular:

- The Addendum to the Second Edition of the Guiding Principles on Chemical Accident Prevention, Preparedness and Response on Natech Risk Management published in 2015 which provides specific guidance on how to consider Natech in the prevention of, preparedness for and response to chemical accidents;
- Two major international events organised in 2012 in Dresden (Germany), which investigated the specificities of Natech Risk Management, and in Potsdam (Germany) in 2018, which collected good practices for Natech Risk Management across OECD and non-OECD countries;
- A record of good practices for Natech risk management issued in 2020. It includes more than 40 examples of Natech risk management-related activities across countries and from different stakeholders, presented in easy-to-read fact sheets. The record has been developed and is hosted by the German Environment Agency.

This guidance is also relevant in the context of the OECD Decision-Recommendation concerning Chemical Accident Prevention, Preparedness and Response.

This guidance builds on expertise of the Joint Research Centre of the European Commission on Natech risk management. It has developed eNATECH, an online database to facilitate exchange of lessons learned from Natech accidents and near misses, as well as the web-based RAPID-N tool for rapid Natech risk analysis and mapping. In 2020, the JRC published Natech inspections criteria for Seveso inspectors and in 2022 technical guidance on Natech risk management for operators of hazardous industrial sites and for national authorities.

This guidance also takes account of legal instruments such as the European Union Seveso Directive on the control of major-accident hazards involving dangerous substances, which in its Annex II, article 4, requires Natech to be included in the site's safety management system, and the UNECE Convention on the Transboundary Effects of Industrial Accidents (Industrial Accidents Convention) which sets out obligations to prevent and mitigate Natech events, among other industrial/chemical accidents. It builds on the conclusions of the joint UNECE/OECD Seminar on effective management of technological risks of accidents triggered by natural hazards (Geneva and online, 29 November 2022). Parties to the Industrial Accidents Convention have also adopted Decision 2022/1 on Strengthening Natech risk management in the UNECE region and beyond, at the twelfth meeting of the Conference of the Parties. Through this decision, Parties committed to preventing Natech events and their disastrous effects on human lives, the environment, infrastructure, regional security and economic development, and to enhancing transboundary cooperation to that effect. It also uses experience and guidance developed by countries and by other international agencies that are relevant to Natech risk management [1].

This guidance was jointly developed by the OECD, the United Nations Economic Commission for Europe (UNECE), the Joint Research Centre of the European Commission (JRC) and the German Environment

Agency (Umweltbundesamt). In preparing the guidance, the drafting group had guidance from a steering group of experts from the delegations of Colombia, Czech Republic, France, Germany (lead country), Japan, Netherlands, Norway, Switzerland, United Kingdom, the United States, the JRC, the International Labour Organisation (ILO), the United Nations Environment Programme (UNEP) / UN Office for the Coordination of Humanitarian Affairs (OCHA) Joint Environment Unit, the UNECE, and the European Environmental Bureau (EEB). The Bureau of the OECD WPCA and Bureau of the UNECE Convention on the Transboundary Effects of Industrial Accidents also reviewed the draft guidance and provided inputs over the course of its development.

Notes

[1] References and links to all the documents mentioned above are available in the “For further reading” section.

1 Natech risk and leadership

Natural hazards, for example lightning, high and low temperatures, landslides, earthquakes, floods, winds, storms, wildfires, and permafrost thawing, can initiate adverse events which challenge the safety and operation of hazardous installations and can result in accidents. These accidents are referred to as Natural hazard triggered technological accidents or Natech accidents.

Recent Natech accidents around the globe demonstrate the significant impacts accidents triggered by natural hazards can have on people, the environment, infrastructure and business continuity (see Box 1).

Leaders in industry and public authorities need to act to ensure the appropriate governance and management of Natech risk. This leadership combined with appropriate technical assessment will enable long-term operability and sustainable development at hazardous installations, including where the threat level changes due to climate change.

The case for Natech risk management is strong for both businesses and public authorities:

- Consideration of the potential impacts from natural hazards at the siting and land-use planning stage can reduce impacts on the site and its surroundings, both in magnitude and frequency. For example, choosing and permitting a site that is located higher than the flood plain, may mean that flooding is less of a consideration. However, all Natech risks should always be considered.
- Consideration of the potential impacts from natural hazards at the design and construction stage can lead to more robust buildings and infrastructure, which will reduce risks and mitigate damage in the event of a Natech accident. Retro-fitting existing sites is also important since some natural hazards may not have been considered in the past and due to the increasingly frequent and severe impacts of climate change. Since retro-fitting can be more expensive, it is however key to consider natural hazards in the original designs of sites moving forward.
- Consideration of the potential impacts from natural hazards at a safety management and emergency planning stage can mean that the employees can be prepared to take the necessary measures early on to prevent Natech events and mitigate damage should they occur, including to prevent damage to installations, releases of hazardous chemicals, harm to the natural and built environment, injuries of employees and nearby populations and beyond. Prevention and preparedness are more cost effective that responding to an emergency under pressure.
- Understanding and addressing Natech risks can mean that companies are more resilient to return to production after a natural hazard event with less disruption and without loss of reputation. Repairing damaged installations and harm to people and the environment can be costly and time consuming. A long period of business interruption can lead to loss of customers and goodwill and damage the economic viability of the company.
- Failure to address the potential impacts from natural hazards can lead to significant costs, damage to people and the natural and built environment, injury, business interruption, loss of reputation and ultimately to the failure of the company.

This guidance, part of a series of Natech guidance notes from the OECD[1], as well as part of the Natech risk management workstreams of the United Nations Economic Commission for Europe (UNECE)[2] and the Joint Research Centre of the European Commission (JRC), is specifically aimed at supporting senior

leaders set direction for implementing Natech prevention, preparedness and response measures. It will challenge senior leaders in industry[3] and public authorities[4] to consider questions such as:

- What should I do to ensure good governance of Natech risk?
- How do I gather and organise the capabilities and competences to do it?
- How do I ensure that my organisation continues to adapt to a changing environment?

This document will aid senior leaders to be able to self-assess how prepared their organisation is in managing Natech risks effectively.

> *"This guide for managing Natech accident risk provides an excellent overview and risk management guidance for chemical accidents that may result from natural hazards. Senior leaders in the chemical industry will benefit from the guidance designed to make users aware and manage the vulnerabilities and risks of Natech accidents. This guidance, supplemented by guidance issued from Natech related investigations by the US Chemical Safety Board and requirements from the US Environmental Protection Agency to account for natural hazards in its risk management planning requirements, provides a complete approach to managing Natech accident risk."*
>
> **American Chemistry Council**

This Guidance is applicable to fixed installations at which hazardous substances are produced, processed, handled, stored or disposed of in such a form and quantity that there might be a risk of occurrence of a chemical accident (called "hazardous installations" or "installations" in this publication). This includes pipelines and transport interfaces such as marshalling yards and port areas.

Box 1. Examples of past Natech accidents

- In August 2022, a lightning strike hit an oil storage terminal in Cuba, triggering a major fire and explosions that eventually involved four large storage tanks. Seventeen fire fighters lost their lives in the attempt to keep the fire from escalating and avoid a domino effect. International aid was needed to control the fire.
- In August 2017, massive rainfall from Hurricane Harvey led to the flooding of a chemical plant handling organic peroxides in the USA. The flood triggered a blackout, resulting in the loss of all refrigeration systems on-site. The organic peroxides decomposed and combusted, exposing first responders to the toxic fumes and necessitating evacuation over a 1.5 mile radius.
- In December 2011, a landslide caused the full-bore rupture of a gasoline pipeline in Colombia. Gasoline spilled into a river, leading to water contamination, and in the subsequent ignition and explosion 32 people died and over 80 were injured. The explosion also caused structural damage to residential areas.
- In March 2011, a major earthquake shook an LPG storage tank farm at a refinery in Japan. One tank collapsed, severing pipes and causing the release of LPG which ignited. The resulting fire and explosions destroyed all 17 LPG tanks. Debris from the explosions damaged adjacent asphalt tanks and triggered fires in two neighbouring petrochemical installations. The fire burned for 10 days.
- In December 2002, low temperature coupled with the deactivation of steam tracing caused the breaking of a cyclohexane manifold in a chemical plant in France. 1200 tons of cyclohexane were released and entered the soil and groundwater. Due to a high risk of polluting the community's drinking water reservoirs and agricultural pumping stations, prolonged clean-up and remedial actions had to be taken.
- In August 2002, flooding of the Elbe River led to the inundation of a chemical plant in the Czech Republic, floating its liquid chlorine tanks and ripping off the safety valves from a tank filled to capacity. Over 80 tons of chlorine were released, resulting in environmental damage and economic losses in agriculture.

Notes

[1] Past reports developed by the OECD on Natech risk management are available at: https://www.oecd.org/chemicalsafety/chemical-accidents/risks-from-natural-hazards-at-hazardous-installations.htm

[2] More information on Natech risk management under the UNECE Convention on the Transboundary Effects of Industrial Accidents is available at: https://unece.org/industrial-accidents-convention-and-natural-disasters-natech

[3] For the purpose of this document "Industry" refers to: enterprises operating hazardous installations at which hazardous substances are produced, processed, handled, stored or disposed of.

[4] For the purpose of this document “Public Authorities” refers to: public authorities at all levels that are involved in the many disciplines inherent in chemical accident prevention, preparedness and response (e.g. environment, public health, occupational health and safety, civil defence, industrial development, international relations). This guidance is relevant to regulatory/enforcement authorities (at the national, regional and local levels), emergency response personnel, public health authorities, medical providers and other types of government agencies.

2 Risk awareness and governance: understanding vulnerabilities and risks

One of the main elements needed to integrate Natech risk into process safety in a commercial or public setting is risk awareness at all levels, led from the top.

Senior leaders in industry should be aware of the Natech risk at their hazardous installations. They should:

- Be aware of the full spectrum of natural hazards of relevance for a specific site, the impacts they may have on the risk of chemical accidents and how they will affect process safety (see Box 2);
- Drive awareness of this risk through the organisation and ensure implementation of a strategy for good governance and compliance with applicable laws and policies, including integration of Natech concerns in occupational safety and health management systems;
- Clearly communicate to all relevant employees, including contractors, the vulnerabilities to natural hazards and associated Natech risks at their installation, and the measures being taken to address them;
- Drive the integration of Natech risk management into chemical accident prevention, preparedness and response at the given installation, even if Natech accidents have never occurred before;
- Be aware that climate change could affect the intensity, frequency and location of natural hazards and assess and update risk management measures as more information becomes available. This should become an integral part of the safety management system.

Similarly, ***senior leaders in public authorities*** should:

- Take Natech risk into account in relevant regulatory action, policy development and standards;
- Ensure that Natech accidents are sufficiently integrated into climate change adaptation, disaster risk reduction, environmental protection and sustainable development action plans and strategies;
- Address Natech risk as part of existing governance and policy processes at the national and local level, including coordination with industry and stakeholders;
- Include Natech-related questions within inspections and audits. Information and experience exchange amongst inspection personnel (at the regional, national or international level) is essential;
- Provide specific awareness raising of Natech risks and guidance on the prevention of, preparedness for and response to Natech accidents.

A regular dialogue between leaders in industry and public authorities is critical. This will support:

- The development of an up-to-date natural hazard assessment;
- The integration of natural hazards in risk analysis for chemical accident prevention, preparedness and response;
- Coordination via a multi-hazard approach with natural hazard risk management and natural disaster management plans;
- Regular exchange regarding preparedness and response planning.

Box 2. Challenges of Natech Risk Management

- The management of Natech risks requires a multi-disciplinary approach with experts such as meteorologists, hydrologists, or geologists working alongside civil, mechanical and chemical engineers, as well as experts on process safety;
- The intensity of a natural hazard may be difficult to predict and challenge the anticipated "worst-case scenario" assumptions, in particular in view of climate change. For example, the water levels during a flood may be higher than any previously experienced floods used as reference scenario;
- Major Natech accidents can occur as a result of "minor" natural hazards, such as lightning or low temperature;
- The management of Natech risk requires anticipation of future changes and adaptation, for example using climate projections;
- Natural hazards can impact key infrastructure elements at hazardous installations, such as electric grids, energy and water supplies, communication systems and transport routes;
- A Natech accident can be exacerbated where the natural hazard impact has caused inaccessibility of roads and transport (e.g. hampering site access for firefighters);
- Natural hazards can trigger accidents at several hazardous installations at the same time, increasing the risk of cascading effects;
- One natural hazard can trigger another one, leading to cascading effects (e.g. an earthquake can cause a tsunami or a landslide), which could aggravate damage and needs to be considered in the worst-case scenario;
- A natural disaster can put a strain on emergency and medical response capabilities, therefore the availability of first responders to respond to a Natech accident can be limited;
- Similarly, a natural disaster can prevent staff from being at work or divert their attention away from hazard management due to personal/family concerns.

3 Preventing Natech accidents

There are a number of actions that are important for the prevention of Natech accidents and that are necessary for the implementation of prevention measures. They are to:

- Identify the natural hazards that may affect an installation, e.g. through the use of natural hazard maps, including transboundary hazard maps, where relevant;
- Assess the risks posed by natural hazards to industrial sites, including related scenarios, and potential consequences of a transboundary nature;
- Consider natural hazards, and the impact of climate change, in the design, construction, modification, siting and operation of hazardous installations, as well as in land use planning decisions and permitting;
- Learn from past Natech accidents and near misses.

Information on natural hazards

Information on natural hazards that can affect hazardous installations is key for preventing Natech accidents. It can be used by senior leaders in decision-making for risk management, inspection criteria, siting and land-use planning, and permitting. It can be presented in various ways, such as through illustrations/maps, to aid understanding and make information accessible to all.

For effective Natech risk management, ***senior leaders in public authorities*** should:

- Ensure that information on natural hazards that could potentially trigger chemical accidents, or that could exacerbate the consequences of accidents from other causes, is collected and made accessible to the respective stakeholders, for example industry, other relevant authorities, neighbouring or riparian[1] countries, experts and the public. This information should include:
  - all natural hazards a site is subject to;
  - the probability of their occurrence and their possible intensity;
  - risks to economic activities, human health, the environment, critical infrastructure and cultural heritage, for example.
- Make sure that natural hazard and risk maps contain easily accessible and appropriate information (or references to information) on hazards and risks for their target audiences;
- Maximize the ease of use of natural hazard and risk maps. Instead of (or in addition to) paper formats, digital solutions and interactive applications should be developed to make it easier for industry and those who could be affected by an accident to assess and understand the Natech risks of hazardous installations;
- Consider the development of maps that compile information from different natural hazard and risk maps as a means to display multiple hazards simultaneously. As developed in certain countries, this can involve overlaying natural hazard maps with maps of the locations of industrial hazardous installations, which should be available as geo-referenced data. In this way, any potential compound effects can be identified;

- Ensure there is appropriate training for relevant employees on the types of natural hazards that can trigger chemical accidents. Training should include methods to assess information on natural hazards and risks to support decisions on the siting of hazardous installations, land-use planning, construction, design and operation of hazardous installations, and emergency planning;
- Facilitate regularly scheduled updates of information and maps, to make sure they represent the latest data, science, understanding and actual situation of natural and technological hazards and risks.

Senior leaders in industry should:

- Require their staff to use the most up-to-date maps available, to be informed of existing natural hazards and natural hazard risks and to take protection measures accordingly, considering all aspects of their operations (storage, production, maintenance, construction, etc.);
- Compare available national or regional information on natural hazards and risks to information of the hazards and risks of their industrial installations, to be able to realistically assess the risks of the potential impact of natural hazards on their activities;
- Ensure appropriate training for the use of natural hazard and risk maps, for example in the context of decision making for siting, construction, design, modification and operation of hazardous installations as well as emergency planning;
- Be aware that natural hazards are likely to affect infrastructure beyond their site boundaries, which can in turn impact their own operations (electricity, gas and water supplies; road and rail transport networks; telecommunications).

> *"The growing interdependence between industrial activities and the environment, combined with the increasingly intense effects of natural disasters, highlights the need to proactively and systematically address the risks of natural, technological, and Natech events. By taking preventive measures and applying mitigation strategies, the mining-energy sector can safeguard its critical infrastructure, protect its employees and communities, contribute to the long-term sustainability of the industry and the transition to cleaner and fairer energy sources"*
>
> **Office of Environmental and Social Affairs – Colombia's Ministry of Mines and Energy**

Risk assessment

Risk assessment is the overall process of risk identification, risk analysis and risk evaluation. It allows the estimation of the risk level of a hazardous installation and comparison with risk acceptability criteria, the detection of safety gaps, scenario ranking, and determining risk reduction priorities and measures (including on- and off-site emergency plans).

Since Natech risk is a multi-hazard risk with a potential for multiple and simultaneous accident scenarios, Natech risk analysis is complex and requires extensions to traditional industrial risk analysis methodologies, regardless of the assessment approach chosen.

In order to ensure the proper consideration of natural hazards in industrial risk analysis, ***senior leaders in industry*** should:

- Be aware that information and expertise on both natural and technological hazards is required for Natech risk analysis;

- Require the collection and use of available technical guidance for Natech risk analysis to identify all relevant Natech scenarios, including those triggered by "minor" natural events (such as lightning, freeze), as well as transboundary causes, that may be relevant for an installation;
- Apply a worst-case approach in Natech risk analysis to account for the possibility that implemented safety barriers may not be operating or be effective due to natural hazard impact in case of an incident;
- Ensure that sufficient time and resources, as well as appropriate knowledge and skills are allocated for identifying and analysing Natech risk;
- Provide dedicated training programmes for staff if the necessary expertise for Natech risk analysis is unavailable within an organisation, or contract the services of external experts;
- Foster a mindful approach to process safety and defer to the expertise of personnel on the ranking of identified Natech scenarios when making process safety decisions;
- Consider the application of safety factors in Natech risk assessment to account for uncertainties in natural hazard severity due to future climate change.

At the same time, ***senior leaders in public authorities*** should:

- Establish standards and requirements for industry to submit industrial risk analyses that are inclusive of natural hazards to be used when applying for permits to establish new hazardous installations or to make modifications to existing ones, and when existing hazardous installations are identified as within the proximity of natural hazards;
- In line with the results of Natech risks analyses, establish requirements for industry to update their safety measures and emergency plans where necessary;
- Employ inspectors tasked with inspecting hazardous installations and ensure that they consider potential Natech risks in their inspection activities, as well as communicate and follow-up with industry regarding any risks identified.

Senior leaders in both industry and public authorities should:

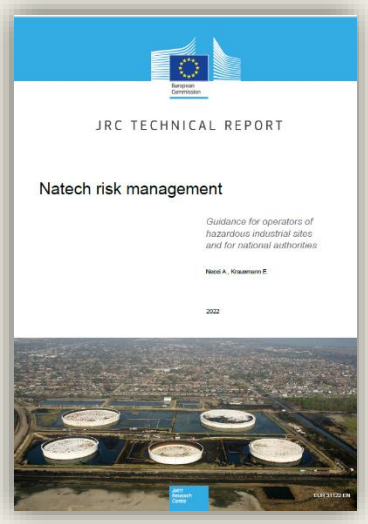
- Foster the development of new or updating of existing risk analysis methodologies and associated software tools to take account of natural hazards that can affect hazardous installations, including the risks arising from them, to inform related decision-making processes, inspection criteria and policy development;
- Promote a territorial approach to Natech risk analysis to acknowledge the increased risk of cascading effects during natural hazard impact, the loss of external utilities of relevance for an installation, and potential transboundary consequences, where geographically relevant, with also consideration for impacts on internal and external emergency plans and communication;
- Understand the underlying uncertainty in Natech risk analysis results considering the high scenario variability, and give due consideration to identified scenarios with low likelihood but potentially catastrophic consequences;
- Request and implement a periodic review of Natech risk assessments in view of possibly changing analysis assumptions due to climate change, land-use changes, or changes in a hazardous installation resulting in higher or lower vulnerability to natural-hazard impact.

Since 2019, Grupo Ecopetrol has been reducing its levels of uncertainty in the processes of physical risk analysis, within the framework of the climate emergency that our planet is facing. Physical risks are related to the company's exposure and vulnerability to the impacts of climate variability and change, which could affect operational continuity and increase the exposure of assets to potential damage (including the identification of Natech scenarios). Acute risks are those caused by extreme weather events, whose frequency and intensity have been increasing due to the gradual increase in global temperature, which in Colombian territory are mainly reflected in the occurrence of the climate variability phenomenon "El Niño" and its opposite phase "La Niña". These conditions could result in, among others, water shortages, heat waves, floods, and fires. On the other hand, chronic risks derive from a sustained change in climate conditions in the medium and long term, which for the company can be reflected in sea level rise, thermal overload, and droughts, beyond 2050.

The physical risk analysis completed in 2023 considered the following Intergovernmental Panel on Climate Change (IPCC) scenarios: (i) Aligned with the Paris Agreement target (SSP 1/RCP 2.6), (ii) Peak emissions in 2040 (SSP2/RCP4.5), and (iii) 'Business as Usual' (SSP5/RCP8.5). Under these scenarios, 7 chronic (drought and heat stress) and acute (precipitation, coastal and river flooding, forest fires and winds) hazards were evaluated at 95 points associated with the main assets of Grupo Ecopetrol."

Grupo Ecopetrol

For more information on Natech risk management, the Joint Research Centre of the European Commission has developed technical guidance which helps to identify, analyse and treat Natech risks at industrial sites with particular emphasis on the identification and modelling of Natech scenarios[2].



Under the auspices of the Convention on the Transboundary Effects of Industrial Accidents, UNECE published "Risk Assessment for Industrial Accident Prevention: An Overview of Risk Assessment Methods, Selected Case Studies and Available Software", https://unece.org/info/Environment-Policy/Industrial accidents/pub/391975. Even if not specific to Natech risk assessment, the publication provides information on methodologies that can be applied and/or further developed in the context of natural hazards and with respect to their probability.

Siting and land-use planning

When establishing land-use planning arrangements and policies related to hazardous installations, ***senior leaders in public authorities*** should:

- Take into account natural hazards, such as floods, extreme temperatures, high winds, earthquakes, or wildfires, as well as the possible impacts of climate change. Public authorities may determine that certain areas, such as flood-prone or earthquake zones, may not be suitable for hazardous installations or may require additional safety measures or more stringent requirements in design, construction and operation;
- Re-assess risk zones when new information becomes available to take account of new information and experience.

Senior leaders in industry should:

- Ensure that a Natech risk analysis is performed before siting a new installation and for the site layout (e.g., hazardous substances should not be stored in areas that are likely to be flooded);
- Consider Natech risk for new developments and sites as well as existing sites and ensure that management systems allow Natech risks to be integrated into operation at a site, e.g. through incorporation in the site's major hazard management system;
- Ensure adequate training for Natech risk management is in place and that it is provided to those responsible for the siting of installations and land-use planning.

Design and construction

Senior leaders in industry should make sure that:

- Natural hazards are taken into account in the design and construction of hazardous installations;
- Retrofitting is considered for existing installations in light of information about natural hazards that was not taken into account in the original design (including, for example, information on additional types of hazards, increase in intensity and/or frequency of hazards as well as slow-onset hazards like sea level rise due to climate change).

Adaptation to climate change

Changes in climate may affect the intensity, frequency and location of natural hazards, and this should be taken into account in the risk analysis. Climate change may also result in altered heating/cooling requirements for the workforce to enable them to do their work safely.

Climate change may impact natural hazards in at least three ways: via the emergence of natural hazards not previously seen in the region, a change in the frequency and severity of natural hazards known in the area, and the gaining in importance of slow-onset natural hazards, such as sea level rise.

Senior leaders in industry should ensure that their organisations:

- Regularly consult and assess regional climate projections, changes in recurrence times of extreme events and potential changes caused by slow-onset climate change events, and communicate to relevant employees the implications for major accident prevention due to them;
- Develop a climate adaptation strategy with senior leader ownership which also includes the potential impact of climate change on staff working conditions;

- Use the organisation's major hazard management systems to incorporate climate change impacts, where necessary, e.g. through the use of ISO14090[3] to ensure risk assessments are maintained against the most up to date data;
- Implement enhanced safety measures, where necessary.

Senior leaders in public authorities should:

- Ensure the establishment of communication mechanisms to inform industry of the type and likelihood of a natural hazard relevant for (a) site(s), in particular when the threat increases, and establish requirements for operators to adapt their scenarios;
- Promote the integration of Natech risks into industrial safety, disaster risk reduction and climate change adaptation policies and strategies;
- Support the consideration of possible changes in climate and their impact on natural hazards in the development and review of regulations, licensing, permitting and inspections.

> *"There is a need to integrate Natech risks into industrial safety, disaster risk reduction and climate change adaptation policies and strategies. This requires good coordination, cooperation, and communication across sectors within a country as well as in a transboundary setting. Sharing of new technology and new use of existing technology would be important to predict how natural hazards might impact industrial sites."*
>
> **Norwegian Directorate for Civil Protection**

> *"The chemical industry relies on effective risk management as its fundamental cornerstone for operations and to ensure sustainable development. For risks related to natural hazard events it is of key importance to account for the dynamic nature of these events in a changing environment especially in the context of climate change. Mitigating the impact of natural hazards even well below critical thresholds for Natech incidents can prevent financial losses and ensure business continuity."*
>
> **BASF - Environmental & Safety Services Ludwigshafen**

Learning from past accidents

The identification and implementation of lessons from past Natech incidents helps to prevent future events and to better mitigate their consequences. In addition to improving safety, this also contributes to economic objectives, e.g. reducing plant downtime and disruption of production, avoiding costs due to clean-up and recovery from accidents, and increasing business efficiency.

Strong **leadership in industry and public authorities** is vital in this context and should:

- Require the systematic collection and analysis of data on Natech events, from internal and external sources. This should include information on near misses, to encourage learning and gain knowledge on the incident causes, dynamics and consequences, as well as contributing factors. This data should be reported to the respective regional, national and international authorities;
- Monitor that the lessons identified from the analysis of past incidents are acted upon to close risk management gaps. This can be done by updating Natech accident scenarios and improving prevention measures, adapting preparedness plans and implementing tailor-made training programmes;

- Prioritise systematic and routine sharing of knowledge gained from past Natech incidents. Leaders should ensure that the lessons identified are disseminated across the organisation. This information should also be shared with contractors, and with other high hazard sectors, to improve safety and ensure the preservation of historical knowledge in the event of staff and management changes;
- Encourage an atmosphere of trust and openness to facilitate the reporting of minor Natech incidents and near misses, as well perceived risk management gaps associated with them.

The Joint Research Centre of the European Commission has developed *eNATECH*[4], an online database to facilitate exchange of lessons learned from Natech accidents and near misses.

Notes:

[1] "Riparian countries" means the countries bordering the same transboundary waters, as provided in the UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes.

[2] Necci, A. and Krausmann, E., Natech risk management, EUR 31122 EN, Publications Office of the European Union, Luxembourg, 2022, doi:10.2760/666413.

[3] ISO 14090:2019 Adaptation to climate change — Principles, requirements and guidelines, https://www.iso.org/standard/68507.html

[4] See, https://enatech.jrc.ec.europa.eu

4 Emergency preparedness and response

Preparing emergency plans

Prevention is key, but when it fails, preparedness is needed. Preparedness is a key element that enables effective response to Natech accidents. It is also crucial for warning the potentially affected population. Industry and public authority coordination is essential for Natech emergency planning. It is also crucial for warning the potentially affected population.

Senior leaders in industry and public authorities should ensure that emergency plans (on-site and off-site) for industrial facilities:

- Are up-to-date and address:
  - the possible consequences of natural hazard impacts that might trigger Natech accidents;
  - the possible impacts of natural hazards on safety barriers, critical infrastructures and resources and capabilities needed for responding to a Natech accident (including, for example, on water and power supplies, site access or evacuation routes and communication systems, or on first responders themselves).
- Are integrated with emergency planning for natural disasters. This integration should result in co-ordinated and consistent emergency plans, and in a co-ordinated command structure;
- Are coordinated with local first responders;
- Take account of a range of scenarios (including worst case scenario and more likely scenarios, also in a transboundary context);
- Integrate the possible impacts of climate change on natural hazard trigger conditions, which might result in changed planning assumptions;
- Include the availability and provision of appropriate emergency response equipment in case of exceptional conditions created by a natural hazard (e.g. extreme weather; flooding);
- Are tested, through table-top and full-scale exercises. These exercises should simulate the specific features of an occurring Natech accident. Any lessons learned from these exercises, in addition to lessons learned from past Natech accidents or near misses, should feed into an update or revision of the on- and off-site emergency plans;
- Include arrangements for training of staff at all levels to ensure a co-ordinated response to natural events which can trigger Natech accidents. Training should include a definition of roles and responsibilities, and specification of alert level thresholds for triggering protective action;
- Involve local stakeholders with an interest and members of the public that could be affected, including in neighbouring and riparian countries, in the development of emergency plans;
- Facilitate communication with all parties and help to establish and maintain acceptance and trust for the emergency planning activities.

In addition, ***senior leaders in public authorities*** should ensure that the public that could be affected is aware of the actions they need to take in case of a Natech event. This includes the sharing of information and exercises.

Responding to natural hazard impacts

Following natural hazard impacts on industrial sites, ***senior leaders in industry and public authorities*** should:

- Organise a damage assessment and evaluate the necessity of activating the emergency plan. If activated, they should oversee its proper implementation;
- Manage staff effectively and ensure that sufficient personnel is available on- and off-site to implement response actions. This includes the replacement of essential staff that may have been harmed during the natural hazard impact or that may have left in a panic (flight behaviour);
- Ensure the implementation of plans for staff shift turnover in case of prolonged emergency conditions to relieve exhausted staff.

Early warning systems and alert systems

Early warning and alert systems are essential elements of preparedness and response.

- Early warning systems for natural hazards are operated by public authorities that will then inform operators of potentially affected hazardous installations and other relevant public authorities of approaching natural hazards that may cause a Natech accident. These systems enable advance warning to prepare operators and allow them to initiate preventive measures.
- Alert systems operated by public authorities or operators, may be used when a natural hazard is already occurring and should trigger the emergency plan of a hazardous installation. They could be used to inform affected populations and, in the case of Natech accidents with possible transboundary effects, neighbouring and/or riparian countries.

Senior leaders in industry and public authorities should ensure that:

- Early warning and alert systems are operational and functioning with 24/7 points of contact;
- Emergency plans take account of existing warning systems and set out the actions all parties should take in response to natural hazard alerts;
- All relevant natural hazard warning systems are incorporated in the emergency plan including local weather forecasts, and all other relevant alerts;
- Cross border warning systems for natural hazards are utilised to enhance response where necessary.

Senior leaders in industry should:

- Ensure that procedures are developed that define the actions to be taken in response to early warning to eliminate or reduce the impact of natural hazard. These procedures should include the roles and responsibilities of personnel within the installation (including contractors), the actions to be performed by each role, the amount of time each action takes, and the conditions that initiate the procedures. The goal of such planning should be that the site and its installations are in a safe operating condition before the natural hazard strikes.
- Ensure that qualified staff is available that allows the proper interpretation of early warnings, and decide on the appropriate preventative measures in accordance with the installation's safety

management systems. Such measures could include tie-down or relocation of equipment, temporary natural-hazard defences, emergency shutdown, etc.

Senior leaders in public authorities should:

- Ensure that natural hazard warning systems and alert systems are regularly tested, maintained, and updated to inform industry and communities of impending natural hazards or disasters;
- Ensure that local conditions are considered in early warning and alert systems to improve their value for operators of hazardous installations.

5 Communication of Natech risks and in case of Natech accidents

General considerations

Communication (both internally and with external stakeholders) is important before, during and after a natural hazard impact. The requirements and options available may be different, depending on the point in the impact timeline. Good communication is important within the installation so that everyone, at all levels of the organisation, understands the risks which are to be managed and their own role in ensuring that this is accomplished.

Senior leaders in public authorities and industry should:

- Ensure that there is a strategy for crisis communication in case of natural hazards and Natech accidents. This strategy should:
  - analyse the communication needs of the different stakeholders before, during and after a natural hazard impact and a potentially triggered Natech accident;
  - consider that the natural hazard impact can also affect communication technology (e.g. direct damage to communication system, congested phone networks, etc.). There should be preparedness for such a situation by using reliable and redundant communication systems.

Communication with employees at hazardous installations

Employees, including contractors, need to be properly informed of the Natech risk at their workplace and know how to react in case of a natural hazard impact or Natech accident.

Senior leaders in industry should ensure that:

- There are procedures that are defined and communicated related to:
  - The roles and responsibilities of personnel within the installation;
  - The actions to be performed by each role;
  - The amount of time each action takes;
  - The exact conditions that initiate the procedure.
- Employees understand:
  - Which natural hazards may affect the installation, and with which intensity and frequency;
  - If there is a risk that these natural hazards could evolve in the future, including due to climate change;
  - How they will be informed of a natural hazard impacting the installation and of its consequences;

  - What type of information will trigger what type of response (for example activating the on-site emergency plan);
  - Which early warning systems and alerts will inform employees that they will start working under abnormal conditions because of the impact of a natural hazard;
  - Which behaviour and actions they need to undertake in different scenarios and how to communicate and coordinate with external responders (e.g. natural disaster response teams, firefighters);
  - What activities are relevant for the safety of their family, and how they will be informed if their family is evacuated and to which location;
  - How they will be informed, if a dangerous situation due to a natural hazard has ended and follow-up procedures.
- Employees participate in emergency planning and related drills;
- The relevant points above are also communicated to contractors and third parties;
- Employees are informed of the results of investigations into damage caused to the installation by a natural hazard impact;
- The cause(s) of a Natech accident are communicated to employees on site.

Communication between industry and public authorities

Senior leaders in industry and public authorities should ensure that:

- There is effective communication between industry and public authorities;
- Their communication is based on a policy of openness, as well as the shared objective of reducing the likelihood of Natech accidents and mitigating the adverse effects of any Natech accident that may occur;
- There is coordination of measures and activities necessary to ensure that emergency plans are drawn up and acted upon in the event of a Natech accident;
- Land-use planning and decision-making on the siting of industrial facilities takes natural hazards into account, including how Natech risks can be effectively managed and whether consideration of other sites would be appropriate. Communication between industry and public authorities on these matters should entail consideration of the views of the public that could be affected;
- In the event of a Natech accident, or any other chemical accident, communication is activated immediately between industry and public authorities so that appropriate emergency measures are initiated and clear information is provided to the public regarding the behaviour to be adopted;
- This communication is two-way, active, informed and continuous. It should also take into account crisis communication planning;
- Communication takes place between different technical disciplines, within industry and various public authorities (at the national and local levels), and with the public, including in a transboundary setting, where relevant.

In addition, ***senior leaders in industry*** should ensure that:

- They receive information concerning Natech risks of existing activities in the vicinity of their installation and that they are involved in consultations on changes in the vicinity at the planning stage.

For this purpose, ***senior leaders in public authorities*** should:

- Publish information on natural hazards that may trigger a Natech accident and communicate it to the senior leaders of hazardous installations that may be affected by them;
- Make sure that early warning and alert systems for natural hazards that may trigger a Natech accident are in place to inform the public that may be affected by a Natech accident, including across borders in case of possible transboundary effects.

Communication with the public and communities

Senior leaders in public authorities should ensure - in collaboration with industry as the public authority deems necessary and appropriate - that the potentially affected public within and across borders:

- Are provided with sufficient information to understand natural hazards, the associated Natech risks and their exposure to those risks. This should also include any related prevention, preparedness and response measures, including actions they should take in case of a Natech accident or the possibility of one occurring;
- Have opportunities to participate in decision-making related to hazardous installations that may be affected by natural hazards. Such participation could, for example, include commenting on proposed regulations or zoning decisions, providing input for procedures concerning licensing or siting of specific installations and contributing to the development of contingency plans;
- Are widely encouraged to take advantage of information provided and of opportunities to participate in decision-making processes. This allows the public to present the perspective of the community and with an aim for all people, regardless of their gender, age, ability and other risk factors, to be engaged;
- In case of a Natech event, is promptly notified of the respective health and environmental risks, and precautionary measures they could take to protect themselves;

In addition, ***senior leaders in public authorities*** should ensure that:

- They facilitate the sharing of experience by providing public databases of past accidents and publishing investigation reports;
- The public has the opportunity to participate in decision-making on off-site emergency plans and that these plans include worst-case and more likely Natech scenarios.

6 Leadership of a multidisciplinary team

Since Natech risk is a multi-hazard risk, Natech risk management should involve stakeholders from different disciplines, each providing input and guidance related to their field of expertise. These stakeholders can include experts in process safety, structural engineering, and natural hazards for Natech risk analysis, or process safety engineers, first responders, public authorities and the public for Natech emergency management.

Leaders in industry should:

- Call attention to the need for multi-disciplinary expertise for Natech risk management and facilitate the setting up of a dedicated expert team to address the various aspects of Natech risk management at site level;
- Ensure that sufficient resources are available for the team, drawing on internal expertise as much as possible and supporting the involvement of external expertise if the required competences are not available in-house;
- Designate a team leader with sufficient experience and communication skills to guide a multi-disciplinary team towards reaching its objectives, including overcoming complexities due to discipline-specific terminology;
- Define management expectations and goals, as well as milestones to monitor the team's progress toward achieving Natech risk management requirements and targets.

Senior leaders in public authorities should:

- Ensure inclusion of natural hazard experts in the team preparing the external emergency plan to account for the natural disaster conditions possibly existing at the time of the Natech accident. They could affect civil protection actions, such as evacuation or shelter in place, or exacerbate the consequences of the accident;
- Develop policy platforms or working groups across ministries/agencies, disciplines and sectors to ensure coordination and cooperation in addressing Natech risks.

7 International and transboundary considerations

Transboundary hazards, risks and interactions need to be taken into consideration to effectively manage and mitigate Natech risks. Natech events can have widespread impacts on the health and well-being of people, through air, soil and water pollution, the latter with the potential for large-scale and transboundary consequences that can affect other countries, regions and transboundary waters and require costly clean-up and remediation efforts. In addition, natural hazards in one country can have transboundary consequences and lead to Natech events in other countries.

This section provides guidance to establish and strengthen international and transboundary cooperation in Natech risk management, including in line with a multi-hazard approach to disaster risk management. International legal and policy instruments and frameworks, such as the UNECE Convention on the Transboundary Effects of Industrial Accidents and the Sendai Framework for Disaster Risk Reduction, provide a basis for such cooperation as specified in this section and integrated across the guidance.

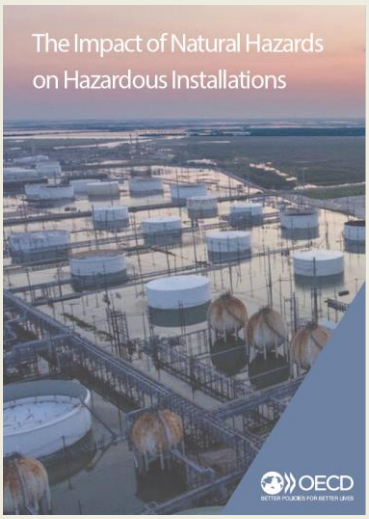
Senior leaders in industry and public authorities should ensure that:

- Knowledge exists of the transboundary causes and the prevention and mitigation of transboundary Natech events;
- International and transboundary cooperation in addressing Natech risks is integrated into relevant policies and measures (e.g. on climate change adaptation, disaster risk reduction, water management, and industrial safety) and coordinated across the respective areas of governance;
- Inter-institutional cooperation between competent authorities on the local, regional and transboundary levels to address (among others) Natech risk management, is established and maintained;
- The risks of hazardous installations capable of causing transboundary effects due to natural hazards are identified and information is shared with countries and communities that could be affected by these;
- Risk assessments of natural hazards with potential impacts on industrial sites in transboundary zones (e.g. river deltas where industrial installations can be present in higher densities) are conducted and the results are used in respective decision-making on land-use planning and siting;
- Transboundary elements of Natech risks are integrated into emergency plans, including through the development of joint and harmonized emergency plans across countries, and into response measures to ensure coordinated responses in case of a Natech event with transboundary effects;
- Early warning, alert and industrial accident notification systems are in place to inform neighbouring and riparian countries and communities of natural disasters that could have transboundary effects and possibly trigger industrial accidents and allowing them to request and render mutual assistance;
- Industrial accident notification systems are operational to inform respective authorities, first responders and communities across countries in case of a Natech event with transboundary

effects, and that an alternative mode of notification is available in case natural hazards prevent their use (e.g. power outages);

- Exchanges of experience, good practices and lessons learned in managing Natech risks are routinely fostered across countries, regions and globally through multilateral fora.

A brochure was developed by the OECD that aims to raise awareness of Natech risks and the challenges associated with their management. It also describes the work and resources of international organisations to support improved understanding of and resilience to Natech, see https://www.oecd.org/content/dam/oecd/en/topics/policy-sub-issues/chemical-accident-prevention-preparedness-and-response/impact-of-natural-hazards-on-hazardous-installations.pdf/impact-of-natural-hazards-on-hazardous-installations.pdf



8 Self-assessment checklist

These self-assessment checklists are provided to:

- **help senior leaders in industry evaluate how well they are including Natech risk as part of their organisation's process safety management;**
- **help senior leaders in public authorities to ensure that the impact of natural hazards on hazardous installations is fully considered in the safety strategy and inspection and enforcement measures.**

The questions focus on key considerations for Natech risk management and they are intended to be answered by senior leaders in industry and public authorities: at this stage answer these questions yourself as best you can. Once you have done so, you should then discuss with your staff how to address any gaps, get more information, or find out the status of 'work in progress' to address known gaps.

The questions are intended to be answered using 'traffic light' scores:

1 = Yes, and I can demonstrate this 

2 = Uncertain, I would need to find out more, or this is work in progress 

3 = No, I think there is a gap 

SELF-ASSESSMENT CHECKLIST FOR SENIOR LEADERS IN INDUSTRY

			
Preventing Natech Accidents			
1. Are you aware of the natural hazards that can impact your installations, wherever they are located in the world?			
• Do you know the type of natural hazards that can have an impact?			
• Do you know what type of impacts these natural hazards can have on your installation(s)?			
• Do you know how climate change projections may alter these natural hazard intensities and frequencies?			
• Are you proactively searching for this information?			
2. Do you know the main challenges of Natech risk?			
3. Have you ensured that Natech risk management is integrated into your chemical accidents prevention, preparedness and response measures?			
4. Have you ensured that Natech risk management identifies all relevant Natech scenarios, including those triggered by “minor” natural hazards, such as lightning and low temperatures?			
5. Have you ensured that sufficient human, financial and time resources are available to fully include Natech risk management as part of process safety procedures within your organisation?			
6. Do you have arrangements in place to make sure that Natech risk management is working effectively, and to identify areas for improvement?			
7. Have you ensured that Natech risk management is included in audits?			
8. When a Natech accident occurs, do you ensure that the triggering natural hazard is clearly reported as the cause of the accident?			
• Have you implemented a system for learning from these accidents?			
• In case there were Natech accidents at your installation(s) have you adapted risk management approaches based on lessons learned from these accidents?			
• Where appropriate, have you shared lessons learned from your organisation’s own incidents with others externally (for example with companies in the same sector)?			
9. Have you ensured that natural hazards are taken into consideration in siting and in design and construction?			

10. Have you considered the possible impacts of climate change on Natech risks at your installations, wherever they are located in the world?			
• Are you in contact with the relevant public authorities to be kept informed of the possibly changing natural hazard risk?			
• Do you have a climate change adaptation strategy that considers Natech risk?			
Emergency Preparedness and Response			
11. Are natural hazards and Natech accidents considered in the on-site emergency plan at your installation(s)?			
12. Have you ensured that alert systems are properly functioning properly?			
Communication			
13. Are Natech risks clearly communicated to all employees within your organisation as well as the measures implemented to address them?			
14. Is there communication and coordination between your organisation and public authorities, in particular at the local level?			
• on the occurrence and type of natural hazards in the region?			
• on warning and alert systems?			
• on the emergency preparedness and response plans in case of a Natech accident?			
15. Does your organisation work with local public authorities to inform communities of Natech risks?			
International and Transboundary Considerations			
16. Are you aware of the possible transboundary consequences of Natech accidents at your installations?			
17. Are you aware of possible transboundary consequences of Natech accidents at other installations which pose a risk to your installations?			

SELF-ASSESSMENT QUESTIONS FOR SENIOR LEADERS IN PUBLIC AUTHORITIES

			
Preventing Natech Accidents			
1. Are you aware of the natural hazards that can impact hazardous installations in your country/region?			
• Do you know the type of natural hazards that can have an impact?			
• Do you know how climate change projections may impact these natural hazard intensities and frequencies?			
• Do you know what type of impacts these natural hazards can have on hazardous installations?			
• Are you proactively searching for this information			
2. Have you ensured that Natech events are monitored in your country and reported into a national database?			
3. Do you encourage reporting of Natech events also into databases of international organisations (for example the JRC's eNATECH database or through national implementation reports to the UNECE Industrial Accidents Convention)?			
4. In case there were Natech accidents in your country/region have you adapted risk management approaches based on lessons learned from these accidents?			
5. Have you ensured that information systems have been developed (such as maps) that show the type, intensity and frequency of natural hazards that can impact hazardous installations?			
• Is this information communicated to industry?			
• Is this information communicated to other stakeholders, for example other relevant public authorities, neighbouring or riparian countries, experts as well as communities and the public?			
6. Are you pursuing multi-sectoral policies and approaches to address Natech risks, including across relevant authorities (e.g. disaster risk reduction, environment, emergency services, occupational safety and health, transport, etc.)?			
7. Have you included the possible impact of changes in climate and climate projections in the information communicated to industry?			

• Do you have guidance material to support industry in the development of climate change adaptation strategies considering Natech risks?			
• Are Natech risks considered in national climate change adaptation strategies?			
8. Have you ensured that Natech risks are considered in land-use planning decisions and licensing/permitting for hazardous installations?			
9. Have you ensured that Natech risk is included as part of inspection activities?			
Emergency Preparedness and Response			
10. Have you ensured that off-site emergency preparedness and response plans include potential Natech risks?			
11. Have you ensured that early warning and alert systems consider Natech risks?			
Communication			
12. Have you ensured that there is communication and coordination with industry concerning Natech risks and emergency preparedness and response?			
13. Have you ensured that there is sufficient communication with communities and the public?			
• on the type, intensity and frequency of natural hazards?			
• on the risk of associated Natech accidents?			
• on Natech prevention measures?			
• on Natech response measures (including recommended behavior in case of Natechs)?			
• on opportunities for public participation in the development of preparedness and response plans?			
International and Transboundary Considerations			
14. Have you ensured that guidance developed at the national and international level on Natech risk management is proactively communicated to the organisations concerned in your country/region?			
15. Are you coordinating and co-operating with neighbouring and riparian countries with respect to Natech events capable of causing transboundary effects, including for harmonised and (where possible) joint prevention, preparedness and response?			

9 For further reading

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eNATECH accident database: https://enatech.jrc.ec.europa.eu/

RAPID-N Natech risk assessment system: https://rapidn.jrc.ec.europa.eu/

OECD Brochure for Natech Risk Awareness (2022) https://www.oecd.org/content/dam/oecd/en/topics/policy-sub-issues/chemical-accident-prevention-preparedness-and-response/impact-of-natural-hazards-on-hazardous-installations.pdf/impact-of-natural-hazards-on-hazardous-installations.pdf

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OECD (2019), Natech Risk Management: 2017-2020 Project Results, ENV/JM/MONO(2020)4

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OECD (2023), OECD Guiding Principles for Chemical Accident Prevention, Preparedness and Response - Third Edition, Series on Chemical Accidents, OECD Publishing, Paris, https://doi.org/10.1787/162756bf-en

OECD, Decision-Recommendation of the Council concerning Chemical Accident Prevention, Preparedness and Response, OECD/LEGAL/0490

UNECE/OECD Seminar on effective management of technological risks of accidents triggered by natural hazards: https://unece.org/environmental-policy/events/uneceoecd-seminar-effective-management-technological-risks-accidents

UNECE Convention on the Transboundary Effects of Industrial Accidents: https://unece.org/environment-policy/industrial-accidents

UNECE webpage on Natech: https://unece.org/industrial-accidents-convention-and-natural-disasters-natech Decision 2022/1 - Strengthening Natech risk management in the UNECE region and beyond: https://unece.org/sites/default/files/2023-05/Decision%202022_1.pdf

UN Convention on the Protection and Use of Transboundary Watercourses and International Lakes: https://unece.org/environment-policy/water

Risk Assessment for Industrial Accident Prevention: An Overview of Risk Assessment Methods, Selected Case Studies and Available Software, UNECE, https://unece.org/info/Environment-Policy/Industrial-accidents/pub/391975

UNECE Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (Aarhus Convention): https://unece.org/environmental-policy-1/public-participation

UNECE Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention): https://unece.org/environmental-policy-1/environmental-assessment

Assessment of and planning for natural hazards, AIChE (2019), CCPS Monograph, https://www.aiche.org/sites/default/files/html/536181/NaturalDisaster-CCPSmonograph.html

UNDRR work on disaster risk reduction: https://www.undrr.org/

ILO Prevention of Major Industrial Accidents Convention No. 174: https://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:55:0::NO::P55_TYPE,P55_LANG,P55_DOCUMENT,P55_NODE:CON,en,C174,/Document

ILO Prevention of Major Industrial Accidents Recommendation No. 181: https://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:55:0:::55:P55_TYPE,P55_LANG,P55_DOCUMENT,P55_NODE:REC,en,R181,/Document

ILO Code of Practice on Major Industrial Accidents: https://www.ilo.org/global/topics/safety-and-health-at-work/normative-instruments/code-of-practice/WCMS_107829/lang--en/index.htm

ILO issue paper - Climate Change and Labour: Impacts of Heat in the Workplace: https://www.ilo.org/global/topics/green-jobs/publications/WCMS_476194/lang--en/index.htm

ILO research report - Working on a warmer planet: The effect of heat stress on productivity and decent work: https://www.ilo.org/global/publications/books/WCMS_711919/lang--en/index.htm

Canadian Standards Association, CSA Group CAN/CSA Z767-24 Process Safety Management, https://www.csagroup.org/store/product/CSA_Z767%3A24/

Managing Risks from Natural Hazards to Hazardous Installations (Natech)

A Guide for Senior Leaders in Industry and Public Authorities

Series on Chemical Accidents

Natural hazards such as lightning, high and low temperatures, landslides, earthquakes or floods can impact the operation and safety of hazardous installations and result in accidents referred to as Natural Hazard Triggered Technological accidents (or Natech accidents). Installations that process, store or handle hazardous substances can in principle be vulnerable to the impact of natural hazards. Recent Natech accidents around the globe have shown significant impacts on people, the environment, infrastructure and business continuity. Leaders in industry and public authorities need to act to ensure the appropriate governance and management of Natech risk. Changes in climate may affect the intensity, frequency and location of natural hazards, and this should be taken into account when analysing Natech risks. Leadership, combined with appropriate technical assessment, will enable long-term operability and sustainable development at hazardous installations, including where the threat level changes due to climate change. This guidance is specifically aimed at supporting senior leaders in industry and public authorities set direction for implementing Natech prevention, preparedness and response measures. This document will aid senior leaders to self-assess how prepared their organisation is in managing Natech risks effectively.