Series on Chemical Accidents

OECD Guiding Principles for Chemical Accident Prevention, Preparedness and Response - Third Edition

OECD

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Foreword

The *OECD Guiding Principles for Chemical Accident Prevention, Preparedness and Response – Third Edition* aim to provide guidance, applicable worldwide, to support public authorities and industry in taking appropriate actions to prevent chemical accidents and to mitigate the adverse effects of accidents that do nevertheless occur. The second edition was published in 2003.

This publication is the result of a **collaborative effort** under the supervision of the OECD Working Party on Chemical Accidents. The development of this Third Edition was most particularly conducted by a steering group of experts composed of: Roland Fendler, Federal Environment Agency, Germany (retired), Pavel Forint, Ministry of the Environment, Czech Republic (retired), Deanne Grant, United States Environmental Protection Agency, Mark Hailwood, State Institute for the Environment Baden-Württemberg, Germany, Rachel McCann, Health and Safety Executive, United Kingdom, Torill Tandberg, Norwegian Directorate for Civil Protection, Maureen Wood, Joint Research Centre of the European Commission, and Bill Gulledge, American Chemistry Council, representing Business at OECD, Marie-Ange Baucher and Bertrand Dagallier, OECD.

The document was edited by Eleonore Morena.

The report is published under the responsibility of the OECD Chemicals and Biotechnology Committee.

Editorial

Chemical accidents with serious consequences are still happening in OECD countries and worldwide. Over the past decades, successive major accidents have caused deaths, injuries, significant environmental pollution and massive economic losses – from the hydrogen fluoride leak in Gumi, Korea, in 2012, to the ammonium nitrate explosion in West, Texas, in the United States in 2013, the Bento Rodrigues tailings dam disaster in Brazil in 2015 or, more recently, the explosion of a chemical facility in Tarragona, Spain, and the explosion in Beirut, Lebanon, in 2020.

While high-profile accidents raise concerns in the public, stakeholder and regulator interest, there are an even greater number of accidents occurring each year that do not make international headlines. The hundreds of chemical accidents that go unnoticed every year still cause severe harm to workers, communities, municipalities, businesses and the environment, leading to an overall deterioration in quality of life. Recovering from industrial accidents sets back development gains, takes time and is expensive.

According to the United Nations Environment Programme (UNEP) *Global Chemicals Outlook II*, the market size of the global chemical industry exceeded USD 5 trillion in 2017 and is expected to double by 2030. The dependence on chemicals for technological progress, including for new energy sources, is increasing and many substances that are needed to implement new technologies are hazardous. Safety and accident prevention should be an integral part of discussions on the green transition and growing environmental issues. Sustainable development requires proper management of the risk of chemical accidents.

Many of the chemical accidents that continue to take place have similar causes and could have been prevented if lessons learnt from past accidents had been implemented and the basics of process safety management were correctly implemented. This Third Edition of the *Guiding Principles for Chemical Accident Prevention, Preparedness and Response* aims to provide guidance, applicable worldwide, to support stakeholders in taking appropriate actions to prevent, prepare and respond to chemical accidents. It reflects on lessons learnt from major accidents throughout the world since the second edition was published in 2003 and on progress made in process safety management.

These Guiding Principles are the technical guidance underlying the application of the OECD Decision-Recommendation of the Council concerning Chemical Accident Prevention, Preparedness and Response updated and consolidated in 2023.

The OECD Programme on Chemical Accidents, through its Working Party on Chemical Accidents, will continue to serve as an international forum to share experiences and challenges across countries and identify good practices to improve the prevention, preparedness and response to chemical accidents.

Jo Tyndall,
Director, OECD Environment

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Reader's guide

These Guiding Principles have been prepared as part of the OECD Programme on Chemical Accidents and within the framework of the Inter-Organization Programme for the Sound Management of Chemicals (IOMC). Their aim is to set out general guidance for the safe planning and operation of installations where there are hazardous substances in order to **prevent** accidents and, recognising that accidents may nonetheless occur, to **mitigate adverse effects** through effective **emergency preparedness and accident response.**

Objective

This revised third edition of the Guiding Principles aims to be a reference for public authorities, industry and other stakeholders to ensure a strong chemical accidents programme that takes into account the latest good practices and advances in the field of prevention, preparedness and response. The Guiding Principles will also serve as a reminder of the key elements of process safety as accidents often happen with similar causes and could have been prevented "just" with basic process safety in place.

This revised third edition takes into account new vocabulary used in the field and reflects on lessons learnt from major accidents worldwide since the second edition was published in 2003 as well as emerging issues linked to the 4th Industrial Revolution, climate change adaptation and the response to unexpected crises for example.

These Guiding Principles are the technical guidance underlying the application of the OECD Decision-Recommendation of the Council concerning Chemical Accident Prevention, Preparedness and Response consolidated in 2023.[1] They can be used in conjunction with the IOMC Toolbox Chemical Accidents Scheme that provides a complementary step-by-step approach to the development of a chemical accidents programme based on a country's available resources.[2]

The principles take into account and are consistent with other international regulatory instruments and guidance materials relevant to chemical accident prevention, preparedness and response. These include instruments and guidance materials prepared in connection with the European Union (EU) Seveso III Directive, the UNEP Awareness and Preparedness for Emergencies at Local Level (APELL) programme and Flexible Framework, International Labour Organization conventions and recommendations, United Nations Economic Commission for Europe (UNECE) conventions, United Nation Office for Disaster Risk Reduction (UNDRR) frameworks, World Health Organization (WHO) regulations and the International Maritime Organization (IMO). They contribute to the achievement of the United Nations Sustainable Development Goals (SDGs).

Scope

For the purpose of this publication, a **chemical accident** refers to any unintentional event, such as a release, fire or explosion at a hazardous installation, involving hazardous substances, that has the potential

to cause harm to human health, the environment or property. This also covers chemical accidents triggered by the effects of natural hazards.

This publication seeks to address the wide range of measures necessary to ensure effective chemical safety, in particular to:

- Minimise the likelihood that an accident will occur (**prevention**).
- Mitigate consequences of accidents through emergency planning, land-use planning and risk communication (**preparedness/mitigation**).
- Limit the adverse consequences to health, the environment and property in the event of an accident (**response**).
- Learn from the experiences of accidents (**follow-up**) in order to reduce the number and impact of future accidents.

These Guiding Principles do not include long-term clean-up and restoration following an accident, nor do they address long-term events, such as chronic pollution from hazardous substances. However, the issues addressed herein are closely related to other aspects of environmental protection, occupational and public health, and sustainable development.

Parties addressed

The Guiding Principles **principally focus on providing guidance to industry and public authorities**. They also contain a dedicated section on communication with **the public** (see Figure 1).

Industry

Since the primary responsibility for the safety of hazardous installations rests with those who own and operate such installations, the largest part of this publication is devoted to the roles and responsibilities of industry. Industry is defined to include owners/shareholders/operators of relevant enterprises (whether private or public entities), management, other employees and contractors working with the installation. In this publication:

- The word “management” should be read to include anyone with decision-making responsibility for the enterprise, including owners and managers; this includes onsite management and management at the corporate level.
- The word “employee” is defined as any individual(s) working at or on behalf of a hazardous installation, including both management and labour, as well as (sub)contractors.
- The word “labour” includes any individual(s) working at or on behalf of a hazardous installation who is not part of management.

For purposes of this publication, government agencies that operate hazardous installations (e.g. wastewater treatment facilities, transport interfaces or chemical warehouses) should be considered “industry”.

Public authorities

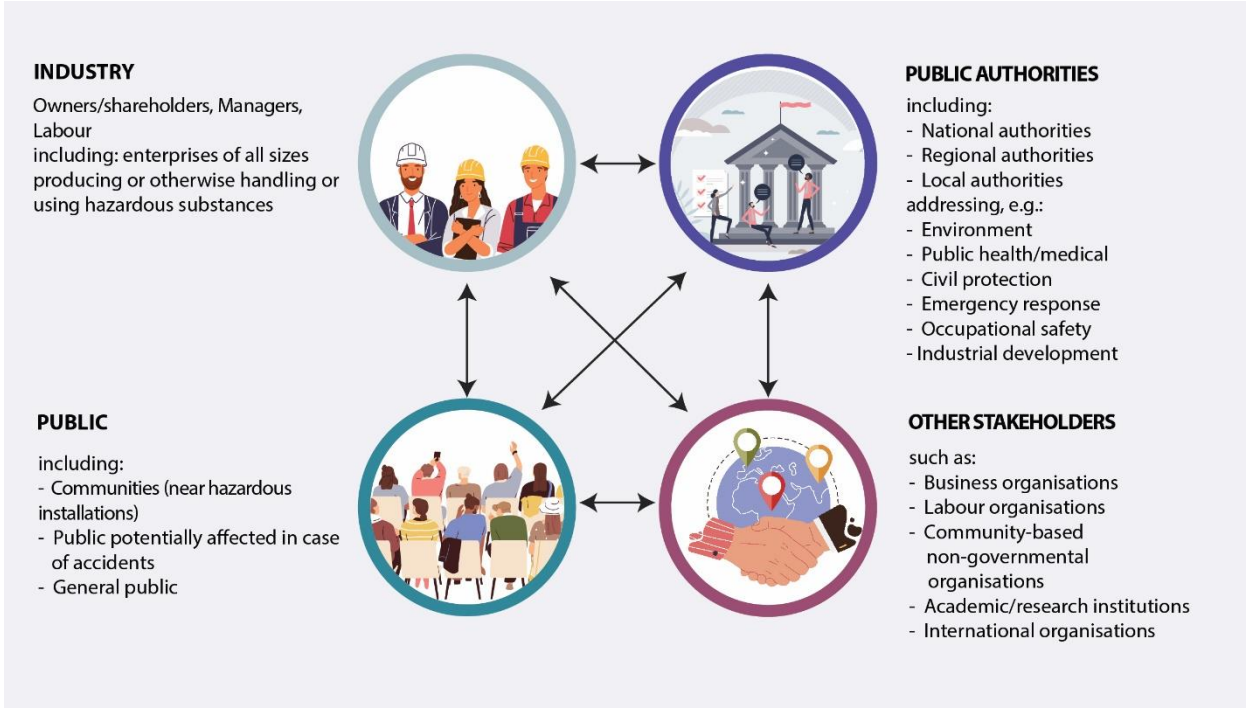
- The Guiding Principles include guidance related to the roles and responsibilities of public authorities at all levels that are involved in the many disciplines inherent in chemical accident prevention, preparedness and response (e.g. environment, public health, occupational health and safety, civil 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.

The public

- The Guiding Principles also address the role of the public, both in general and more specifically the members of the local community near a hazardous installation and those potentially affected in the event of an accident. The focus is on the provision of and access to information concerning the hazardous installation and emergency preparedness and response, as well as on public participation in decision making related to hazardous installations.

Figure 1. Stakeholders addressed in the Guiding Principles



Installations covered

The Guiding Principles apply to fixed installations at which hazardous substances are produced, processed, handled, stored, used or disposed of in such a form and quantity that there might be a risk of occurrence of a chemical accident (called “hazardous installations” in this publication). The principles do not generally address the transport of hazardous substances but cover pipelines and transport interfaces such as marshalling yards and port areas.

Accidents involving the release of radioactive materials or biological matter have not been addressed in this publication. However, the Guiding Principles do address accidents involving chemicals that have been produced at nuclear facilities and by biological processes. Furthermore, many of the principles described in this publication also apply in the context of nuclear and biotechnology installations. Certain aspects of the Guiding Principles do not apply to military facilities to the extent that this might compromise national security.

Use

The Guiding Principles have purposely been drafted to allow **flexibility in their application**, so that users can choose the relevant provisions and adapt them in light of their particular circumstances, including the local culture, legal context, nature of the risks and the extent and type of resources available. In this regard, it should be recognised that not all provisions will apply in all circumstances. The publication also tries to achieve a balance between guidance that is general and flexible and, at the same time, sufficiently specific and detailed so that it will be a valuable resource to decision makers.

Notes

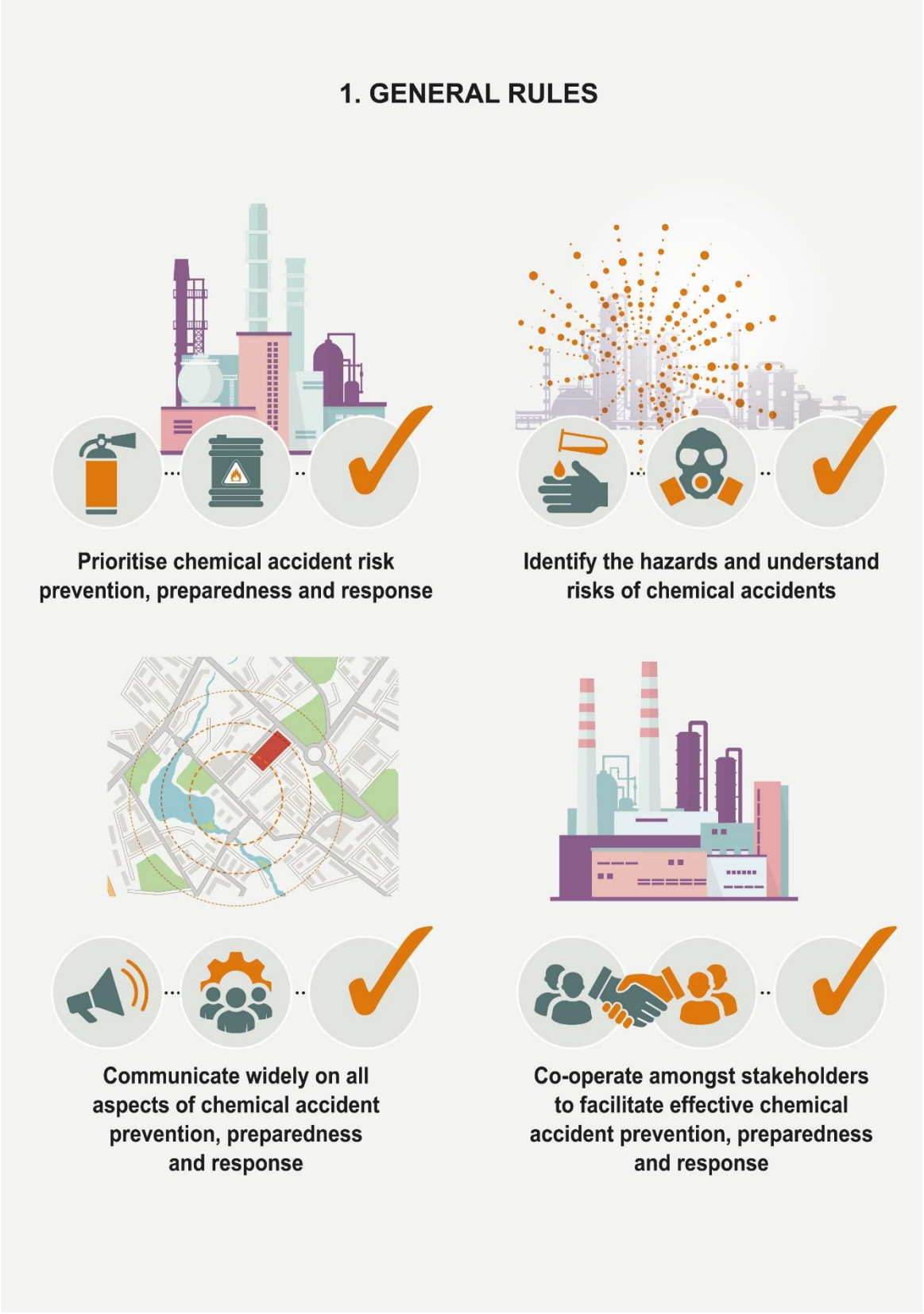
[1] See https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0490

[2] See https://iomctoolbox.org/ for more information.

Golden Rules

The objective of these Golden Rules is to highlight over few pages the primary roles and responsibilities of the major stakeholders involved in chemical accident prevention, preparedness and response. It should be recognised that these points represent good practices and objectives to be achieved over time. They are not one-time actions but rather require ongoing vigilance.

Infographic 0.1. General Rules for all stakeholders



General rules for all stakeholders

Prioritise chemical accident risk prevention, preparedness and response

Chemical accident prevention preparedness and response require efforts from all stakeholders within their own roles and responsibilities to ensure that hazardous installations and their risks are managed effectively. Beyond the local responsibilities, there are roles and activities that must be undertaken at the regional, national and international levels. Accidents may have a potential impact across borders, thus requiring the exchange of information and trans-frontier activities. Managing the risks of chemical accidents effectively requires leadership within industry and civil society. Leadership requires risk awareness, information from within the whole of the organisation, competency and decisive action to be effective.

Identify the hazards and understand the risks of chemical accidents

Industry must systematically identify the hazards associated with handling hazardous chemicals and understand the risks of chemical accidents associated with the operation of their installations. In doing so, they should take into account the potential impact of natural hazards. Hazard identification and risk assessment should be undertaken from the earliest stages of design and construction, throughout operation and maintenance, up until cessation of operations and closure. It should be recognised that temporary situations or any changes in operations require hazard identification and risk assessment to be reviewed, and appropriate measures to manage the changes in risk taken.

The measures taken by industry to address the risks of chemical accidents should be appropriate so as to reduce them as far as reasonably practicable. Considerations should be given to technological failures as well as to the influence of human factors on the safe operation of the facility. Measures should be taken to ensure as far as reasonably practicable that malicious acts (e.g. sabotage, cyberattack, terrorism, vandalism, theft) which may lead to a chemical accident are prevented, including cybersecurity.

Public authorities must understand the risks posed by chemical accidents from hazardous installations to people, the environment and property. This understanding should be used in developing the inspection and control measures for the oversight of the installations, the offsite emergency planning to be able to respond in the event of a chemical accident, and in ensuring that appropriate land-use planning is developed to minimise potential impacts to the community and the environment.

Members of the public and communities should be aware of the risk posed by chemical accidents in their vicinity and be involved in the planning and communication activities related to them.

Communicate widely on all aspects of chemical accident prevention, preparedness and response

Communication should be based on a policy of openness as well as the shared objective of reducing the likelihood of accidents and mitigating the adverse effects of any accidents that occur. One important aspect is that the potentially affected public should receive the information needed to support prevention and preparedness objectives. Communication mechanisms should be set up to ensure that trans-frontier communication is enabled.

Good communication is important within the facility in which the hazardous installations are sited 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 done. Effective communication is essential between the management of the facility and the local authorities, not only to co-ordinate the measures and activities necessary to ensure that emergency plans are drawn up and acted upon in the event of a chemical accident, but also to allow the development of land use planning in the vicinity of the facility so as to avoid conflicts and manage risk effectively.

In the event of a chemical accident, effective communication must be activated immediately between the facility and the local authorities so that appropriate emergency measures are initiated and clear information is provided to the public regarding the behaviour to be adopted. This communication must be two-way, active, informed and continuous. This communication should take into account the existing crisis communication plan.

The public should participate in decision making relating to hazardous installations where this is possible. The laws in many communities require public authorities to provide opportunities for members of the public to participate in decision making related to hazardous installations, for example by commenting on proposed regulations or zoning decisions or providing input for procedures concerning licensing or siting of specific installations. Members of the public should take advantage of these opportunities to present the perspective of the community. They should work towards ensuring that such opportunities exist, whenever appropriate, and that the public has the information necessary for effective participation.

Co-operate amongst stakeholders to facilitate effective chemical accident prevention, preparedness and response

Management should co-operate with all employees and their representatives, public authorities, local communities and other members of the public in achieving the goals of chemical accident prevention, preparedness and response.

In addition, management should strive to assist other enterprises (including suppliers and customers) to meet appropriate safety standards. This may, for example, be through effective product stewardship programmes, the work of industry and trade associations, or chambers of industry and commerce.

Management should co-operate with local authorities and emergency responders to ensure that emergency planning is appropriate to the risks presented by a chemical accident. This may include providing not only information on the chemicals handled, the processes operated and their location, but also specialised equipment, other resources or training to enable the delivery of an effective response.

Communities and the public should co-operate with the management of the facilities in their area and with the local authorities so that, in the event of a chemical accident, the appropriate behaviours are followed and the impacts are minimised as far as possible. They should be aware of the risks in their community and know what to do in the event of an accident. This includes reading and taking note of the information provided with regard to the appropriate behaviours, sharing this information with others in their household and seeking additional information as appropriate.

Infographic 0.2. Role of industry (including management and labour)

Role of industry (including management and labour)

Promote a mature safety culture throughout the enterprise

The safety culture, reflected in an enterprise's safety policy, consists of both an attitude showing that safety is a priority and appropriate organisation. The safety culture is led from the top of the organisation. To be effective, a safety culture requires a visible top-level commitment to safety in the enterprise and the support and participation of all employees[1] and their representatives. It should endeavour to improve the level of safety beyond legal requirements and guarantee a high level of safety where legal requirements are not available.

A mature safety culture involves everyone. It is open to receiving communication from all levels of the organisation and providing feedback, particularly to management, when appropriate. This should ensure that everyone is cared for and that no one is exposed to unacceptable risks. All employees of the facility and of contractors working for the facility should comply with all procedures and practices relating to accident prevention, preparedness and response in the discharge of their responsibilities. This should be in accordance with the training and instructions given by their employer, respectively organised by the facility management.

Establish safety management systems and regularly review their implementation

Safety management systems for hazardous installations include using appropriate technology and processes, as well as establishing an effective organisational structure (e.g. operational procedures and practices, effective education and training programmes, appropriate levels of well-trained employees and allocation of necessary resources). These all contribute to the reduction of hazards and risks. In order to ensure the adequacy of safety management systems, it is critical to have appropriate and effective review schemes to monitor the systems (including policies, procedures and practices). Senior management should take responsibility for regularly reviewing the performance of the safety management system and ensuring that corrective action is taken where deficiencies are identified.

Utilise inherently safer technology principles in designing and operating hazardous installations

This should help reduce the likelihood of accidents and minimise the consequences of accidents that occur. For example, installations should take into account the following, to the extent that they would reduce risks: minimising to the extent practicable the quantity of hazardous substances used; replacing hazardous substances with less hazardous ones; reducing operating pressures and/or temperatures; improving inventory control; and using simpler processes. This could be complemented by the use of backup systems.

Identify and manage the risks arising from change

Any significant changes (including changes in process technology, organisation, staffing and procedures) as well as maintenance/repairs, start-up and shut-down operations, increase the risk of an accident. It is therefore particularly important to be aware of this and take appropriate safety measures when significant changes are planned – before they are implemented. In particular, any change of ownership, that is mergers or acquisitions, should be considered for potential impacts on the safe operation of the facility. Care should be taken to address the ageing of plants, equipment, procedures and people as a continuous change process, which can have a significant impact on safety.

Prepare and plan for any chemical accidents that may occur

It is important to recognise that it is not possible to totally eliminate the risk of an accident. Therefore, it is critical to have appropriate preparedness planning in order to minimise the likelihood and extent of any adverse effects on health, the environment or property. This includes both onsite preparedness planning and contributing to offsite planning, as well as the provision of information to the potentially affected public.

Educate and train for employees to work safely

Management should ensure that all employees are suitably trained and qualified to carry out their tasks and understand the risks of chemical accidents associated with them. They should define the necessary qualifications for each job when recruiting new personnel or when appointing existing personnel to a new position. Training must be provided when carrying out tasks for the first time and regularly repeated to ensure that a high standard of compliance with expected operating procedures is achieved. Changes in operating procedures require new training. Training and instruction must be provided to contractors working on site.

Track and learn from past accidents

Industry must learn from past accidents. To do this, it must record and investigate all relevant accidents, report them, where required, to the appropriate authorities, develop lessons learnt from the accidents and disseminate not only the account of the accident but also those lessons learnt. Industry must actively follow up on accidents which are reported within their organisation, their business and beyond and adopt appropriate measures to ensure that lessons learnt are turned into measures to prevent the recurrence of similar accidents.

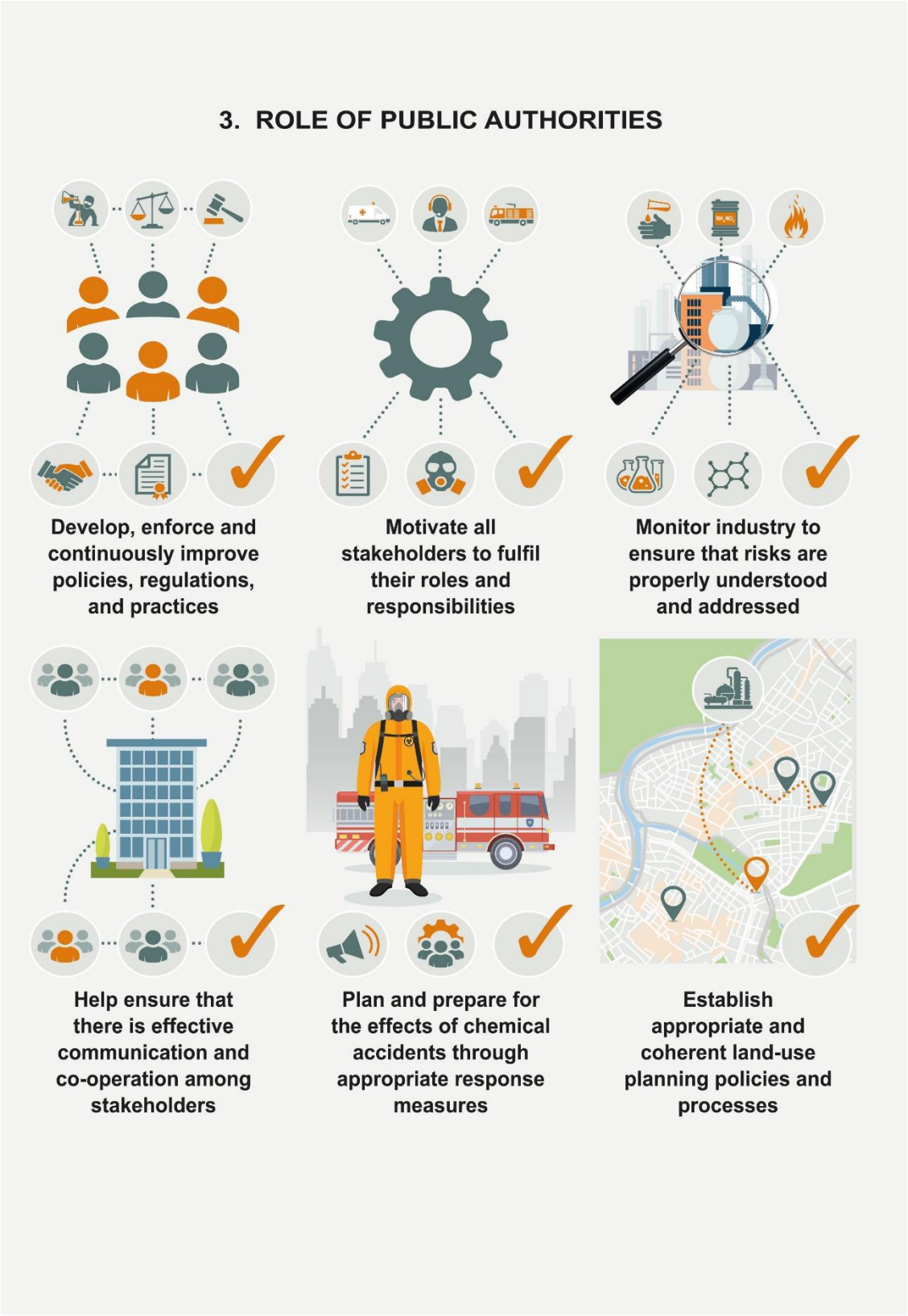
Seek continuous improvement through applying good engineering and management practices

Although it is not possible to eliminate all risks of accidents at hazardous installations, the goal should be to find improvements in technology, management systems and employees' skills in order to move closer toward the ultimate objective of zero accidents. In this regard, management should seek to learn from past experiences of accidents and near misses, both within their own enterprises and at other enterprises. To this end, there should be an exchange of good practices within the organisation and across the industry.

Exercise corporate governance in all operations and all locations of an enterprise

Management should make sure that best practice is applied at all hazardous installations, independent of their location and age. The transfer of technology, that is the introduction of technology or hazardous substances to a location that does not have prior experience and knowledge, should be accompanied by the information and knowledge required for its safe operation. Local standards which are lower than the corporate standards, or the standards applied where the company has its headquarters, should not lead to lower standards in the operation of a facility.

Infographic 0.3. Role of public authorities



Role of public authorities

Develop, enforce and continuously improve policies, regulations, and practices

It is important for public authorities at the national, regional and local levels to establish policies, regulations and practices and have mechanisms to ensure their enforcement. Public authorities should also regularly review and update, as appropriate, policies, regulations and practices. In this regard, public authorities should keep informed of and take into account relevant developments. These include changes in technology, business practices and levels of risks in their communities, as well as experience in implementing existing laws and accident case histories. Public authorities should involve other stakeholders in the review and updating process.

Motivate all stakeholders to fulfil their roles and responsibilities

Within their own sphere of responsibility and influence, all relevant public authorities should seek to motivate other stakeholders to recognise the importance of accident prevention, preparedness and response, and to take the appropriate steps to minimise the risks of accidents and mitigate the effects of any accidents that occur. In this regard, the authorities should establish and enforce appropriate regulatory regimes, promote voluntary initiatives and establish mechanisms to facilitate education and information exchange.

Monitor industry to ensure that risks are properly understood and addressed

Public authorities should establish mechanisms for monitoring hazardous installations to help ensure that all relevant laws and regulations are being followed and that the elements of a safety management system are in place and are functioning properly, taking into account the nature of the risks at the installations (including the possibilities of malicious acts or accidents triggered by natural hazards or disasters). Public authorities should engage in dialogue with management to ensure that lessons are learnt and that continuous improvement is achieved.

Help ensure that there is effective communication and co-operation among stakeholders

Information is a critical component of safety programmes. Public authorities have an important role in ensuring that appropriate information is provided to and received by all relevant stakeholders. Public authorities have a special role in facilitating the information to the public concerning chemical risks in their community so that members of the public are reassured that safety measures are in place, that they understand what to do in the event of an accident and that they can effectively participate in relevant decision-making processes. Public authorities are also in a position to facilitate the sharing of experience by providing public databases and publishing investigation reports.

Public authorities should publish information on natural hazards and communicate it to the management of hazardous installations that may be affected by them. Public authorities should make sure that there are early warning systems in case of chemical accidents or natural hazards.

Plan and prepare for the effects of chemical accidents through appropriate response measures

Public authorities (often at the local level) have primary responsibility for ensuring response to accidents that have offsite consequences, helping prevent deaths and injuries, and protecting the environment and property. They should make sure that the on- and offsite planning includes appropriate planning for monitoring and clean-up of releases, fires and explosions, including the definition of responsibilities for these activities.

Establish appropriate and coherent land-use planning policies and processes

Land-use planning can help to ensure that all installations are appropriately located, with respect to the protection of health, environment and property, in the event of an accident. It should establish and implement both general zoning as well as specific siting of hazardous installations and other developments. Land-use planning policies and processes can also prevent the inappropriate placement of new developments near hazardous installations. The construction of new residential, commercial or public buildings within certain distances of hazardous installations should be avoided. Land-use planning policies and arrangements should also control inappropriate changes to existing installations. They should also allow for the possibility of requiring changes to existing installations and buildings to meet current safety standards.

Effective land-use planning needs to involve public authorities from both the field of chemical accident prevention as well as urban and regional planning. In addition, stakeholders from industry and civil society should be actively engaged and consulted to provide balanced and acceptable management of chemical accident risks.

Note

[1] For the purposes of this publication, “employee” is defined as any individual(s) working at or on behalf of a hazardous installation. This includes both management and labour, as well as (sub)contractors.

Part I Prevention of chemical accidents

1 General principles for prevention

This chapter sets out general principles relating to the prevention of chemical accidents. It provides key elements to ensuring effective prevention and on the main roles of industry and public authorities.

The primary objective of safety-related programmes at hazardous installations is the prevention of chemical accidents (recognising that chemical accidents may, nonetheless, occur).

The prevention of chemical accidents is the concern of all stakeholders. This includes industry (e.g. owners and managers of hazardous installations, other employees and (sub)contractors working at or on behalf of such installations, and employee representatives);[1] public authorities at the national, regional and local levels, the public and other stakeholders (e.g. business, labour, communities, international organisations and academic institutions).

For chemical accident prevention activities to be effective, co-operative efforts should be undertaken by all stakeholders. Within communities where there are hazardous installations, it is important for industry, local authorities and the public to work together to reduce the risks of accidents. This co-operation should be based on a policy of openness, to build trust and manage the risk of chemical accidents in the most effective way.

All hazardous installations should comply with the same overall safety objectives and the same expectation of safety, irrespective of size, location or other factors. Industry's obligation to operate safely applies to enterprises of all sizes that produce, use, handle, transport, store or dispose of hazardous substances, including those enterprises that are not chemical producers or otherwise not considered part of the chemical industry.

It is undisputed that learning from past chemical accidents is an essential and important part of major accident control. In order to learn from past accidents and improve safety over time, it is important to gather reports of chemical accidents and disseminate the learnings. Provided that lessons learnt are disseminated properly, all concerned should be able to avoid similar accidents.

Management at all levels of organisations operating hazardous installations has the responsibility for operating installations safely and for developing the means and the resources to do so. Industry should periodically monitor and review safety performance in hazardous installations in order to assess achievements with respect to the general goals set and demonstrate management's commitment to safety and provide motivation for improvement.

Producers of hazardous substances should promote the safe management of substances they produce throughout the total life cycle of the substances, consistent with the principle of product stewardship. Producers should make special efforts to help prevent accidents during the handling and use of a hazardous substance by downstream users. The importance of a standardised system of classification and labelling of hazardous substances should be raised and the role of the United Nations (UN) Globally Harmonized System of Classification and Labelling of Chemicals (GHS).

All *employees* should share responsibility for and have a role to play in the prevention of accidents by carrying out their jobs with an active regard for safety, supporting the ability of others to do so, and by contributing to the development and implementation of safety policies and practices.

Public authorities should set general safety objectives, establish a clear and coherent control framework and ensure, through appropriate inspection and enforcement measures, that all relevant requirements are being met. They should be proactive in stimulating the development of new approaches for accident prevention, in addition to their more traditional reactive role in responding to specific public concerns. They should take a leadership role in motivating all sectors of society to recognise the need for accident prevention, in identifying the tools needed and in developing a national culture that promotes chemical accident prevention.

Public authorities, industry associations and others should improve the sharing of information and guidance materials promoting the prevention of chemical accidents and improving the health, safety and environmental performance of hazardous installations.

All stakeholders should be involved in addressing the fundamental issues related to risk acceptability/tolerability in a community with regard to chemical accidents. In this regard, each country/organisation should decide on its own criteria for acceptability/tolerability. Reaching a consensus on what is acceptable/tolerable can be helped by having an agreed framework for judging the criteria. While risk assessment informs the decision-making process, it should not be the sole decisive influence. Such questions are a matter of socio-political judgement.

Members of all stakeholder groups should be able to communicate effectively to their colleagues and superiors about safety and risk issues. Risk communication should take into account the fact that groups of people in an organisation may have different objectives (which may be conflicting) and that different disciplines may use different terminology when addressing safety and risk issues.

Means should be made available to assist *enterprises with limited resources* that need support or assistance to improve their safety programmes. A multi-faceted approach, with a variety of entities and programmes, may be necessary in order to address possible concerns and limitations of enterprises that might need support or assistance.

Note

[1] Different countries and enterprises may have different types of representatives of employees, including union representatives or safety representatives.

2 Prevention of chemical accidents: Principles to industry

This chapter recognises that enterprises have primary responsibility for chemical accident prevention and that safety should be an integral part of all phases of an enterprise from design and construction, through operation and maintenance, to decommissioning/closure/demolition. In addition to addressing the role of management, it also includes provisions relating to the role of labour (defined to be all employees other than management working at or on behalf of a hazardous installation including (sub)contractors).

Corporate governance and process safety management

> *"Corporate governance involves a set of relationships between a company's management, its board, its shareholders and other stakeholders. Corporate governance also provides the structure through which the objectives of the company are set, and the means of attaining those objectives and monitoring performance are determined." (OECD, 2015[1])*
>
> *"The major objective of Process Safety management of highly hazardous chemicals is to prevent unwanted releases of hazardous chemicals especially into locations that could expose employees and others to serious hazards." (OSHA, 1994[2])*

At hazardous installations, there is a need for high standards of corporate governance and safety management.

Analysis of past incidents reveals that inadequate leadership, poor organisational culture and lack of safety management have been recurrent features, with:

- A failure to recognise things were out of control (or potentially out of control), often due to a lack of competency at different levels of the organisation.
- A failure to manage process safety effectively and take the necessary actions.
- An absence of, or inadequate, information on which to base strategic decisions – including the review and evaluation of safety management systems.
- A failure to understand the full consequences of changes, including organisational ones.

There are four key components to achieving high standards of corporate governance and safety management that are described in this section (see Figure 2.1).

Figure 2.1. Corporate governance and process safety management

Recognise the essential elements of corporate governance for safety

Corporate decisions have a direct bearing on process safety outcomes. They set the vision and culture for the whole organisation.

Be a leader in process safety

Senior leaders should:

- Keep process safety on their agenda, prioritise it strongly and remain mindful of what can go wrong.
- Encourage people to raise process safety concerns and be transparent about negative situations which may involve significant costs or disruption to operation to deal with them. This requires the development of a climate of trust within the organisation.
- Be aware of situations where people may feel compromised due to loss of face.
- Take every opportunity to be a role model, promoting and discussing process safety.
- Delegate appropriate process safety duties to competent personnel whilst maintaining overall responsibility and accountability.
- Be visibly present in their businesses and at their sites, asking appropriate questions and constantly challenging the organisation to find areas of weakness and opportunities for continuous improvement.
- Promote a safety culture that is known and accepted throughout the enterprise (see section on developing and maintaining a safety culture below).

Understand the vulnerabilities and risks

Senior leaders should know the hazards and risks at installations. They should:

- Know the importance of process safety throughout the life cycle – whether the design, operation and maintenance phases of their manufacturing facilities, or storage, logistics and decommissioning at those locations.
- Understand the critical and different layers of protection that are in place between a hazard and an accident and seek to strengthen those layers continually.
- Ensure appropriate and consistent management systems for analysing, prioritising and managing the risk, including strong management of change processes for people, technology and facilities.
- Personally involve themselves in risk assessing the process safety impact of any proposed budget reductions and production at the expense of process safety risk.
- Take responsibility for emergency planning for the range of consequences from a process safety incident including the credible worst-case scenario.
- Know the hazards and risks at installations where there are hazardous substances.

Share information and ensure data drive process safety programmes

Senior leaders should have metrics which help to monitor the health of the process safety culture and management systems. They should:

- Ensure that the organisation analyses audit and assessment results.
- Monitor site- and corporate-level process safety key performance indicators and near misses.
- Have metrics which help to monitor the health of the process safety culture and management systems.
- Actively share experiences and learning within their own organisation and within other high-hazard sectors and ensure an appropriate, high-quality follow-up.
- Establish safety management systems and monitor/review their implementation. Seek continuous improvement (see section on maintaining and establishing a safety management system below).

Ensure the organisation's competency to manage the hazards of its operation

Senior leaders should ensure the continual development of process safety expertise and learn from new regulations and guidance. They should:

- Understand which questions to ask their personnel and know which follow-up actions are necessary.
- Ensure there is competent management, engineering and operational personnel at all levels.
- Ensure continual development of process safety expertise and learning from new regulations and guidance.
- Provide resources and time for expertise-based hazard and risk analyses, effective training and comprehensive scenarios planning for potential accidents.
- Defer to the expertise of personnel and do not dismiss expert opinions. They provide a process or system to ensure company leaders get expert process safety input as a critical part of the decision-making process for commercial projects or activities.
- Ensure that the organisation monitors and reviews the process safety competency of contractors and third parties.
- Be capable of openly communicating critical aspects of process safety with all internal and external audiences.

Articulate and drive active monitoring and plans

Senior leaders should engage in articulating and driving active monitoring and plans. They should:

- Ensure practices are consistent with corporate process safety policies.
- Ensure that safety measures are incorporated at the earliest conceptual and engineering design stages of an installation to enhance the intrinsic (inherent) safety of the installation wherever practicable.
- Incorporate process safety considerations into major capital investments, long range planning and integration of mergers or acquisitions.
- Ensure process safety risk mitigation plans and emergency response plans are developed and maintained for all sites within their business and at an organisation-wide level, with appropriate levels of competent resources available to execute the plans.
- Ensure implementation of both process safety risk mitigation plans and reviews of progress versus the plans at the site and corporate levels.
- Monitor that corrective actions are applied and closed out promptly following audits and after thorough root cause investigations of all incidents, including potentially high-consequence near misses.

Senior leaders should refer to the *OECD Corporate Governance for Process Safety: Guidance for Senior Leaders in High Hazard Industries* (2012[3]), which highlights the skills and knowledge required to actively develop and maintain a mature safety culture (see Box 2.1).

Box 2.1. *OECD Guidance on Corporate Governance for Process Safety: Guidance for Senior Leaders in High Hazard Industries*

The OECD Programme on Chemical Accidents established "best practice" for senior decision makers who have the authority to influence the direction and culture of their organisation. This guidance aims to identify the essential elements of corporate governance for process safety.

With its checklist, the guidance encourages every director, chief executive officer (CEO) and president of a major hazard company to check themselves against a set of self-assessment questions organised around the following themes:

- Do you know what the major accident risks are for your organisation?
- Do you know what your main vulnerabilities are?
- What are you doing about them?
- How concerned are you about the level of risk?
- How confident are you that all the safety systems are performing as they should?
- Do you seek out the "bad news" as well as the good?
- If there is an incident, who do you blame? Others, or yourself?
- Are you doing all you can to prevent a major accident?

Source: OECD (2012[3]), *Corporate Governance for Process Safety: Guidance for Senior Leaders in High Hazard Industries*, https://www.oecd.org/chemicalsafety/corporategovernanceforprocesssafety.htm.

Develop and maintain a mature safety culture

Recognise the elements of a mature safety culture

Enterprises should develop and maintain an effective corporate safety culture, reflected in a corporate safety policy. A safety policy statement is a written document reflecting the corporate safety culture and the overall aims and principles with respect to chemical safety. Safety should be an integral part of the business activities of an enterprise.

An effective safety culture is an essential element of safety management. The safety culture should:

- Reflect the rules established by the enterprise concerning the roles, rights and obligations of all those concerned with the assurance and maintenance of safety.
- Derive from the values, attitudes and behaviour of senior management and the communication of these throughout the organisation. It starts with the visible commitment of the board members and senior executives of the enterprise, who should set an example and demonstrate leadership by being actively involved in safety.

In addition to management's commitment to safety as a priority, there should be a similar commitment by all employees. Inherent in the safety culture, all employees should be dedicated to doing their jobs in a safe manner, following established procedures and assisting their colleagues in carrying out their tasks.

> *"The safety culture of an organisation is the product of individual and group values, attitudes, perceptions, competencies, and patterns of behavior that determine the commitment to, and the style and proficiency of, and organisation's health and safety management. Organisations with a positive safety culture are caracterised by communications founded on mutual trust, by shared perceptions of the importance of safety and by confidence in the efficacy of preventive measures." (ACSNI Human Factors Study Group, 1993[4])*

Assessment of the safety culture has proven to be an important tool to promote safety.

- Assessment should address the beliefs and actions of management and other employees. Management/leadership behaviour is a crucial target when assessing safety culture.
- Assessment should go beyond the individual mindset and stated values. It should address group-level phenomena, such as: the beliefs and motivations of employees; social and group dynamics; shared basic assumptions that influence beliefs and behaviour; learning processes; and informal leadership.
- Assessment techniques need to be tailored to specific enterprises, organisations and groups.

A characteristic of a mature safety culture of an enterprise is an open, learning attitude including in its relations with the public and other stakeholders.

Eliminate complacency, encourage alertness

The safety culture should help guard against complacency or structural/procedural shortcomings, all of which lead to unsafe acts or practices.

Management should promote the idea of "constant vigilance" and that continuous efforts are needed to maintain safety.

The main objective is to avoid the perception that accidents are rare events that will not happen during the management's tenure and to prevent complacency if there have not been any accidents at an installation over a period of time.

The safety culture should encourage initiative and alertness in the interest of safety.

Promote a just culture

> *The term "Just Culture" has been principally used in the aviation and medical sectors. For example, Just Culture has been described as a culture that "considers wider systemic issues where things go wrong, enabling professionals and those operating the system to learn without fear of retribution. […] generally in a just culture inadvertent human error, freely admitted, is not normally subject to sanction to encourage reporting of safety issues. In a just culture investigators principally attempt to understand why failings occurred and how the system led to sub-optimal behaviours. However a just culture also holds people appropriately to account where there is evidence of gross negligence or malicious acts." (Williams, 2018[5])*

The safety culture should be associated with a just culture.

One important characteristic is "error tolerance":

- A safety culture should develop the capacity of employees to effectively perform their duties and not be focused on assessing blame or punishing errors.
- The safety culture should encourage an atmosphere of co-operation and openness in which employees feel comfortable about discussing errors and near misses in order to improve learning.
- An error-tolerant culture nevertheless requires appropriate responsibility and accountability.

To promote such a safety culture, employees and their representatives should be provided with opportunities to participate in the development and review of procedures and should be empowered to take action consistent with safe operation and/or protection of life without fear of reprisals.

Ensure employees know their roles and responsibilities, and have the necessary competency

Management should take the appropriate actions to ensure that all employees are aware of their roles and responsibilities, and have the necessary skills, education, training and support to assume these roles and responsibilities. These should be appropriately resourced.

Management should ensure that all safety procedures are up to date, disseminated, well known and understood by all employees (and others, as appropriate).

Apply the safety culture in the case of affiliated operations

When an enterprise has an investment in but not operational control over another enterprise operating hazardous installations, the enterprise making the investment should consider, where appropriate, entering into contractual arrangements to assist in the establishment and maintenance of safety standards.

An enterprise should provide each of its affiliates and subsidiaries full access to all safety-related information – including newly discovered information, research results, technology and management techniques that could reduce the likelihood of accidents or mitigate the consequences should an accident occur – at the location of the affiliate or subsidiary.

Financial institutions, in determining the level of funding to be provided to enterprises for investment in a hazardous installation, should take into account the number of resources needed to comply with safety requirements as well as with corporate safety policies and guidelines.

Develop and maintain a safety policy

A safety policy is a written statement reflecting the corporate safety culture and the overall aims and principles with respect to chemical safety.

Have a clear and meaningful written safety policy statement

Each enterprise should have a clear and meaningful written statement of its safety policy that reflects the corporate safety culture and contains the overall aims and principles with respect to chemical safety. The safety policy should:

- Address the fundamental goals for accident prevention, preparedness and response, including the elements of the safety management system.
- Incorporate safety objectives established by public authorities together with the “zero incident” goal.
- Incorporate, as an essential element, the goal that all accidents are preventable.
- Set out to protect the safety and health of all persons involved in or who may be affected by the production, process, handling, use, storage, disposal or elimination of hazardous substances, as well as to safeguard the environment and property.
- Address measures to assess and improve the safety culture.
- Be at the top of a hierarchy of documentation related to chemical safety at an enterprise. Subsequent levels in the hierarchy explain in more detail the application of the policy.
- Be agreed, promulgated and applied throughout the enterprise.

- Be reviewed regularly and amended, as appropriate, in light of experience gained and any relevant changes in technologies, laws and regulations.

Commitment from management is evidenced by practices such as:

- Clear and visible management interest in safety performance through personal involvement in safety matters.
- Good communication on safety issues among and between management and other employees.
- Positive feedback concerning actions taken to increase safety.
- Quick response to remedy identified faults.
- Financial and career incentives for good safety performance.
- Participation of employees at all levels in developing and reviewing safety management procedures.
- Timely investigations of all accidents and relevant near misses, and rapid dissemination of the findings of the investigations.

Involve employees at all levels in developing, reviewing and complying with the safety policy

In developing, reviewing and amending the safety policy, management should consult with and involve employees at all levels.

Management and other employees should co-operate to comply with the enterprise's safety policy and meet its safety goals.

Management and labour have different but complementary roles and responsibilities in the prevention of chemical accidents by carrying out their jobs in a safe manner, by contributing actively to the development and implementation of safety policies and practices, and by co-operating with each other and with other stakeholders.

Labour and their representatives should co-operate with management in promoting chemical safety and should be provided with effective means (structures and processes) to do so.

Co-ordinate the safety policy with activities relating to occupational safety, health and environmental protection

The objectives of the safety policy should be reviewed with respect to other safety, health and environment policies and potential conflicts should be resolved.

In the same way, management should co-ordinate the safety policy with their sustainable development goals. It should be recognised that it is not possible to have sustainable development without a high standard of safety, health and environmental protection.

Communicate the safety policy

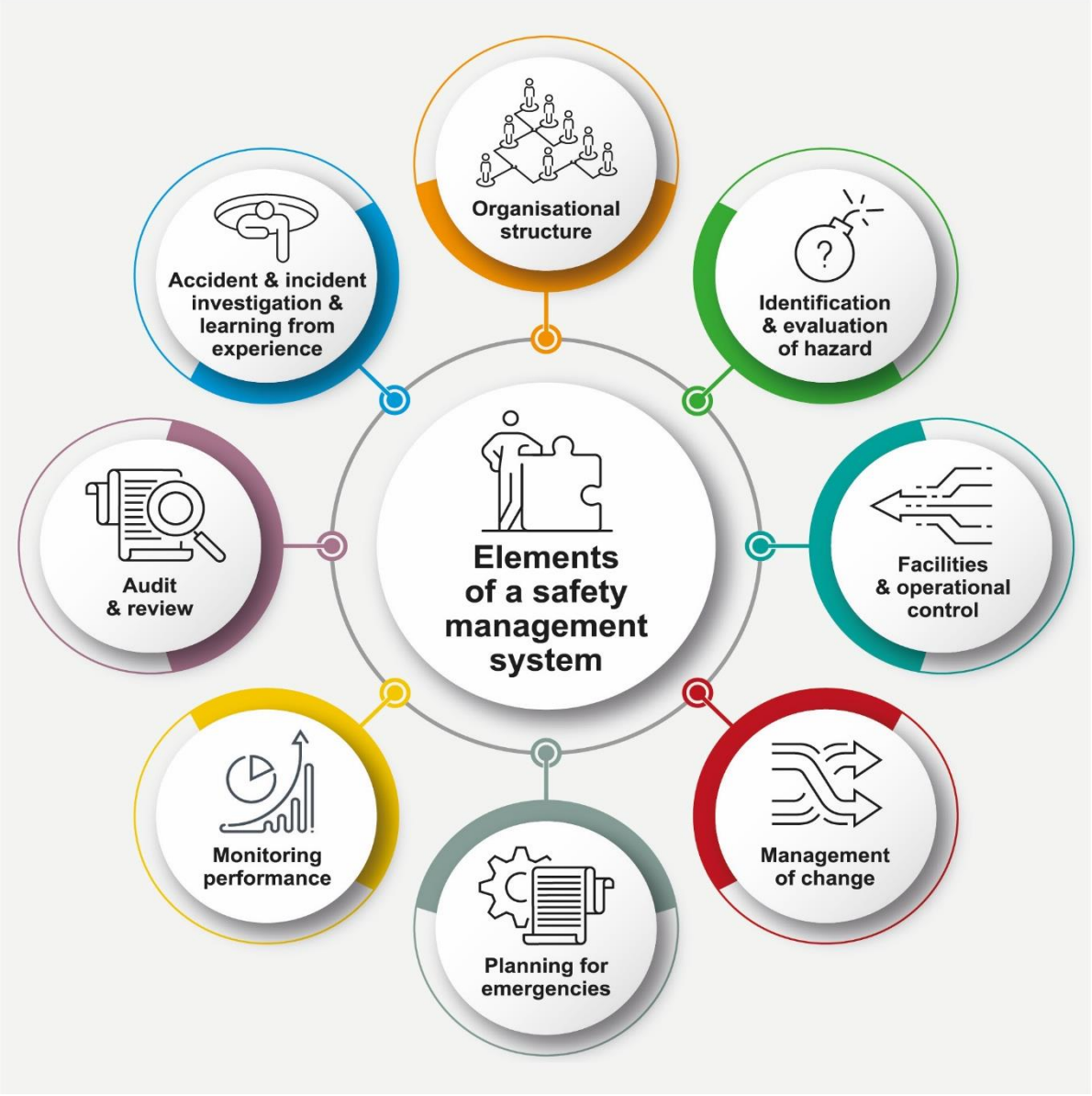
The safety policy should be widely communicated throughout the enterprise. Management should strive to ensure that the intent of the policy is understood and appreciated by all employees throughout the enterprise.

The safety policy should be made accessible to the public.

Establish and maintain a safety management system

The safety management system is a set of activities that ensures that hazards are effectively identified, understood and minimised to a tolerable level. The safety management system establishes objectives to facilitate ongoing understanding and awareness of the risk associated with the presence of hazardous substances and the selection of "lines of defence" at all levels of the organisation.

Figure 2.2. Main elements of a safety management system



Management should establish a safety management system (as a fully integrated part of its general management system) that addresses chemical accident prevention, preparedness and response. An effective safety management system is good business practice.

The safety management system should include the organisational structure, practices, procedures and resources for implementing the safety policy.

The safety management system should reflect the safety culture of the enterprise and there should be a commitment to the system from the highest level of the enterprise.

There should also be a commitment from all employees, from frontline operatives to senior employees, to the safety management system. The enterprise should involve employees and their representatives in the development of the safety management system so that they can develop a sense of ownership and trust in the system.

Adequate resources and personnel should be allocated for the implementation of the safety management system. There should be a clear allocation of responsibilities for each element.

> *"Effectively managing for health and safety is not just about having a management or safety management system. The success of whatever process or system is in place still hinges on the attitudes and behaviours of people in the organization." (UK HSE, 2013[6])*

Leading performance indicators should be used as one way to measure safety and determine whether actions being taken are leading to reduced risk. Such indicators could help to focus audits and inspections on areas with the highest priority.

Efforts can be made towards the integrated management of safety, health and environment (SHE) throughout the regular business operations of an enterprise. The integration of management systems for SHE issues and the development of enterprise-wide procedures applicable to all sites lead to improvements in safety.

The safety management system should address at least the following areas (see Figure 2.2):

- **Organisational structure**: including the roles, responsibilities, education, training, qualifications and inter-relationship of individuals, as well as contracted organisations and personnel, involved in work affecting safety.
- **Identification of hazards and evaluation of risks**: developing and implementing formal procedures to systematically identify hazards and evaluate them – including their likelihood and severity – arising from, for example:
  - Normal and abnormal operations.
  - Substances handling, production, transportation, storage, or disposal.
  - The location and surroundings of the site and other external factors of the site, in particular, the impact of natural hazards that may result in Natural Hazard Triggered Technological Accidents (Natech) (see Box 2.2).

Hazard refers to an inherent property of a substance, agent, source of energy or situation having the potential to cause undesirable consequences.

Risk means the likelihood of a specific effect occurring within a specified period or in specified circumstances.

- **Facilities and operational control**: addressing design and construction, as well as the procedures for safe operation, including maintenance of plant, processes, equipment and temporary stoppages, taking account of ageing.
- **Management of change**: planning and controlling changes, including temporary changes, in: organisation, personnel, ownership, installation, processes, including pre-start-up reviews, maintenance and decommissioning, materials, equipment, procedures, software, design and external circumstances that are capable of affecting safety.
- **Planning for emergencies**: related to developing, adopting, implementing, reviewing, testing and, when appropriate, revising and updating emergency plans.
- **Monitoring performance**: concerning the ongoing assessment of compliance with the safety policy and safety management system, and mechanisms for taking corrective action in the event of non-compliance.
- **Audit and review**: addressing the periodic, systematic assessment of the safety policy and effectiveness and suitability of the safety management system.
- **Chemical accident investigation and learning from experience**.

Box 2.2. Natech – Natural Hazard Triggered Technological Accidents

Natural hazards, such as earthquakes, floods or storms, can initiate events which may challenge the safety and operation of hazardous installations and trigger an accident. Those accidents are referred to as Natural Hazard Triggered Technological Accidents or Natech.

Most of the installations that process, store or handle hazardous substances can, in principle, be vulnerable to the impact of natural hazards. Many past natural disasters have caused major damage to installations resulting in loss of life, health effects, environmental pollution and economic losses.

Data and projections show that the frequency and intensity of natural hazards linked to climate change will increase in the decades to come and some may occur at locations where they have never been observed before. Coupled with a growing human expansion (industrialisation, urbanisation), integration of climate change risks and uncertainties into Natech risk management is essential to the prevention of, preparedness for and response to Natech accidents.

The collection and analysis of data from past Natech accidents have shown that lightning, flood and low temperature are the three most common triggers of Natech events. Other natural hazards have caused Natech accidents. For instance, loss of containment during earthquakes is very common and flammable releases are likely to ignite, often causing high-severity accidents.

Since 2008, the OECD Programme on Chemical Accidents investigates the specificities of Natech for the prevention of, preparedness for and response to chemical accidents, and supports the exchange of experience across countries (e.g. good practices, lessons learnt from accidents). Specific guidance for Natech risk management has been developed (https://www.oecd.org/chemicalsafety/chemical-accidents/).

Review and evaluate the safety management performance

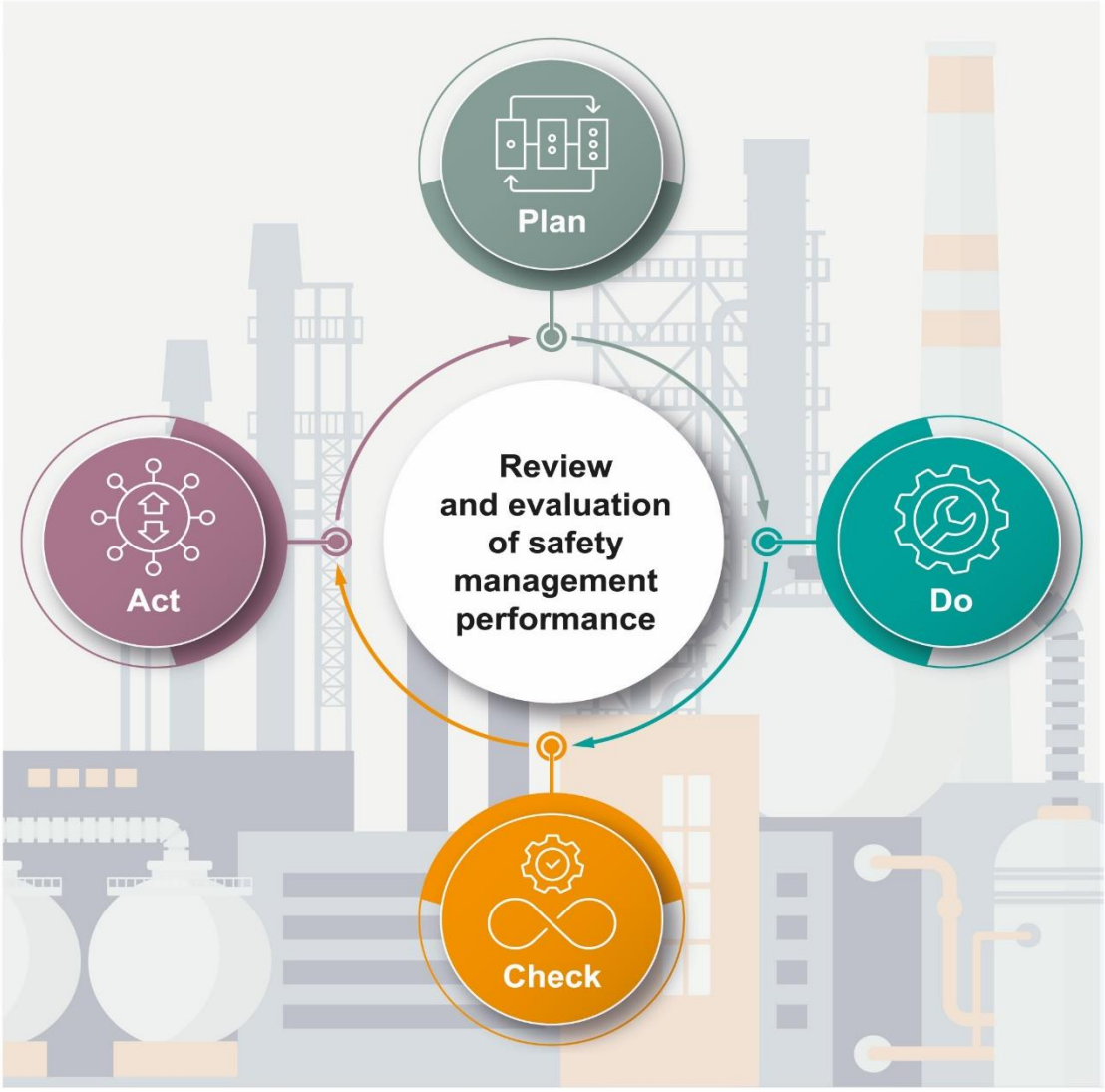
All enterprises should establish monitoring programmes, consisting of several levels of audits, to check various technical and management systems within an installation. Such monitoring programmes allow management to review their operations to ensure that no previously unrecognised risks have been introduced and that there is the required degree of compliance with relevant national and international legislation, standards, codes and guidance, as well as with the enterprise's own requirements and

guidance. In addition to identifying any deficiencies or potential problems in the installation, the audit should also recognise successful actions, learning experiences and improvements made with respect to safety.

All monitoring should be defined in terms of a "feedback" loop (i.e. plan, do, check, act), designed to achieve continuous improvement. The key elements in monitoring programmes (Figure 2.3) to support the continuous improvement of safety performance are:

- Establish monitoring programmes (Plan).
- Define monitoring programmes to achieve continuous improvement (Do).
- Use audits as an effective tool in the review and evaluation of safety management performance (Check).
- Implement and share results of audits (Act).

Figure 2.3. Key elements in monitoring programmes



*Plan – **Establish monitoring programmes** (developing a monitoring plan)*

Monitoring activities by industry should include:

- Continuous assessment of environmental, health and safety management.
- Self-assessment by the facility.
- Corporate audits of the facility.
- Third-party audits/inspections.

Systematic approach with a monitoring plan that includes:

- Regular reviews for each installation.
- Involvement of labour and their representatives.
- Periodic detailed checks on specific activities and procedures.
- Overall audit of performance.
- Annual safety assurance reports from different leaders in the hierarchy.
- Monitoring of aspects that are vital for the particular installation.
- General aspects to be covered in all monitoring: organisation and management, training, plant integrity, fire protection and prevention, accidents and incidents investigation and reporting, emergency procedures.

Do – Define monitoring programmes to achieve continuous improvement

- Clearly defined goals.
- Identified scope.
- Schedule (plan of action with timeframes).
- Experts trained and qualified for the specific tasks and goals.
- Reviews of appropriate documentation, interview with key personnel.
- Identification of deficiencies and proper practices.
- Formal report of findings.
- Management review to define responsibilities and timescale for follow-up actions to ensure that they are carried out.
- Demonstration that the follow-up actions have been carried out.

Check – Use audits as an effective tool in the review and evaluation of safety management performance

The term audit is used to describe different types of self-assessment activities carried out within a company. An audit can be a tool for evaluating safety programmes, strategies and practices within an organisation. It is therefore a good methodology for the review and evaluation of safety management performance. The following offer relevant keywords for how audits can be performed:

- Audit can be performed at a plant level.
- Audit can be performed at the corporate level.
- Follow-up of audits is crucial for lessons learning.
- Audit can be an element of the safety management system.
- Audits can be a basis for reviewing the adequacy of the safety management system.
- The use of a third party to conduct audits might be relevant.

- Audits include interview with key employees, labour and management.
- An audit team should be established for each audit activity.
- Audit team members should have practical experience and be well-trained.

Act – Implement and share results of audits

- A plan for follow-up actions and how these have been implemented.
- Creating a system for improving the exchange of information and experiences among installations within an enterprise and between enterprises.
- Transparency in the conduct of audits is a good way of building trust within and outside the organisation. This will help the public to better understand the nature of risk and the risks posed by the hazardous installation.
- Making information publicly available on the relevant policies, monitoring programmes and outcomes from audits.
- Inclusion of community representatives in audits.
- Share experience on audits and inspections within the country and internationally.

Management of change

> *"The management of change (MOC) is a review and authorization process for evaluating proposed adjustments to plant design, operations, organization or activities prior to implementation, to make certain that no unforeseen new hazards are introduced and that the risk of existing hazards to personnel, the public, or the environment is not unknowingly increased. It also includes steps to help ensure that potentially affected personnel are notified of the change and that pertinent documents, such as procedures, process safety knowledge, training programs, are kept up–to-date. The design and authorisation procedures of changes should involve all departments and units concerned as well as other specialised employees involved in the operations, such as maintenance, health and safety". (EC, 2017[7])*

The MOC over the life of a hazardous installation is one of the basic elements in an effective safety management system. Even installations that have management of change procedures can be vulnerable to chemical accidents if the management of the change process is incomplete or not systematically applied to all changes.

There are four types of changes that are described in this section:

- Intentional changes (modifications).
- Unintentional/incremental changes.
- Organisational change, including change of ownership.
- Changes in the vicinity of a site (related to land-use planning).

Studies from past accidents, (e.g. Flixborough, United Kingdom, 1974, BP, Texas City, United States, 2005, as well as many less well-known accidents) clearly show that a vast portion of chemical accidents have resulted from a failure to screen or analyse the impacts of a proposed change on risk, whether temporary or permanent.

Intentional changes (modifications)

Establish formal procedures to ensure that no modification compromises safety

Management of a hazardous installation should establish formal procedures to ensure that no modifications to plant, equipment, processes, software (including automated controls), facilities or procedures compromise safety.

Modification procedures should apply to both permanent and temporary changes and should be based on appropriate up-to-date process documentation and, where appropriate, a physical inspection of the installation.

All proposals to make modifications to a hazardous installation should be recorded, documented and assessed so that the necessary hazard analyses and risk assessments are carried out, the appropriate design changes are made and the modifications are properly engineered and recorded.

- Proposals for significant modifications should be reviewed by competent technicians who are independent of those directly responsible for the proposals.
- The level of management approval necessary for a modification should be based on the associated level of risk.
- Supervisors having the authority to make a modification (for example, to change a manufacturing procedure or operating instruction) should be fully aware of the hazards involved and should consult the relevant competent specialist(s) before initiating such a change.
- Major modifications should be subject to the same notification and reporting requirements to public authorities as new installations.

Review hazard analysis in the event changes are made to a process that could affect safety

In cases where changes made to a process could affect safety – for example, use of different process materials, alterations of conditions, increase in batch size or use of larger/different equipment – the original risk assessment should be reviewed and the documentation supplemented accordingly.

Make aware all employees, including contractors when relevant, of any modification to the installation

All relevant employees should be aware of any modifications to the installation. Any significant modifications to the plant, processes, facilities, personnel, software or other aspects that might affect safety should trigger a review of training and education practices to determine whether additional training and education are needed.

Contractors involved in any modifications should be subject to the same procedures, including the same requirements for registration, reporting and assessment, as an employee of the installation. Procedures should be in place to ensure that contractors involved in modifications inform the management of any safety-related concerns.

Ensure procedures are in place for the start-up of a plant after modification of the plant, equipment or software

Procedures should be in place for the start-up of an installation after modification, repair and/or overhaul of a plant, equipment or software. These procedures should require test runs and safety checks to be carried out to ensure the integrity of the installation. Test runs should be conducted in the presence of a manager responsible for the operation of the installation. The manager should be required to formally approve the restarting of operations.

Unintentional/incremental changes

It should be recognised that the sum of minor changes can be equivalent to a major change. Minor changes may be unintended results of alterations elsewhere in the process.

Techniques should be developed to assess how a series of minor changes in the installation, taken together, could affect safety and what could be done to mitigate any increased potential for chemical accidents.

Organisational change, including change of ownership

Procedures should exist to ensure that changes in management, labour and organisation do not compromise safety (including, for example, changes in corporate structure or financing, downsizing of staff and outsourcing of certain activities). Such changes should trigger review procedures to ensure safety has not been adversely affected (see Box 2.3).

Ensure safety is a priority when a company undergoes a reorganisation or significant personnel changes

When a company undergoes a reorganisation or significant personnel changes, the management of safety should be a priority.

- Procedures should exist to ensure that changes in management, labour and organisation do not compromise safety (including, for example, changes in corporate structure or financing, downsizing of staff and outsourcing of certain production activities). Such changes should trigger review procedures to ensure safety has not been adversely affected.
- It is important to manage any reorganisation or significant personnel changes with respect to its impact on the corporate safety culture.

Box 2.3. Organisational change

The organisation is the structure within which individuals and groups of people interact with each other. The organisation defines hierarchies, fields of responsibility and activity. This means that changes in the organisation are changes in hierarchies, responsibilities and activities. Such changes can have an impact on the safety of facilities that handle hazardous substances. Examples of organisational changes that can have a significant impact are as follows:

- **Change of ownership**

  New owners may have a different safety culture, different levels of knowledge and competency with respect to safety and the prevention of and preparedness for chemical accidents. They are also likely to have different organisational structures and a different distribution of responsibilities.

- **Outsourcing and reduction of internal capacities**

  If maintenance activities or the engineering department are externalised, i.e. moved off site away from the installations or, more extreme, are outsourced and become a separate company then this can have a significant impact on chemical accident prevention and preparedness. Interventions that have to be requested have a hidden hurdle; this hurdle is greater when explicit costs are involved. Such costs may be internal charging mechanisms or external contracts. If changes in access to knowledge and expertise are made, then management must be aware of the potential consequences and the need for compensation. The explosion at the Esso Gas

Plant in Longford, Victoria (Australia) on 25 September 1998 is a case where organisational change was a significant contributor to the event.

- **Restructuring of safety responsibilities**

  There are two common forms of organisation for safety responsibilities. One is to have a centralised safety department in which expertise is built up and made available to the facilities and operating plant as they require it. This may also entail carrying out periodic safety audits and checks to ensure compliance with corporate standards and expectations. The second form is to have decentralised responsibility for safety, where each facility or plant is responsible for its own safety-related activities. Each form has advantages and disadvantages. Where centralised forms can build expertise, they may not be as aware of the individual requirements, cultures and situations on site. Decentralised forms can take account of local needs but not be as able to build up expertise in some areas of special knowledge.

  Any changes in organisational structures related to roles and responsibilities should take into account the impact on specialist expertise and local requirements. Often, reorganisations lead to personnel-related consequences (relocation, redundancy, retirement). Management must be aware of the consequences of what losing particular employees may mean to the level of safety within the organisation.

- **Shift patterns**

  Many facilities use shift work to enable operations to run for a maximum number of hours. The reasons for this may be economic, i.e. the more hours of operation, the more product can be manufactured. The reasons may be the result of the process: a continual process such as in a petroleum refinery or a power plant has to be run 24 hours a day and cannot be shut down at the end of a working day. There are a number of different shift patterns which are implemented in the process industries and these regulate who works when, how shifts move through cycles to ensure that people work at different times of day and also have recuperation time. Any change to the staffing levels, numbers of shifts, length of shifts, recovery times and shift make-up (which trades and professions work which shifts) are organisational changes. Management needs to be aware of what changes in shift patterns can mean for the safe operation of the plant.

Organisational change is a special case of management of change. The consequences of any organisational change, however superficial it may seem, must be investigated and the risks to chemical accident prevention and preparedness assessed.

Source: Dawson, D. and J. Brian (1999[8]), *The Esso Longford Gas Plant Accident*, http://www.parliament.vic.gov.au/papers/govpub/VPARL1998-99No61.pdf; Hopkins, A. (2000[9]), *Lessons from Longford: The Esso Gas Plant Explosion*, CCH Australia Limited.

Ensure safety is a priority when an installation goes through a change of ownership

Ownership change transactions are very common in hazardous installations and can potentially affect the safety management of an installation. If not handled well, the effects of a change of ownership can be severe and significant, creating uncertainty in the companies involved and leading to an increase in occupational, process safety, environmental and chemical accident risks.

In particular, when an installation is going through a change of ownership, the management of safety should be a priority for all:

- Stakeholders involved in an ownership change should be able to identify, understand and minimise the risks before, during and after a change of ownership at a hazardous installation.

- The current owner of an installation should know the information and documentation necessary to be provided to the prospective new owner to support the evaluation of the safety status of the installation. The prospective new owner should know what documentation to ask for throughout the process.

Prior to the acquisition of or investment in an existing or planned hazardous installation, an enterprise should carry out a hazard evaluation to determine the nature and level of hazards at the installation. The enterprise should also determine the requirements for operating the installation in conformity with its own standards.

- The "seller" of an existing installation should be responsible for disclosing all known or suspected safety problems associated with the installation involved.
- The "purchaser" also has a responsibility to ensure that disclosure is complete and that the necessary actions have been taken to ensure safe operation following the takeover.

All relevant corporate safety policies and guidelines for chemical accident prevention, preparedness and response should be applicable to acquisitions.

- Following an assessment, when an enterprise acquiring an existing installation concludes that the installation does not meet the standards of the enterprise or internationally accepted safety levels, the installation should be brought up to such safety levels within a reasonable period of time.
- In cases where retrofitting cannot be accomplished to meet these levels, the investing enterprise should, in a timely manner, inform the public authorities, employees and employee representatives of the situation and their intended plans.

Stakeholders can refer to the OECD Guidance on Change of Ownership in Hazardous Facilities (2018[10]) for more information on key aspects to take into account during a change of ownership (see Box 2.4).

Box 2.4. OECD Guidance on Change of Ownership in Hazardous Facilities

The OECD Guidance on Change of Ownership in Hazardous Facilities (2018[10]) is a concise document providing a framework to assist stakeholders in identifying, understanding and minimising the risks during and after a change of ownership at a hazardous facility and help make the change of ownership a better-informed process.

The guidance provides:

- A list of risk drivers prior to, during and after the change of ownership.
- A set of self-assessment questions for the original owner and prospective owner so that they can evaluate how well their organisation is managing the ownership change.
- A "template for transparency" as a structured approach to carrying our technical due diligence with a list of documents and information which those selling a facility should be expected to provide.
- A list of factors for the regulators to consider before, during and after the change of ownership.

Source: OECD (2018[10]), *Guidance on Change of Ownership in Hazardous Facilities*, OECD, Paris.

Changes in the vicinity of a site (also related to land-use planning)

Changes in the vicinity of a site include the construction of new buildings and infrastructure. It also covers the change in the use of existing buildings. These changes may lead to increased or new risks to the

installation from outside the site, it may also lead to an increase in vulnerable people, assets or environmental resources that may be affected by a chemical accident.

Operators should be aware of existing activities in the vicinity of their installation and ensure that they receive information and are involved in consultations on changes in the vicinity at the planning stage.

Risk assessment and safety reports

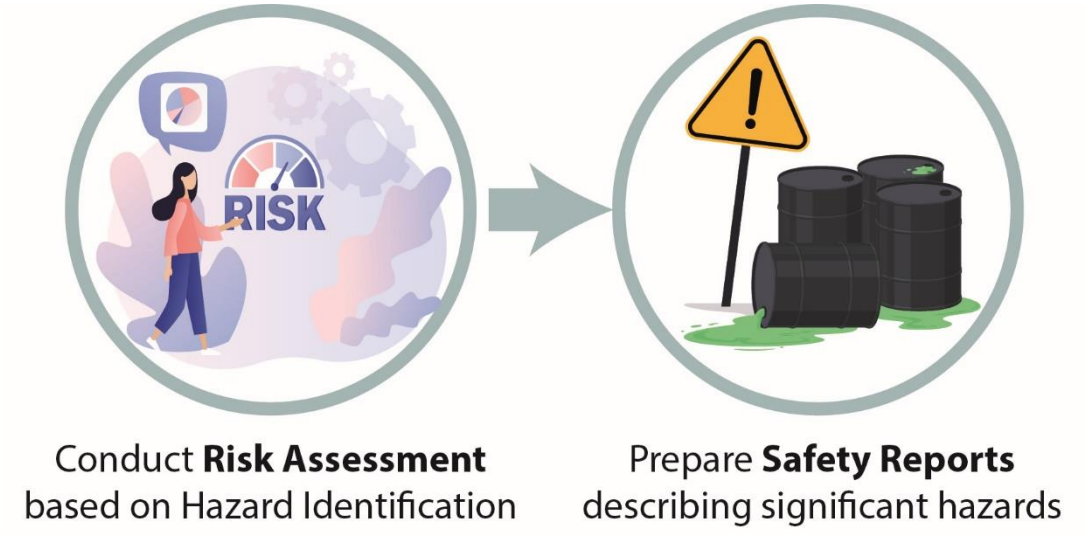
> *"Risk assessment is a tool used in risk management to help understand risks and inform the selection and prioritisation of prevention and control strategies. It consists of a number of sequential steps, including hazard identification; event scenario assessment; consequence assessment; likelihood assessment; and risk integration and comparison." (ISO, 2019[11])*

With risk assessment, risks can be ranked on a relative scale and technical/organisational/policy options can be evaluated. Risk assessment also provides information to policy makers to help them develop risk acceptability or tolerability criteria against which different objectives or programmes can be assessed.

When there is a national requirement for safety reports, these should be directly linked to risk assessment. Safety reports are a documented demonstration that the hazardous installations are designed, constructed and operated in a safe manner, that the hazards related to the location, process plant and hazardous substances have been identified and that their risks are managed appropriately. In addition, it should be demonstrated that a safety policy and safety management system have been put in place in view of the assessed risks. Safety reports can be used to demonstrate and communicate that hazards associated with an establishment have been systematically identified and that their risks are adequately controlled, leading to suitable chemical accident prevention, preparedness and response. Safety reports do not usually contain detailed information related to the risks of malicious acts. This detailed information is usually to be found in a Security and Vulnerability Analysis (SVA) or additionally in a cyber security analysis, for example, according to ISO 27001 or other national or international standards. These are separate documents that need to be treated with confidentiality.

This section will provide more information on how to conduct a risk assessment based on thorough hazard identification and the preparation of safety reports (see Figure 2.4).

Figure 2.4. Risk assessment and safety report



Conduct risk assessment based on thorough hazard identification

Conduct a hazard identification taking into account the diverse risks at an installation

Management should undertake a risk assessment in a systematic way for all hazardous installations, starting with a hazard identification process that follows a fixed predetermined scope, identifying and assessing every possible hazard within that scope.[1] All types of hazards (e.g. technical hazards, human factors, natural hazards) able to cause accidents should be considered. It is the first and a critical step in the risk assessment process – the quality of its results depends on the accuracy and reliability of the hazard identification.

Risk assessments and risk management decisions should take into account the full range of risks at a hazardous installation, as well as the multidisciplinary nature of risks. It is important to recognise that some sites have complex technical, organisational and/or social issues that should be addressed (such as staff shift patterns and language differences among employees).

The possibility of human errors and technological failures, as well as the possibility of natural hazards and/or malicious acts triggering a chemical accident, should be taken into consideration when deciding what accident scenarios should be included in the risk assessment process.

A scenario is always an undesirable event or a sequence of such events characterised by the loss of containment or the loss of physical integrity and the immediate or delayed consequences of this occurrence.

Risk assessments should take into account the possibility of “domino effects” between hazardous installations, and between transport systems and fixed installations.

Take into account all consequences, including environmental and health

Risk assessments related to hazardous installations should take into account all possible consequences, including possible health and environmental consequences.

When death/health consequences are the only quantified parameters in the risk assessment process and the non-quantifiable parameters are not considered, the process may result in misleading or otherwise inadequate conclusions. The non-quantifiable parameters can often be assessed in a qualitative manner and give further insights into other risks of the chemical accident. This will lead to improved decision making.

Assessing environmental consequences is complex due in part to the large number of receptors and pathways. Management and public authorities should work toward improving the quality of the assessment of environmental consequences through co-operation and exchange of experience.

Often, substances that are not expected by themselves to be hazardous to the environment can, in combination with other substances and/or factors, create significant hazards or there can be synergistic effects involving small quantities of chemicals causing significant impacts.

Consider various approaches and methods to conduct a risk assessment

When undertaking a risk assessment, management should carefully consider the various possible approaches and methods available. They should choose an approach/method that is appropriate for the particular circumstances since all approaches/methods have strengths and weaknesses and none are perfect.[2] The choice of a particular approach/method should be governed by a number of factors, including:

- The objective/purpose of the risk assessment.
- The estimated extent and nature of the risks (including the possibilities of malicious acts or accidents resulting from natural hazards or disasters).
- The availability and adequacy of data.
- The expertise and resources needed for a particular approach/method, and their availability.
- The history of accidents at the installation and other related installations.
- Unavoidable constraints on the process.
- The socio-political context in which the assessment will be carried out.
- The assumptions on which the approach/method is based.

Risk assessments should be accompanied by information concerning the assumptions, data limitations and uncertainties imbedded in risk assessment approaches/methods, as well as in decision-making processes so that the results of risk assessments can be appropriately utilised:

- It is important to address possible data limitations and inappropriate selection of data in order for the results of the assessments to be reliable and comprehensive.
- There may be gaps and inadequacies in the data available on, for example, equipment failure rates and modes, human error predictions, long-term or delayed health effects of acute exposures, the likelihood and extent of natural hazards, and the effects of chemicals on the environment.
- Data limitations can be managed, in part, through the use of less detailed, more generic approaches/methods, or the use of comparative assessments to aid in choosing among alternative options. The use of comparative assessments normally involves similar assumptions, limitations and uncertainties and therefore their effect on the assessment results is dissipated.

Ensure transparency in the risk assessment process

All parties should strive for transparency in the assessment process, to permit better communications and understanding and to allow for comparisons.

For assumptions that cannot be eliminated, it is advisable to seek consensus with all parties involved in the decision-making process. Failure to do this can lead to a lack of credibility and support for the assessment.

Any efforts towards improving consistency and communication concerning risks should take into account the various methods used by different countries and organisations.[3]

A shared understanding of the concepts that underpin risk assessment is important, particularly where the people who assess risks and the people who make risk management decisions are different.

The decisions that are influenced by risk assessments may be of fundamental importance to employees (including long-term and regular contract employees), the public potentially affected in the event of an accident and emergency response personnel for example.

Review and reassess risk periodically and document risk management decisions

Risk assessment should be a continuous and evolving process. Assessments should be reviewed and reassessed periodically and when there are indications that a revision may be needed.

A risk assessment may need to be revisited when there are changes, new findings or other particular circumstances, for example, when:

- There are new or changed substances, processes or equipment at hazardous installations, or significant changes in transport of hazardous substances, or significant increase in inventory.
- Accidents occur
- New technology offers scope for improvements.
- Perception of labour and management conflicts with the outcome of the risk assessment.
- New information about the behaviour or effects of substances, which may lead to a new hazard classification and processes, becomes available.
- New information about the potential for natural hazards or disasters that could trigger a chemical accident becomes available.
- There are proposals for new construction or other developments inside the premises of the installation or nearby.
- Risk assessments should be reviewed routinely to test assumptions, try to resolve uncertainties and take advantage of experience and improvements in methods.

Risk management decisions should be well documented. This is important for a number of reasons: for example, documentation helps to support further decision making, comply with legal requirements, understand what went wrong when an accident occurs, assist with enforcement and facilitate communications.

Exchange experience in risk assessment with other enterprises and industrial organisations

Enterprises and industrial organisations, in particular nearby industries, should exchange information concerning risk assessment methods and outcomes so that competency in the use of risk assessment approaches/methods is enhanced. Such information exchange can also be used to facilitate training to increase the expertise available.

Prepare safety reports describing significant hazards at installations

Within the process of preparing a safety report, operators should systematically identify all possible significant accident hazards and be able to demonstrate that they have sufficiently controlled the risk.

Management of hazardous installations should prepare reports describing the significant chemical hazards at these installations and demonstrating that appropriate steps have been taken to prevent chemical accidents and to limit their consequences.[4]

The extent of the safety report should be proportional to the extent of potential consequences and the complexity of the installation/process/systems involved.

- One of the main elements of the safety report is the definition of reference accident scenarios. These scenarios are normally the basis for demonstrating that the necessary measures are adequate. For this purpose, the description of the scenarios should be structured and evidence provided to highlight the consistency between the scenario selected and the measures taken.
- The safety report should be of a summarising character, in which the information provided is limited to its relevance in regard to chemical accident hazards. However, the information should be sufficient to demonstrate that the requirements with regard to chemical accident hazards have been met and allow the competent authority to come to justified conclusions.
- The description of measures should be limited to the explanation of their specific objectives and functions. Specific technical details should be provided within the safety report when this is necessary to demonstrate that the measures are sufficient, i.e. the measures have the required reliability and effectiveness.
- Other areas of safety legislation may have an impact on the scope of the assessment.

The reports should be reviewed regularly and updated, as appropriate. They should include a description of, or a reference to, documents addressing:

- The identification of installations and other activities of the establishment that could present a major accident hazard. The installations of an establishment to be submitted to a detailed risk analysis should be selected through a screening method such as a preliminary hazard analysis. The selection may flow through the use of index methods or threshold criteria for hazardous substances or other suitable methods. Those installations that have not been selected will not be considered an essential element of the safety report. For this reason, this part of the analysis is particularly sensitive in terms of the safety report study.
- The installation or establishment, including its purpose, activities, processes, layout, intrinsic hazards, personnel, services and technical equipment.
- Inventory of hazardous substances (physical, chemical, toxicological characteristics and an indication of the hazards, both immediate and delayed for humans and the environment).
- The area surrounding the installation, including a description of the establishment, sensitive environments, the population and activities in the area of the establishment (including commercial, residential and industrial activities) and general geological context, including type and conditions of the ground/underground.
- Natural hazards in the area which are potential triggers for Natech, such as those related to extreme temperatures, high winds, floods, storms, earthquakes and wildfires with relevant descriptive data such as average and maximum precipitation levels, thunderstorm severity, lightning probability, indices or values on humidity, fog, frost and winds, stability classes, maximum and minimum recorded temperatures.
- Hazard identification and risk assessment of the installation.

- An outline description of the procedures for safe operation in all process stages for the installations identified in the report as hazardous, together with the appropriate maintenance programme.
- The onsite emergency plan, including the relationship with offsite plans and communication and co-ordination with emergency response personnel.
- The corporate safety policy.
- The enterprise's safety management system.
- The procedures for reporting incidents and learning from accidents and near misses.

The safety report does not need to contain detailed information on structural characteristics and other design data of the storage or process installation handling the dangerous substances, only summarising descriptions.

The demonstration in the safety report must be "convincing". This means that the rationale for deciding the completeness of hazard identification and the adequacy of the measures employed should be supported and accompanied by all assumptions made and conclusions drawn.

The safety report should provide evidence that the process in its preparation was systematic which means that it followed a fixed and pre-established scope.

Safety reports should be submitted for review by public authorities.

Siting, design and construction

In making planning decisions about siting new hazardous installations, significant modifications to existing ones or the development of land around a site, safety is a critical element to be considered by industry, which should follow a number of requirements.

The design stage has a critical role to play in ensuring safety throughout the lifespan of a hazardous installation. It should help reduce maximum risks during the operation of an installation. A hazardous installation should be "smart" and "safe" by design. Design can be the design of an entire installation, only part of it and also includes redesign or modification to an existing design.

Construction is also a stage bringing particular risks. A plan should be developed to ensure that risks at each stage from the beginning to the end of construction have been identified and a strategy to manage them defined, which should be effectively communicated to those involved.

Siting

Use land-use planning and zoning requirements and guidance when choosing sites for new hazardous installations

Management of an enterprise, when choosing possible sites for new hazardous installations, should comply with land-use planning and zoning requirements and guidance. Management should:

- Seek sites which would minimise the adverse effects to health, the environment and property in the event of an accident at the installation or as a result of transport of hazardous substances to and from the installation. For large sites, the same should be considered for the location of new installations on the site.
- Take into account neighbouring activities including technical hazards (risks linked to technical activities around the site) and the risk of domino effects.

- Take into account the risks posed by natural hazards when considering possible sites.

Management and public authorities (in particular, those responsible for land-use planning decisions) should co-operate in order that hazardous installations are located and built so as to minimise the risks to human health, the environment and property.

Develop maps and plans to scale in case of construction of a new installation or significant modification to an existing one

Management of an enterprise proposing to construct a new hazardous installation or make a significant modification to an existing installation should develop maps and plans to scale of the proposed development. They should reflect information made available by public authorities and should show:

- The locations and quantities of the hazardous substances present on site relative to the surrounding area.
- Areas that may be affected by natural hazards, for example flooding zones.
- Technological activities such as industrial activities and major transports.
- Recreational areas.
- The nature of land use in adjacent areas.
- The local population, in particular centres of higher density, and local areas of environmental significance.
- The potential offsite effects posed by their proposal.
- For the location of an installation close to regional or national borders, that the situation beyond those borders has been considered.

Management should describe details of the processes which will involve hazardous substances, the inventory of hazardous substances to be stored, the conditions under which the hazardous substances are to be handled and the risks associated with possible sites (including risks of accidents resulting from natural hazards/disasters or malicious acts).

Management should develop an assessment of the consequences for human health and the environment from the proposed installation. These assessments should be carried out in conjunction with local authorities and the public as early as possible in the process of planning for the installation so as to facilitate siting decisions and consideration of cost-effective alternatives.

The maps and plans, related information and assessment should then be provided to the appropriate authority.

Reduce risks and resolve land-use planning conflicts associated with hazardous installations

Management of hazardous installations and public authorities should make themselves aware of the risks of chemical accidents in the context of the existing land-use planning situation. The public authorities responsible in the land-use planning and construction permitting processes may not be the same authorities that oversee the permitting and operation of the hazardous installations. Therefore, it is very important to ensure that all relevant authorities are involved.

Management and public authorities should elaborate and adopt measures at existing sites so that they achieve, as far as practicable, a reduction of risks to an acceptable level and fulfil the requirements of current land-use planning and zoning laws and guidance.

Management and public authorities should work with other stakeholders in the community to ensure that inappropriate developments of residential areas and other vulnerable uses do not take place in areas potentially exposed to significant chemical accident risks.

Design

Integrate "inherently safer" technology, equipment, facilities and engineering procedures at the design stage

Safety measures should be incorporated at the earliest conceptual and engineering design stages of an installation to enhance its inherent safety wherever practicable.

The terms "inherent safety" or "inherently safer" when used in connection with hazardous installations should not be read to imply that there is no residual risk. The facility will be designed to be safe but there are hazards that will still remain. The need for "traditional" safety equipment such as a blowdown system and stoppers for runaway reactions remains necessary.

The design of a hazardous installation should integrate the appropriate technology, equipment, facilities and engineering procedures that would reduce the risk from hazards as far as is reasonably practicable (i.e. all measures to reduce risk should be taken until the additional expense would be considered to far exceed the resulting increase in safety). The aim is to:

- Use inherently safer technology in the manufacture, transport and use of chemicals (e.g. reducing inventories of hazardous substances, using safer production processes and enhancing secondary containment).
- Use inherently safer processes and installation designs to reduce risk. Inherently safer approaches involve careful selection of the process, along with the good design of the installation (in effect designing out certain hazards, minimising the effects of human error and better tolerating errors which might occur).

The principles of inherently safer design should not be used in isolation but rather as part of an integrated approach to safety (Box 2.5).

Box 2.5. Principles of inherent safety

Inherent safety is based on a set of principles which, when applied reduce the hazards, include:

- **Minimise (intensify)**: Reducing the amount of hazardous substances present at any one time by using smaller batches, reducing the storage of intermediates to the quantities required. However, this should not be misunderstood to mean that bulk storage of fuels should be in small tanks. The transfer operations (coupling and uncoupling of hoses, transportation) are the most hazardous parts of the process.
- **Substitute**: Replacing a hazardous substance with a substance of lesser hazard, e.g. lower toxicity or non-carcinogenic to avoid exposure of the workforce or the public in the event of an accident, higher flammable limits (to avoid explosive atmospheres).
- **Moderate (attenuate)**: Using less hazardous conditions, a less hazardous form of a material or facilities that minimise the impact of a hazardous material or energy.
- **Simplify**: Eliminating problems by design and thus avoiding complexity rather than adding additional equipment to deal with the problems and making operating errors more likely.

In addition to these two further principles are used by some:

- **Error tolerance**: Designing equipment and processes to be sufficiently robust so that they can withstand possible faults or deviations from design, for example, piping and joints being designed for the maximum possible pressure when valves are closed.
- **Limit effects**: By designing the system so that the worst possible condition will be automatically mitigated, for example sloping the concrete surface below a horizontal tank to take flammable liquid away towards a safer place, providing bunds and retention to prevent hazardous liquids spreading to undesired locations.

Source: Edwards, D. et al. (2015[12]), "Inherent safety: It's common sense, now for common practice!", Symposium Series No. 160, Hazards 25, https://www.icheme.org/media/8500/xxv-paper-33.pdf.

Care should be taken to ensure that design choices or modifications do not inadvertently increase or transfer risk. For example, in some cases, reducing inventories of hazardous substances may increase overall risk due to the need for more frequent transport and handling (e.g. loading and unloading) of the substances.

Hazardous installations should be designed to take into consideration the possibilities of human and/or technical errors.

Hazardous installations should also be designed so that exposure of employees to hazardous substances is prevented or minimised, thereby reducing the need for personal protective equipment.

Identify the need for enhanced protective systems and for systems minimising effects

Although emphasis should be on inherent safety in design and operation, the need for enhanced protective systems should be identified using a systematic process, thereby assuring safety through mitigation measures.

- Procedures should be designed to minimise the chance of failure and, should there be a failure, to prevent or minimise adverse effects.
- Systems/mechanisms to contain leaks, spills or firefighting waters (using, for example, containment walls or catch basins) should also be incorporated in the design of hazardous installations, bearing

in mind the quantity of hazardous substances which could be released. Such systems/mechanisms could also include an increased number of barriers to prevent the release of hazardous substances, e.g. double encapsulation.

- If there is a loss of containment, adverse effects may be minimised by other mitigation measures, such as using fire protection equipment and emergency procedures.

Take into account human factors at the design stage

Tests should be used to determine whether the operating design of the installation is feasible and practical (e.g. that it takes into account the limited quantity of information that can be processed by humans under conditions operators might face at the installation). This will help avoid designing a facility that has latent operating errors.

Systems should be designed so that individual component failures will not create unsafe process conditions (i.e. they should be "fail safe") and/or will be capable of accommodating possible human errors.

Involve relevant personnel in the planning and design

Relevant personnel who will be involved in the operation of a hazardous installation should be involved in the planning, design and construction phases of the installation. Employees, and their representatives, should participate in decisions concerning the design of their workplace and should be given the opportunity to provide input in the design, application and improvement of equipment so that employee know-how and experience can be utilised.

Incorporate the most up-to-date national and international standards, codes of practice and guidance to the design of new installations and when operating significant modifications to existing ones

To achieve a high level of safety, the design of new installations and significant modifications of existing installations should incorporate the relevant, most up-to-date national and international standards, codes of practice and guidance, relevant to hazardous installations, which have been established by public authorities, industry and professional associations, and other bodies.

Standards, codes of practice and guidance should take into account process risks associated with technological or process-related accidents as well as risks associated with accidents caused by malicious acts or natural hazards/disasters.

Such standards, codes of practice and guidance should be considered minimum requirements. Improving safety is a dynamic process that should reflect advances in knowledge and technology. Therefore, these should be supplemented by documentation developed from within the enterprise, embodied in inhouse engineering design guides and specifications, as well as based on operational experience and specialist knowledge.

Existing installations should be assessed to determine whether they meet these standards, codes and guidance. Where they do not meet the standards, appropriate improvements should be carried out as soon as practicable.

Incorporate an appropriate level of automated control systems and decision support systems into design

An appropriate level of automated control systems and decision support systems should be incorporated into the design of a hazardous installation.

While automation and decision support systems can increase safety due to rapid diagnosis and response, such systems only address "known" or predicted abnormal events. Events which are not within the design specifications, or which were not predicted, need to be dealt with manually. Thus, the presence of an operator who is well informed and well trained to respond is indispensable.

If the system is automated to the extent that the operator has very limited tasks, the operator may not be sufficiently aware or experienced to handle rare abnormal situations.

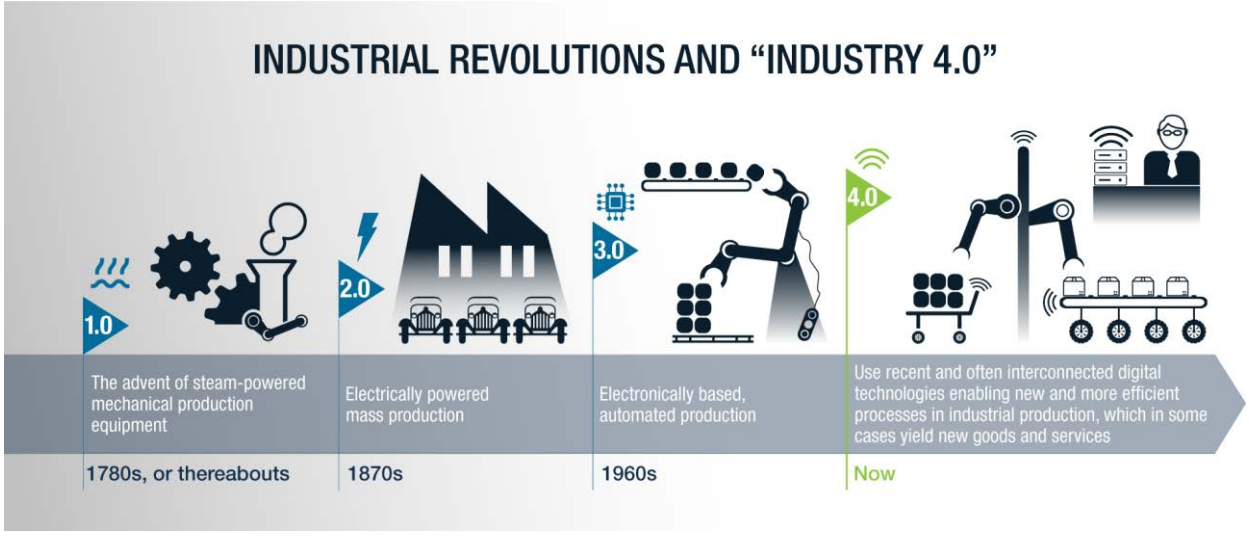
Process control systems are an important component of operating safety. They should:

- Support operators in carrying out their tasks and provide easy and rapid access to operating procedures and related information.
- Be able to capture information useful for determining the root causes of incidents and provide easy and rapid access to documentation on the enterprise, for emergency planning and for training and education.

Safety systems, whether automated or requiring human intervention, should be designed according to criteria[5] and tested so that critical signals get through to the operator (even when there are several simultaneous failures) and so that the systems cannot be overloaded and therefore fail to work (see also the issue of alarm management in Box 2.9).

The use of smart technologies in the design and operation of hazardous installations provides opportunities to enhance safety (Figure 2.5) but brings new challenges such as cyber security (see section on physical and cyber security).

Figure 2.5. Industrial revolutions and "Industry 4.0"



Source: OECD (2017[13]), *The Next Production Revolution: Implications for Governments and Business*, https://doi.org/10.1787/9789264271036-en.

Pay special attention to the site layout with safety goals in mind

In the design phase, management should ensure there is adequate consideration of the site layout guided by overall safety goals. Particular regard should be given to:

- The establishment of safe separation distances to minimise any "knock-on" or "domino" effects[6] either on site, within the boundaries of the installation or off site involving other enterprises.

- The location of hazardous processes and substances relative to the location of personnel and to critical safety-related equipment and instruments.
- The location of hazardous processes and substances in light of natural hazards, in order to minimise the likelihood of an accident in the event of a natural disaster.
- The location of offices, control rooms and other premises so as to minimise the adverse effects on health and increase the ability to maintain control of the installation in the event of an accident.
- Possible effects on the local community and environment.

Design a storage facility or any hazardous installation that stores hazardous substances according to the nature and quantity of hazardous substances

A storage facility, or any hazardous installation that stores hazardous substances including waste, should be designed taking into account the nature and quantity of hazardous substances to be stored in the facility.

- The design of storage facilities should incorporate safety features to minimise the likelihood and extent of a chemical accident. In this regard, the design should allow for the separation of incompatible substances and subdivision of inventories by the use of, for example, separate buildings or fire walls. Furthermore, the facility should be designed in a way that reduces the likelihood of domino effects should an accident occur.
- Particular attention should be given to incorporating automated systems for handling hazardous substances, for example, automated high-rack warehouse systems.
- The design should enable access for inspection of hazardous substances and permit firefighting and effective evacuation. Fire protection equipment should be available and adequate retention facilities (e.g. fire water retention, bunded areas) should be provided to facilitate the activation of spill mitigation procedures.
- Security measures should also be in place, such as fencing and limited access to unauthorised personnel.

Give consideration to special issues, such as the risk of natural events and malicious acts

At the design stage, special consideration should be given to:

- The possibility of malicious acts occurring at an installation.
- Maximising protection of vulnerable parts of the enterprise in order to avoid damage from malicious acts.
- The possibility for natural hazards that could trigger a chemical accident including, for example, extreme temperatures, floods, high winds, wildfires, earthquakes and landslides.

Collate all safety-related information on process and associated equipment

The management of hazardous installations should collate all safety-related information on the process and associated equipment concerning, for example, design, construction, operation, maintenance and emergencies.

- Such a file or dossier is essential for training, as well as operational purposes.
- The file or dossier is also needed for developing safety reports, which may be required by public authorities and for inspections/control by public authorities.
- The operating concept/procedures should document the safety features incorporated in the design (including automated safety systems) as well as the role of operators, managers, maintenance staff and others.

In addition, this process documentation file or plant dossier should include information concerning:

- Manufacturing procedures.
- Process and operating instructions (including safe start-up and shutdown).
- Line diagrams of process flow showing key equipment.
- Quantities and properties of substances produced, stored or handled on site.
- Results of safety tests and safety data on raw materials, solvents, catalysts, intermediates and by-products and reaction materials and products.
- Secondary reactions and chemistry.
- Data resulting from hazard studies.
- Waste treatment (containment and disposal).

The process documentation file or plant dossier should be kept up to date.

Construction

Pay attention to quality assurance during construction, in particular with equipment suppliers, contractors and other third parties

The management of a hazardous installation should pay particular attention to quality assurance during the construction phase of a project.

Safety checks and inspections should be routinely carried out during the construction phase to ensure that the integrity of the original design is maintained. This involves checking if:

- Plans are being followed properly.
- Requirements of the hazard studies are being fully implemented.
- Associated equipment is being correctly installed.
- Correct materials (for example for construction), methods (such as welding techniques) and tests (such as pressure/leak tests) are being used by suitably qualified personnel (employees and contractors), in accordance with recognised standards.

Any modifications to the original design of an installation should be documented and these modifications should be reflected in quality assurance and safety reviews prior to commissioning and start-up of the installation.

Quality assurance (QA) systems can provide useful tools to ensure the conformity of equipment with standards and other requirements.

An enterprise should purchase equipment only from reputable suppliers and should formally inspect equipment to ensure that it conforms to design specifications and safety requirements before being put into use.

In the construction of a hazardous installation, an enterprise should do business only with contractors who are able to satisfy the enterprise that their services will be carried out in compliance with all applicable laws and regulations, as well as in compliance with relevant safety standards and policies of the enterprise, so as not to increase the risk of a chemical accident.

Contractors should be provided with the necessary documentation and information to be able to carry out their tasks. Contractors should work to the standards set by the management of the installation and, to the extent appropriate, under the direct surveillance of management.

Pay particular attention to the start of the operation

Management should ensure that the operation of an installation is not started while it is under construction and before the safety checks and inspections at the commissioning have been conducted with success. In some regulatory regimes, the authorities require notification before start-up is permitted.

Safety checks should also be carried out at the commissioning and start-up phases of a project (e.g. new construction on an existing site) to ensure that the design intent has been completely fulfilled, if modifications have taken place or if changes are necessary. Functional tests should be carried out for all components, controls and safety devices critical to the safety of the installation.

Operation

The safe operation of a hazardous installation is multi-aspect. It includes a range of disciplines and actions that should be co-ordinated at different levels and that are based on a mature safety culture in the enterprise and the implementation of a safety management policy and system.

Safe operation includes the development and implementation of procedures for safe operation, the management of personnel and the recognition of the role of human factors, strong internal communication and proper education and training (Figure 2.6).

Figure 2.6. Operation

Develop and implement procedures for safe operation

Implement the enterprise safety policy

It is the management's responsibility to ensure that the corporate safety policy (see section on corporate governance and process safety management) is implemented through appropriate organisational arrangements.

The chain of command and layers of responsibility for ensuring safety should be clearly defined. The roles and responsibilities of all employees (i.e. management and labour, including contractors) related to safety should also be clearly identified.

Have easily accessible written operating procedures and instructions for operation under normal and abnormal conditions

Management should ensure that each installation in an enterprise has written and easily accessible operating procedures and instructions. These should:

- Establish the conditions necessary in order to satisfy the design intent of the installation and maintain its integrity to protect the safe operation of the plant.
- Take into account relevant standards, codes and guidance in order to ensure that equipment, installation and premises provide a safe place of work under both normal and abnormal operating conditions.

Written procedures should:

- Include detailed work instructions and simple job aids, such as checklists.
- Be clear and easily accessible, in a form those involved can understand and use (for example including pictures, photographs and diagrams).
- Be understood by all relevant employees and contractors. There should be education, training, review and monitoring systems for ensuring that all employees know, understand and follow at all times appropriate procedures.
- Be periodically reviewed and updated to take into account any significant changes in plant design or operation.
- Be designed and developed with the active involvement of those who use them. This helps ensure that procedures are realistic, workable and consistently applied, and facilitates the idea that those who have to follow procedures "own" them.

Written procedures should, in addition to the normal operation of the plant as covered by standard operating procedures (SOPs), cover the following:

- All maintenance tasks.
- Isolation and making the area safe for maintenance and activities.
- Management of overrides of process safeguarding systems and process safety alarms.
- Permit to work (Box 2.10).
- Supervision of contractors.
- All periodic examination and assessment ("operator inspection") tasks.
- Fitness to work, including fatigue management and supervisor referral to a health professional if concerned about an individual's fitness to work.
- Any other human factors good practice applicable to the task.
- What to do in an emergency or if a safety risk emerges.
- Management of changes to the maintenance task as planned, in particular those changes which extend the length of time of the task or function of any safety or control systems in the installation.
- Communication within and between shifts, including handover and status of any ongoing maintenance operations or activities of contractors under supervision.

Procedures and arrangements should be introduced at a hazardous installation for the safe handling of chemicals and the prevention of explosions, fires and releases of hazardous substances. There should be appropriate arrangements for the protection of personnel, buildings and equipment, the environment and for response (e.g. firefighting) should an explosion, fire or release occur.

A high standard of housekeeping (i.e. cleanliness and tidiness) and operational efficiency should be maintained at hazardous installations, including storage facilities, since there is a clear correlation between these functions and good safety performance.

Procedures should exist to help manage the unexpected and ensure effective protection against chemical accidents during abnormal conditions. Abnormal conditions could include, for example:

- When critical instruments, alarms and emergency equipment are not functioning.
- When there are unusual (short-term) production demands, extreme overtime work or a slow-down in production.
- When there are resource constraints (including staffing and financial resources).
- When there are emergency shutdowns or evacuations.
- When there is a natural hazards impact such as extensive precipitation, floods, earthquake, seismic event, tsunami, high winds or extreme temperatures.
- In case of electrical power failures.
- In case of failures of an electronic control system including cyber attacks.

Procedures should mention how to react in case of a change or modification (see section on management of change).

Develop procedures for the storage of hazardous substances

Procedures should be established at facilities where hazardous installations are present, including storage facilities, to minimise the risks of accidents and, in particular, to prevent the degradation of hazardous substances or packages, labels or other markings.

The operators should ensure that all relevant legislative requirements and applicable codes of practice for the safe storage of hazardous substances are strictly applied, wherever applicable.

In order to prevent explosions and fires, consideration should be given to whether the conditions of storage (including, for example, temperature and pressure) create special risks. Consideration should also be given to avoiding potential sources of ignition (e.g. hot surfaces, open flames, electrical spark and sources of static electricity).

A plan should be drawn up by the operator showing the nature of the hazardous substances in each part of the facility.

- The storage plan should be made available to first responders and relevant local authorities. Employees should know how to react in case of an accident.
- Information concerning hazardous substances held in a storage facility should be maintained up to date and be easily accessible to employees, labour representatives and emergency responders.

Where storage is the responsibility of a third party (off site), the owner of the hazardous substances (products, raw materials and intermediates) should confirm that the facility for the storage is suitable for these substances and that the operator of the storage is competent. The outsourcing of activities such as storage should be in compliance with the safety policy of the establishment. This could involve the owner/supplier of the substances monitoring the storage facility and training employees of the offsite facility.

The owner/supplier of hazardous substances should provide the necessary information to the operators' third-party storage to ensure substances are stored in appropriate manners, incompatible substances are segregated and the hazard associated with the materials are understood.

Develop procedures for handing over new chemicals/substances, processes or equipment

Management should ensure that relevant written, agreed operating procedures and safety instructions accompany new chemicals/substances, processes or equipment before they are handed over from one department to another (or from one owner to another) so that knowledge and experience gained in research, development, pilot plant and production are passed on. This handover should be formalised by an appropriately signed handover/clearance report.

Operating procedures and safety instructions should also be provided whenever installations, or technology, are transferred.

Manage personnel to ensure safe operation

Ensure each operation has an appropriate staffing level for safe operation

It is the management's responsibility to ensure that each operation has appropriate staffing, which allows for the safe operation of installations at all times. Consideration should be given to the ability of employees to fulfil their tasks and responsibilities in a safe manner (taking into account both physical and psychological factors).

In this respect, employees should not be assigned tasks if such assignments may compromise the safe operation of the installation.

Special attention should be given to tasks:

- Carried on by lone workers/monotonous tasks.
- That may imply working under high-stress conditions.
- That require particular strength or size.
- Not suitable for particular people considering physical limitations, allergies, unskilled and cognitive abilities.

Employees and their representatives should participate in decision making concerning the organisation of their activities and the staffing needs of the installation, to the extent that these may affect safety.

Management should establish performance indicators to review the staffing level.

Management should give special consideration to ensuring sufficient staffing and supervision during nights and weekends, and during periods when there are difficult or unusual situations, as well as to controlling overtime work or irregular work patterns if these may present an increased risk of a chemical accident.

In planning staffing schedules, consideration should be given to avoiding stress of personnel and overwork. For example, hours of work and rest breaks should be compatible with safety requirements. Overtime and rest days worked by any individual should not be excessive. A record of all such abnormal hours should be maintained to facilitate control of hours worked.

Management should identify and address the need for special staffing requirements and technical skills posed by start-ups, shutdowns, abnormal or unique operating situations, periods when there are unusual production demands, resource constraints or emergency situations, or other situations that might create stress in personnel.

Sufficient professional safety personnel should be available within an enterprise. Their role should be to remain impartial and independent of line management, to provide expert advice and, as such, to function as the enterprise's safety conscience. In this regard, safety professionals should:

- Have the necessary authority to carry out their responsibilities and should be seen as having management support.

- Interact with and be respected by employees at all levels in the enterprise.
- Be technically competent, either through specialised training or adequate experience (preferably both).
- Possess good interpersonal and communication skills.

The number of safety professionals should be appropriate for the size, technology and complexity of the enterprise.

Management should consider rotating employees between line management and the safety function in order to increase understanding of safety-related problems, generate better solutions to safety-related problems and strengthen the safety culture within the enterprise.

Consideration should be given to whether reductions in staffing levels, related to both labour (such as operators) and management, may have an adverse effect on safety.

- This is an important issue since economic conditions can lead to a reduction in the number of employees and changes in corporate structures.
- Reductions in staff manning levels do not necessarily affect safety since there are other factors involved, including design, management and operation. However, it is possible that staff cuts can lead to reduced safety communications, a disconnect between policy and hands-on action, increased stress and less time for training, voluntary inspections and time-off between shifts. It can also result in the loss of experience and a greater number of operators working alone rather than with colleagues.

Special consideration should be given to the impact of external factors on staffing, for example in case of public health events (e.g. influenza pandemics), large-scale strikes, industrial actions and natural events.

Consideration should be given as to whether certain tasks, because of their relationship to the prevention of accidents, should be subject to specific management controls, for example a requirement for a specific authorisation such as a permit to work.

Specific policies with respect to personal activities that may affect the safe operation of an installation – smoking, substance abuse and similar matters – should be agreed on and included in every individual employee's contract or conditions of employment. There should be an evaluation of "fitness for service" with respect to specific activities.

Give special consideration to the engagement of contractors

When engaging contractors, management should ensure there is no negative impact on safety.

Management should only hire contractors who are:

- Capable of performing their tasks to a sufficiently high standard of safety.
- Competent to carry out the contracted work in accordance with all applicable laws and regulations, safety policies and standards of the enterprise, and any additional practices particular to their task.

Compliance with relevant laws, regulations, safety policies and standards should be an integral part of the contract with contractors.

Management should monitor the safety performance of their contractors and, in general, contractors should be subject to the same safety management systems as staff at the enterprise. Contractors should also have equivalent rights and responsibilities with respect to safety as staff at the enterprise.

Third parties are responsible for involving personnel with appropriate skills and training such that the work is performed safely and the finished work meets all relevant technical standards and safety requirements.

Third parties should keep records and be able to provide these records of competency assessments and provide training, supervision and other support delegated in the contract.

In any event, management retains the responsibility for the safety of installations.

Consider safety as an essential component of every employee's performance, including managers

Safety performance should be considered an essential component of every employee's overall performance and should be reviewed periodically. The role of managers and labour (at all levels) regarding safety should be clearly defined so that safety performance can be appropriately monitored and reviewed.

Co-operation between management and labour, at all levels, is essential to assuring safe operation of hazardous installations.

Management should encourage and facilitate the ability of employees to fulfil their roles and responsibilities.

Labour may make use of the experience and support of unions, confederations and their international organisations to help them.

Plans for personnel development and rotation of jobs should always be consistent with maintaining operational safety requirements. This applies to employees at all levels, including management.

Ensure personal protective equipment for employees

Management should ensure that all employees and contractors know what personal protective equipment (PPE) is required, have the correct PPE where necessary and ensure that such equipment is currently fitted, maintained in good condition and used.

- Management should also ensure that regular training is provided on the use of PPE.
- Employees should be responsible for using suitable PPE in accordance with safety procedures and policies.
- Efforts should be made to design installations so that the need for PPE is minimised.

Ensure that all employees, including contractors, are informed of the hazardous substances they may be exposed to

Management should take all reasonable measures to inform onsite employees, including those of contractors, of the hazardous substances to which they may be exposed in the case of an accident.

Adequate information on hazards (including emergency exposure levels), on the procedures to be followed for safe handling of all substances at the installation (including those used, manufactured as intermediates, stored or available for sale) and on the procedures to be followed during a chemical accident should be obtained, kept up to date and disseminated widely, in a language(s) which all employees can understand.

Special attention should be given to working under abnormal conditions.

Ensure that employees follow procedures and take care of their personal safety and the safety of others

Each employee should be responsible for following the procedures laid down by management and for taking reasonable care of his or her personal safety and the safety of others who may be affected by his or her acts or omissions at work.

Each employee should support the ability of others to carry out their jobs in a safe manner and co-operate actively with management in the application of safety procedures and arrangements.

Employees at all levels should be given the education, training and resources they need to carry out their tasks and, at the same time, for them to accept responsibility (and be held accountable) for carrying out their tasks, both as individuals and as part of a team.

While the individual has responsibility for his/her own safety performance, the enterprise has to provide the conditions that allow the individual to act responsibly and effectively. Experience suggests that safety benefits when an organisation gives employees responsibility in an atmosphere of trust and provides the tools needed to work and make decisions.

Build internal communication for safety

Establish "formal" mechanisms to communicate about safety

Management should use mechanisms that will allow for open communication that encourages truthful exchanges and finding out about problems. These mechanisms can take different forms and should allow for two-way communication channels between management and employees, with feedback loops to management on safety issues that directly threaten the operation of a plant or the safety of the plant. These mechanisms should help create and maintain a high level of motivation for all employees to operate the installation safely.

The regular communication channels should be reinforced through a formal mechanism for consultation between management, labour and their representatives on safety matters, for example by the establishment of safety committee(s) in the case of larger enterprises or the establishment of regular safety meetings for smaller enterprises. The safety committees should support - but not be a substitute for – direct communication between management and employees, and individual and line management responsibilities for safety.

Safety committees should operate at different levels in an enterprise. Such committees could, depending on the size of the enterprise, consist of:

- Employees at various levels (including safety representatives[7] where they exist).
- Managers with the authority to implement the committee's recommendations.
- Safety specialists.
- Contractors, where appropriate.

Safety committee members should receive safety training and specialist advice as necessary.

Resources (for example people, time, a place to meet and finances) should be available for the safety committee to undertake its activities. Participation in the committee should be considered an integral part of an employee's time.

Management should act upon the recommendations of the safety committee, recognising that the ultimate responsibility for safety remains with management.

In addition to safety committees at individual hazardous installations, the establishment of similar mechanisms at corporate, sectoral, national or international levels may be considered useful in helping to disseminate safety information and providing input to the relevant decision-making processes concerning safety.

Communication should be based on the use of a commonly understood "language" that is plain and simple and which takes into account the different nationalities working (or which need to intervene) on site.

Management should recognise the need to address possible language differences so that employees can understand the education and training, and are able to communicate with their co-workers:

- Where appropriate, education and training should be available in languages other than the primary language used at the installation, for example where there are foreign employees or where the installation is located in a multilingual area.
- Where employees speak different languages, management should provide the necessary language training, so that there is a common language for communication needed to operate the installation safely and to respond in the event of an emergency.

Ensure that internal communication is based on a mature safety culture with no fear of reprisals for reporting safety issues

Internal communication should aim for the plant to be safer.

No measures prejudicial to an employee should be taken if, in good faith, the employee complains to competent authorities or other employees with responsibilities for safety, of what he/she considers to be a breach of statutory requirements or an inadequacy in the measures taken with respect to safety or information on incidents or potential causes of accidents. Management should support this approach if the necessary "open" attitude to safety matters is to be achieved.

An employee should have the right to refuse to perform any tasks that he/she believes may create an unwarranted risk of a chemical accident.

- The employee should immediately report to management the reasons for refusing to perform these tasks.
- In certain cases, an employee or a safety representative where one exists, may interrupt hazardous activities in as safe a manner as possible when he/she has reasonable justification for believing that these activities present an imminent and serious danger to safety.

Employees should immediately report to management, without fear of reprisals, any situations that they believe could present a deviation from normal operating conditions, in particular situations which could develop into a chemical accident.

- Management should investigate these reports within a reasonable timeframe.
- Any employee should be entitled to report unsafe conditions to relevant public authorities.

Ensure proper education and training

Ensure that all employees, including temporary employees and contractors, receive appropriate education and training to perform their tasks under normal and abnormal conditions

Management should take all reasonable measures to ensure that all those employed at a hazardous installation, on any level and including temporary employees and contractors, receive appropriate education and training and are competent to carry out their tasks under both normal and abnormal conditions.

Education and training should address the needs and requirements of each individual appropriate to their role and associated tasks (see Box 2.6 for special considerations for engineers and safety specialists). It should address, as appropriate, the following:

- Hazard identification, risk identification, evaluation, mitigation and appropriate corrective measures to address safety concerns.

- Any special hazards unique to their job.
- Actions that should be taken in abnormal or emergency situations, including the prediction or occurrence of a natural hazard or disaster.
- Correct procedures for handling hazardous substances including waste.
- Human factors and risk communication.

Box 2.6. Special considerations related to engineers and other safety specialists

Engineers and other safety specialists have a duty to identify safety issues and to provide leadership with respect to safety issues to others in their communities. Managers should recognise the important role of engineers and safety specialists in risk management decision making and seek input and reasoning as to why a situation may be safe or unsafe.

In this regard, engineers and other safety specialists should:

- Be called on to raise the awareness of management and other employees, and educate them with respect to issues concerning safety and risk.
- Be able to communicate effectively to their colleagues and to management about safety and risk issues, recognising that others in the enterprise or organisation may have different objectives and use different terminology.
- Be aware of which forces drive the decision-making process and ensure that good engineering practices with respect to safety, health and the environment are considered appropriately.
- Be aware of the limits of their own knowledge with respect to their role in the safe siting, design construction, operation, maintenance and/or decommissioning of hazardous installations. They should seek ways to continue acquiring additional information and training, as appropriate.
- Must maintain their level of competency taking into account new technological, legal and other developments. This could be done through in-house training programmes, continuing education courses, online and written materials, external training activities, etc.

Enterprises and other organisations that employ engineers and other safety specialists should support continuing professional development and maintaining their level of competency (including with respect to risk assessment and risk management). The training of engineers and safety specialists should, at a minimum, include the concepts of risk and risk management, operational deviations, probability of failure and failure consequences recognising that specific training programmes will take into account the different educational systems in different localities.

Safety training should be part of the initial induction training given to all new employees to create safety consciousness and commitment. There should also be regular follow-up training and education and specialised training as appropriate.

- Training should be structured to give all employees the skills they need to do the job which they have been assigned and be sufficiently broad-based so that employees understand the workings of the installation, equipment, operations and processes, and possibilities for abnormal situations.
- The approach to education and training should create the high level of awareness necessary not only to prevent accidents but also to respond to abnormal occurrences quickly and effectively.
- Training should make clear not only what employees are required to do but also why certain actions are necessary for safety. In this regard, training should instil in employees the confidence to raise concerns related to safety (both technical and management issues), when appropriate.

- Training should include practising the different modes of operations so that recovery from abnormal situations can be achieved safely. Operational perception, especially with respect to making decisions in an emergency situation, is an important factor in operational safety. Perception can be complex, drawing on previously acquired information and on existing understanding of systems.

Records should be kept and maintained up to date of all safety-related education and training of all personnel, including managers and contractors.

Employees and their representatives should be involved in the development of education and training programmes. This support could take the form of direct training of individuals or by facilitating the training activities of others through, for example, the development of a syllabus, provision of training materials and programmes, supplying tutors and speakers, and assisting with the sharing of experience related to training.

Labour organisations should facilitate co-operation with management at the national and international levels. For example, as one of the tripartite constituent groups of the International Labour Organization (ILO), labour organisations have had and continue to have a leading role in the development and promotion of ILO conventions and recommendations (Box 2.7).

The experience and understanding gained by labour organisations from their training and education programmes and from their practical day-to-day experience can be used to help improve prevention policies and activities.

Box 2.7. International Labour Organization (ILO) – Prevention of Major Industrial Accidents Convention and Recommendation, 1993

In the last 100 years, the ILO has adopted more than 50 legal instruments for the protection of workers, as well as the public and the environment, from chemical hazards. In addition to legally binding instruments, the ILO also offers technical assistance programmes and provides training and guidance tools to global stakeholders.

In 1993, the ILO issued the Prevention of Major Industrial Accidents Convention (No. 174) and Recommendation (No. 181) (ILO, 1993[14]). The purpose is the prevention of major accidents involving hazardous substances and the limitation of the consequences of such accidents. It provides for the development of a coherent national policy concerning the protection of workers, the public and the environment" and measures involving central and local government, employers and workers, and it establishes roles and responsibilities at the workplace level.

The ILO developed a *Code of Practice: Major Industrial Accidents* as a complementary practical guidance to Convention 174, which aims to provide guidance for setting up an administrative, legal and technical system for the control of major hazard installations.

Source: ILO (1993[14]), *Prevention of Major Industrial Accidents Convention (No. 174) and Recommendation (No. 181)*, https://www.ilo.org/dyn/normlex/fr/f?p=NORMLEXPUB:55:0; ILO (1997[15]), *Code of Practice: Major Industrial Accidents*, https://www.ilo.org/safework/info/standards-and-instruments/codes/WCMS_218624/lang--en/index.htm.

Consider the most effective methods for training

In developing and implementing training programmes, consideration should be given to the most effective methods of training for particular circumstances, including training for day-to-day operations and for dealing with abnormal or emergency situations.

Different approaches to training could include, for example, operator-to-operator training, online systems and electronic simulation models. The use of simulator training provides a means for learning about the application of diagnostic and corrective actions in the operation of automated systems as well as the simulation of highly hazardous operations.

Consideration should be given to training employees in groups rather than individually. Group training can be an effective way of developing a shared safety culture developing positive group behaviour and establishing increased ability for group members to predict potential safety problems and develop solutions. There should also be joint training activities for managers and labour to facilitate understanding of each other's roles and responsibilities.

Assess changes in safety training and education needs

Requirements should be assessed on a regular basis, any changes identified and the training and education programmes amended as required.

Education and training programmes should be modified to reflect changes in processes used, technology applied and procedures followed at an installation.

This evaluation and revision process is particularly important in times of change, such as when employees, including managers and supervisors, are being assigned to a new or different installation.

Ensure that managers keep themselves informed about safety standards and risks

Managers have an obligation to keep themselves informed about safety standards and risks. They should know and fully understand the properties and behaviour of the hazardous substances being used, the limitations of the equipment and technology, and should be competent to implement the measures to be taken in case of an emergency.

Every manager should ensure that those on his or her team know how to safely carry out the tasks entrusted to them and how to maintain a high level of safety awareness. To achieve this, they should receive appropriate training in communication techniques, safety leadership, accident investigation and reporting procedures, safety and health analyses, and the conduct of safety meetings.

Recognise the importance of human factors

Give particular attention to the role of human factors in preventing accidents

Particular attention should be given to the role of "human factors" (Box 2.8) in preventing incidents at hazardous installations and in being able to respond during abnormal events.

Box 2.8. Introduction to human factors

> *"Human factors refer to environmental, organisational and job factors, and human and individual characteristics, which influence behaviour at work in a way which can affect health and safety." (UK HSE, 2021[16])*

It should be recognised that humans will, on occasion, fail and that the majority of accidents are in some part attributable to human error, meaning human actions or inactions which unintentionally exploit weaknesses in equipment, procedures, systems and/or organisations. However, human error is never the single root cause of an accident but the result of a more complex situation.

The term “human factor” is often used in a negative context (equating it to human error). However, humans are often the only means for effectively responding to abnormal situations since they have the capability to reason and then override automatic reactions of machines. Humans have (a limited) capacity to forecast action, integrate complicated information and understand how to address unusual situations based on experience and training. Thus, an employee may be able to remedy potentially unsafe situations if he/she is provided with sufficient information and training, and the workplace is designed in a way which allows him/her to take corrective action.

Take into account the human factor in all phases of the functioning of a hazardous installation

The “human factor” should be taken into account in all phases of a hazardous installation including: design, construction, hazard identification and risk assessment, operation, alarm management (Box 2.9) training and education, maintenance, shutdown and decommissioning.

The human factor, including both positive and negative aspects of human behaviour, is applicable to all employed in a hazardous installation (i.e. managers and labour, including contractors).

The demands of tasks that may affect the safe operation of an installation should be analysed so that employees can be placed at tasks that are appropriate to their physical and psychological abilities and to help ensure that employees are not overloaded or excessively stressed.

Box 2.9. Human factors and alarm management

There is significant evidence that poorly designed alarm systems have a role in major accidents. Every hazardous installation should have a clear and well-defined alarm management strategy, as part of its safety management system.

Good alarm management will help prepare for unanticipated events by providing: detection of failure(s); identification of problems and causes; and implementation of countermeasures aimed at returning the process to a normal or safe situation.

- The alarm management strategy should include means to prevent: alarm flooding; overloading of the operator; complacency by the operator when an alarm is triggered; and/or operator(s) ignoring alarms he/she considers to be unimportant.
- The alarm management strategy should provide for an effective alarm system, which provides a signal in response to any deviation from the normal situation which requires immediate action.
- The purpose of an alarm system is to direct the operators’ attention towards conditions at the installation requiring timely assessment and/or action.
- Every alarm presented to the operator should be useful and relevant to the operator. Alarm systems should be designed taking into account the operators’ needs.
- Every alarm should have a defined response and adequate time should be allowed for the operator to carry out this response.
- There should be a system that helps prioritise when multiple alarms are activated at the same time.
- When a high alarm is reached, the automated process safety system should take over.
- The alarm system should be continuously monitored, tested, analysed and improved.
- The alarm system should accommodate human capabilities and limitations.

Any overriding or bypassing of alarms should be: assessed as a temporary measure, consistent with the management of change process; logged through manual or computer-generated written documentation; regularly reassessed; and reinstated when the override or bypass is no longer necessary. The reinstatement should also be documented.

For more information, see Standard IEC 62682 on the management of alarms systems for the process industries (https://webstore.iec.ch/preview/info_iec62682%7Bed1.0%7Db.pdf).

Encourage employees to share their experiences to reduce the risk of human error

Employees should be encouraged to share their experiences in order to reduce the risk of human error.

- This can be accomplished through, for example, safety workshops, discussions of near misses and other group discussions, as well as through inspection and observation of the workplace by employees and, where appropriate, by safety representatives.
- Experiences relating to human errors should also be shared among different enterprises and, to the extent possible, among public authorities.

Certain situations can lead to conditions where employees can be placed under elevated levels of stress that can then lead to human errors. Measures should be taken to identify these potential situations and consider appropriate steps to reduce the potential for failure. Possible situations could be when there are unusual short-term production demands, extreme overtime work or a slow-down in production, when there are resource constraints, or when there is a change of ownership at an installation.

Stress affecting safety could result from pressure on individuals or groups of employees or on the enterprise as a whole (for example, to increase production or cut costs), during and after modifications and maintenance, during shutdown/start-up, and following outages, since human errors tend to increase during and after these periods.

Management should communicate that safety considerations take precedence over other considerations.

Maintenance

> *Maintenance means keeping the workplace, its structures, equipment, machines, furniture and facilities operating safely, while also making sure that their condition does not decline (UK HSE, 2021[17]).*
>
> *The maintenance programme should have in place a number of structural elements that form the logical basis for making rules, taking decisions and performing actions involving maintenance interventions. With a well-structured maintenance programme, the operator should be able to identify and track the mechanical integrity of each safety critical element throughout its life on the basis of demonstrated knowledge about its actual condition and potential degradation pathways. The aim is to ensure that all necessary information is available and that all systems and processes are primed to ensure that equipment in operation is always fit for service (EU, 2019[18]).*

Maintenance-related accidents are very frequent and remain a serious cause of concern.

Establishing a maintenance programme

Management of hazardous installations should establish programmes for regular maintenance, including inspection, testing, servicing and repair of equipment (and where necessary replacement with identical components) to ensure that it is at all times fit for the purpose for which it was designed.

Maintenance programmes should:

- Take into account information obtained from hazard identification and risk evaluation procedures. Activities in maintenance programmes should be subject to risk assessment, including identification of the special hazards, if they are made during the operation of the installation or while hazardous substances are present.
- Ensure that alarms, instrumented systems, protective devices and emergency equipment, and all devices critical to controlling and responding to the incident and the orderly shutdown of operations, are regularly inspected and maintained.
- Be adhered to strictly and be reviewed periodically to ensure they continue to be appropriate in relation to safety requirements.

Special attention should be paid during periods of maintenance since there is a higher risk of accidents during such periods. Maintenance standards and procedures should be developed to ensure the safety of each operation and all jobs should be performed according to such procedures.

Where the function of these systems is related to mitigation and response activities by public authorities, maintenance should be carried out in co-ordination with these authorities.

“Ageing” should be considered a key aspect of maintenance programmes:

- Ageing is a multi-aspect phenomenon: everything associated with a site and its processes can age, not only equipment but people, procedures and technologies.
- The physical ageing of equipment is not necessarily linked to chronological ageing per se but to the degradation of equipment over time from its initial condition.[8]
- The operator should integrate the different aspects of ageing into maintenance programmes.

Carrying out maintenance

Undertaking maintenance activities can potentially expose the personnel involved and others in and outside of the installation to a range of risks:

- Permit to work procedures should exist for particular activities (Box 2.10).
- Mechanisms should be established for safe operation, such as Lock out, Tag out and Try out (LOTOTO).
- Management should ensure that all contractors responsible for maintenance or repairs are aware of, and follow, all relevant standards and procedures (see section on operation).
- Procedures should exist for the safe shutdown and start-up of installations during the maintenance of equipment. Special efforts should be made to avoid potential causes of risk such as communication problems and split responsibility; this may be a particular concern when contractors are involved (who may not be fully aware of the details of an installation’s operations, policies and procedures).

Box 2.10. Permit to work (PTW)

Permit to work (PTW) is a particular element of the safety management system, which is used to ensure that work recognised as hazardous is carried out safely. In particular, the PTW is used for standardised activities, which are carried out at particular times or in conjunction with particular modes of operation of the plant. The PTW is a document that enables the responsible person to be able to identify the hazards and assess the risks in a structured manner, to document the necessary measures for safe forms of work and to ensure that those carrying out the work are appropriately informed. The PTW is

an important element of all maintenance work. Operations that involve the issuing of a PTW are, for example:

- General work (activities which are not usually carried out on a day-to-day basis and covered by other workplace risk assessments).
- Entry into confined spaces.
- Isolation of equipment.
- Breaking into a line which has been carrying a hazardous substance by opening a flanged or screwed joint, or by cutting.
- Hot work (such as welding, soldering, grinding and drilling), i.e. any flame, spark-producing or heating activity.
- Positioning a crane and carrying out the lifting of loads in the vicinity of a plant.
- Erecting of scaffolding.
- Excavation (to ensure that no cables, underground pipes, foundations or the stability of the excavation work are compromised).

Connected to the PTW system are certain good practices, which support safe operating practices. In particular, the LOTOTO procedure is a means of ensuring that equipment which has been made safe for maintenance by isolating it from energy sources and hazardous chemicals cannot be reactivated without authorisation.

Documenting maintenance

Records should be kept of:

- All safety-related maintenance work carried out and equipment reviews and reliability assurance procedures should be established.
- Any faults found during maintenance of equipment that might materially affect safety and prompt action should be taken to rectify such faults.

Decommissioning, closure and demolition

Appropriate procedures and organisational structures should be developed for the safe shutdown, decommissioning and demolition of hazardous installations.

Such procedures should be designed to ensure that risks are controlled during the shutdown process and while the installation is out of operation, to avoid leaving a contaminated site once the installation has been decommissioned and to ensure that the demolition process is conducted in a safe manner and the site meets all relevant environmental and safety laws.

Management should ensure that contractors involved in shutdown and decommissioning follow the safety procedures.

Responsible risk management – responsible management of hazardous substances and technology

This section addresses three specific areas of responsible risk management: the safe management of hazardous substances throughout their life cycle (product stewardship), the transfer of technology, investments and physical and cyber security.

"Product stewardship" and assistance to other enterprises

Promote the safe management of the produced substances throughout their life cycle, including handling and use by downstream users

Producers of hazardous substances should promote the safe management of substances they produce throughout the total life cycle of the substances, from their design through production and use, to their final disposal or elimination, consistent with the principle of product stewardship. Producers should make special efforts to help prevent accidents during the handling and use of a hazardous substance by downstream users.

Product stewardship is the responsibility to understand, manage and communicate the health and environmental impacts of chemical products at each point in their life cycle.

The International Council of Chemical Associations (ICCA) has published *Product Stewardship Guidelines* to assist companies in designing and implementing product stewardship programmes built on a management systems approach.

For more information, see the ICCA Global Product Strategy webpage (https://www.icca-chem.org/global-product-strategy-gps/).

Producers of hazardous substances have a responsibility for their products and, therefore, should create a full awareness of any potential hazards that could arise in the use, handling, storage, transportation or disposal of their products and they should provide assistance and/or guidance, as necessary.

In this regard, producers should provide technology, information and assistance to their contractors, distributors, transporters, customers and users so that they can follow appropriate prevention practices. Producers should be encouraged to voluntarily provide their customers' education, training, information and other services related to risks and safe handling of chemicals.

Producers of hazardous substances should ensure that a complete safety data sheet is prepared for each substance in accordance with the Global Harmonized System (GHS) and relevant additional national regulations and is being kept up to date and made available to all customers in the appropriate language(s).

Enterprises should seek to co-operate with others in their region or within their industry sector, or establish partnerships, help facilitate sharing of information and learn from experience (Box 2.11).

Box 2.11. The role of industry/trade associations, local chambers of commerce and other industrial and professional organisations

Industry/trade associations, local chambers of commerce and other industrial and professional organisations should provide a useful means of disseminating information related to the prevention of chemical accidents.

Industry/trade associations and industrial/professional/standards organisations should be critical sources of guidance, consultant services, training and other technical tools, providing a mechanism for channelling the collective experience of their members towards the development of resources which can be made available to both members and non-members.

Enterprises and industry/trade associations should strongly encourage enterprises that act less responsibly to improve and meet appropriate safety objectives.

Larger enterprises and/or industry/trade associations should offer encouragement and assistance to companies needing help. This could include, for example, mentoring, outreach activities and encouragement to participate in industry-led initiatives relating to safety such as the chemical industry's Responsible Care® programme. They should share their experience and provide guidance and assistance to suppliers, customers, contractors and others with whom they have influence and/or business relationships.

Smaller enterprises with limited resources should actively engage with their relevant industry association and use the assistance provided.

Actively determine whether customers can safely handle substances and take decisions on whether to sell accordingly

Enterprises selling hazardous substances should actively try to determine whether their customers can safely handle the substances (including, as appropriate, processing, use and disposal of the substances).

- If this cannot be determined, judgement should be exercised to decide whether to accept such customers.
- If customers are found to be incapable of safely handling the hazardous substances, the seller of the substances should take appropriate action (such as assisting the customer to obtain this capability) or else not accept such customers.

Suppliers and distributors of hazardous substances should be key information channels for enterprises that might need information and assistance.

Box 2.12. Responsible Care® programme of the chemical industry

Responsible Care® is an initiative developed and adopted by chemical industry associations to improve the health, safety and environmental performance of their member companies' operations and products, and the level of community involvement and awareness of the industry.

Through Responsible Care®, participating companies are committed to supporting a continuing effort to improve the industry's responsible management of chemicals and specifically agree to:

- Continually improve their health, safety and environmental performance.
- Listen and respond to public concerns.
- Assist each other to achieve optimum performance.
- Report their goals and progress to the public.

Source: ICCA (2023[19]), *Homepage*, http://www.icca-chem.org/; ACC (2023[20]), *Responsible Care®: Driving Safety & Industry Performance*, https://responsiblecare.americanchemistry.com/.

Transfer of technology

The transfer of technology is the introduction of technology or hazardous substances to a location that does not have prior experience and knowledge.

Whenever an enterprise transfers process technology or other safety-related technology, the management of that enterprise should strive to ensure that the technology will be applied in a way which will result in a level of safety equivalent to that achieved in the technology supplier's own installations using that technology.

Enterprises transferring process or other safety-related technology for hazardous installations have a responsibility to develop the technology and associated operating procedures so that installations can be operated to an acceptable level of safety, recognising that certain safety technology may not be appropriate in all locations.

For the transfer of technology, a process should be established that involves the supplier of the technology and the recipient. This process should clearly establish roles and responsibilities throughout the transfer.

As a first step in the transferring of technology, an assessment of the local situation in which the technology is to be transferred should be carried out. This assessment should take into account:

- Local meteorological conditions and natural hazards and their potential impact on the safe operation of the installation.
- The regulatory situation and requirements regarding the siting, construction and operation of the installation, including inspection by the public authorities.
- The local cultural and administrative conditions which may have a significant effect on the practices of management and other employees.
- The ability of the receiver to safely apply the technology under the existing condition, respective of the need to adapt both the technology and local conditions, as far as reasonably possible, to enable the safe operation to take place.
- The requirements for regular inspection and maintenance, particularly with regard to the use of particular technologies for testing and the availability of replacement parts in the intended location.

The assessment should involve, where appropriate, local authorities and community representatives, and should ensure that local authorities are given the results of the evaluation. Those carrying out the assessment should have access to all the necessary information and should use currently accepted techniques for the identification of hazards and evaluation of risks.

The technology supplier should not seek to transfer technology to another location that would not be acceptable on grounds that it is a legally prohibited technology or that the technology cannot be operated safely at its own existing sites.

The technology supplier should assist the technology receiver with education and training and all such transfers of technology should be accompanied by related safety information.

Technology should not be transferred unless the supplier and receiver are satisfied, having conducted a fact-finding study and a review of an appropriate risk assessment, that the technology receiver can apply and use the technology in a safe manner, taking into account local circumstances as well as the legal and administrative infrastructure necessary for its safe operation.

There should be a contract governing the transfer of the technology and this contract should, among other matters, clearly define and regulate the division of responsibilities between the parties involved with regard to effective control of operations, prevention of accidents and emergency preparedness and response.

- If appropriate, this contract should also have provisions relating to the procedure for the handover of a turnkey plant.
- The sections of the contract relating to the areas described above should be available, on request, to competent public authorities and to employees and employee representatives.

When a hazardous installation involving the transfer of technology has been built to the specified design and its capability to be operated safely (in accordance with specified procedures) has been satisfactorily demonstrated in an acceptance test run, a handover document should be signed by all parties involved, including contractors.

Physical and cyber security

The management of facilities handling hazardous substances should be aware of the need to control access to their site and the operations on site. This access covers not only physical access but also virtual access through a computer network and control systems. The control is to ensure that any undesired access is prevented as far as practically possible regardless of whether this is deliberate (Box 2.13) or inadvertent.

To understand the level of threat to the site and its operations, an assessment of the security and vulnerability should be carried out. The results of this assessment should assist management in defining the necessary measures to maintain the necessary level of security on site.

In considering the vulnerability of the site, management needs to be aware that this may be influenced by a number of factors which are independent of their operations involving hazardous substances. This includes amongst other factors: the location of the site, including the political geography; name and reputation of the company and its corporate owners; trading partners (suppliers and customers); past and current activities of the company.

Box 2.13. Malicious acts

Malicious acts are defined for the purposes of these Guiding Principles to be actions by an individual(s) purposely intended to create harm. This would include sabotage, cyber attack, terrorism, vandalism and theft. Thus, it does not include such actions as slips or lapses (actions that were not as planned) or unintended actions, mistakes (errors of judgement or decision making) or violations (non-compliances, shortcuts and workarounds which are intentional but usually well-meaning deviations from the correct procedure) where the operator has no malicious intent to cause harm or damage.

Both public authorities and management of hazardous installations have roles and responsibilities with respect to security and safety in the prevention of accidents caused by malicious acts. This subsection focuses on the role of industry but also addresses some aspects of the authorities' roles. Consideration should be given to which authorities should be involved in addressing chemical accidents caused by malicious acts. This will generally include agencies responsible for domestic/national or international security and the police, in addition to the various public authorities that are normally involved in chemical accident prevention, preparedness and response.

It is beyond the scope of this document to address the range of issues associated with site security at hazardous installations, which are the concern of national and international security agencies. However, these guiding principles are relevant to the prevention of, preparedness for, and response to accidents involving hazardous substances irrespective of their cause.

It is important to keep in mind that, in some situations, it may be necessary to balance safety and security concerns where there are competing interests.

Security and vulnerability assessments

With regard to security and vulnerability assessment, some countries have published regulations with specific requirements for security and vulnerability assessment within the framework of national safety and security programmes. Operators of sites handling hazardous substances should make themselves aware of any specific local requirements.

Other organisations have published guidance, recommendations and standards covering a variety of aspects relevant to security.

Physical access to the site

To control physical access to the site it is necessary to define the site boundaries. This is often achieved with a fence of an appropriate height and construction type. If the site is part of a chemical or industrial park, then there may be a fence surrounding the whole park. There may also be agreements within the contracts and regulations governing the chemical park regarding the construction of fences and control of site access. When a fence is erected, then access is controlled through the use of gates, which may be operated through staff in a gatehouse or through electronic devices such as chip cards, transponders, vehicle number plate recognition, etc. In addition, traditional mechanical keys may be used, in particular where the number of people requiring access is low or infrequent.

Within the fence line, access to particularly sensitive areas may be restricted through the use of internal fences or by locked doors, which require mechanical or electronic keys. Areas may be considered sensitive due to the access to hazardous substances, in particular toxic substances in readily transported containers or due to access to process control systems and equipment which when operated maliciously may lead to a process disturbance and release of a hazardous substance.

Measures for personnel

Management should decide which members of staff have access to which areas and buildings within the site. Appropriate measures should be taken to ensure that this is achieved. This may involve staff being issued with keys or electronic chip cards to gain access as required.

Management should ensure that the necessary personal security and reliability assessments of individual employees and contractors are carried out where this is necessary. The legal requirements of the local jurisdiction with respect to this are to be applied.

Procedures should be established for authorising access to non-site personnel. Non-site personnel may include:

- Contracted staff such as cleaners and grounds maintenance personnel who are on site on a regular basis.
- External contractors who are on site for a limited period of time for a defined activity.
- Company personnel from a different site.
- Site visitors.

The procedures should define the limits of access (location and time period), whether movement on site is accompanied or unaccompanied, and the length of time the access is valid for. Non-site personnel should be identifiable and should be monitored appropriately.

Procedures should be established for ensuring that, when contracts are terminated, measures are undertaken to ensure that access is no longer possible. This includes surrendering keys and code-/chip cards as well as changing access codes, passwords, etc.

Employees should be trained in the security rules on site, in particular made aware of the action to take should they discover unauthorised persons on site or in particular locations on site, or become aware of any suspicious activity related to the security of the site.

Transportation modalities and supply chain

Operators should protect their facilities and transportation and supply chains with the goal of preventing malicious activities leading to chemical accidents. Controls should be established for the transportation of hazardous substances, including the setting of routes, to take into account the need to protect against malicious acts.

Security for purposes of accident prevention entails not just site security but necessarily extends to the management of chemicals from supply chain sourcing and transportation to the environmentally sound disposal of hazardous wastes. It includes secure operations information systems as well as health, safety and emergency response regimes.

Operators should put procedures in place to manage the cyber security of their supply chain, such as: specifying security requirements for third parties, use of trusted third parties, periodic assessment of the suitability of third parties and ensuring clear roles and responsibilities for third parties and contractors.

Cyber security

Reducing the risk of a major accident often includes the use of electronic control plant or equipment (known as Industrial Automation and Control Systems [IACS], Industrial Control Systems [ICS] or operational technology [OT]). Such technology is often programmable and connected to a network and so vulnerable to cyber threats. Cyber security is the term used to define measures taken to protect such technology against threats – accidental or deliberate. International standards exist and should be used.

Procedures should be established for the purchasing, installation and commissioning of process control equipment and software. Appropriate expertise should be involved in the decision making. In particular interactions between OT and information technology (IT) systems must be systematically analysed, documented and regularly reviewed and maintained.

Employees should be made aware and trained in issues relevant to cyber security relevant to their role, in particular with regard to the connection of mobile devices for charging purposes or the use of mobile data storage media.

Industry should take measures to ensure its operations are protected from malicious acts. This may involve other national and local regulations or public authorities, for example security services.

Co-operation with public authorities and non-governmental organisations (NGOs)

Industry, public authorities and NGOs should co-operate and establish partnerships to enhance the security of hazardous installations and improve their ability to prevent, detect and mitigate malicious acts intended to cause chemical releases, explosions or fires.

Balancing safety and security

Operators of hazardous installations should give appropriate attention to the security of their site, including the threats posed by malicious acts such as sabotage, cyber attacks, terrorism, vandalism and theft.

Public authorities with responsibility for industrial safety and domestic/international security should co-operate to ensure installations are not given conflicting advice or required duplicate actions.

Box 2.14. Examples of guidance on cyber security

UK HSE *Guidance on Cyber Security for IACS, Second Edition*

This guidance describes the required cyber security countermeasures to address low levels of cyber security risk. The following guiding principles were used in producing this guidance:

- *Protect, detect and respond*. It is important to be able to detect possible attacks and respond in an appropriate and timely manner in order to minimise the impacts.
- *Defence in depth*. No single cyber security countermeasure provides absolute protection as new threats and vulnerabilities can be identified at any time. To reduce these risks, implementing multiple organisational, protective and detect-and-respond countermeasures in series avoids single-point failures, i.e.:
  - Organisational countermeasures – Governance, risk management, asset.
  - Management, supply chain management, policy and procedures.
  - Competence and awareness.
  - Protective countermeasures – Identity and access control, data security.
  - System security and resilience.
  - Detect and respond countermeasures – Security monitoring, Incident response.

Source: UK HSE (n.d.[21]), *Guidance on Cyber Security for Industrial Automation and Control Systems (IACS), Second Edition*, https://www.hse.gov.uk/foi/internalops/og/og-0086.pdf.

OECD Recommendation of the Council on Digital Security of Critical Activities

Digital transformation is accelerating the digital reliance on critical economic and social activities while digital security threats are growing in number and sophistication. Many governments are anticipating a greater occurrence and severity of digital security incidents affecting critical activities in the coming years, potentially leading to large-scale disasters. This situation pushes governments to adopt policies that strengthen the digital security of critical activities. However, such policies should not undermine the benefits of digital transformation in critical sectors through constraints that would inhibit innovation or unnecessarily restrict the use, dynamic nature and openness of digital technologies.

The OECD Recommendation of the Council on Digital Security of Critical Activities sets out a range of policy recommendations to ensure that policies targeting operators of critical activities focus on what is critical for the economy and society without imposing unnecessary burdens on the rest.

Source: OECD (2019[22]), *Recommendation of the Council on Digital Security of Critical Activities*, https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0456.

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Notes

[1] See ISO 31000:2018 – Risk Management, guidelines that provide principles, framework and a process for managing risk (https://www.iso.org/iso-31000-risk-management.html).

[2] See IEC 31010:2019 – Risk Management – Risk Assessment Techniques, which provides guidance on the selection and application of techniques for assessing risk in a wide range of situations (https://www.iso.org/standard/72140.html).

[3] See ISO 31000:2018 – Risk Management, guidelines that provide principles, framework and a process for managing risk (https://www.iso.org/iso-31000-risk-management.html); and ISO/IEC 31010:2009 – Risk Management – Risk Assessment Techniques (https://www.iso.org/standard/72140.html).

[4] Such reports are known in some countries as “safety reports” or “risk management plans”.

[5] See for example the “Functional safety of electrical/electronic/programmable electronic safety-related system (BS IEC 61508)”, https://www.hse.gov.uk/comah/sragtech/techmeascontsyst.htm.

[6] Domino effects occur when an accident causes greater adverse effects or triggers further accidents as a consequence of the proximity of other parts of the installation or nearby installations and their inventories of hazardous substances.

[7] Safety representatives are responsible for dealing with the health and safety interests of fellow employees. They also play important roles with respect to mediation and communication between management and other employees.

[8] See definition of ageing from HSE Research detailed in Research Report 509 (http://www.hse.gov.uk/research/rrhtm/rr509.htm).

3 Prevention of chemical accidents: Principles to public authorities

This chapter covers the fundamental roles played by public authorities in the prevention of chemical accidents. In this chapter, the term “public authorities” includes the wide range of government bodies at the local, regional and national levels that are responsible for environmental protection, public health, occupational health and safety, civil defence, emergency response and other aspects of chemical accident prevention, preparedness and response. These bodies fulfil the roles of policy and legislative development, government regulatory implementation as well as inspection and enforcement roles.

The text of this chapter does not specify which type of government body should be responsible for various activities since different countries allocate responsibilities in different ways in light of local laws and culture. Co-ordination among these respective authorities is essential for effective chemical accident prevention, preparedness and response.

The involvement of public authorities in prevention does not diminish the fact that the primary responsibility for the safety of hazardous installations rests with industry management.

This chapter covers the development of a safety strategy, a control framework and inspection and enforcement activities (Figure 3.1).

Figure 3.1. Principles for public authorities

Safety strategy

Public authorities should establish a long-term strategy for reducing the risks of chemical accidents and for limiting the adverse consequences of accidents that do occur. This strategy should:

- Include clear and appropriate objectives.
- Be part of a good governance strategy reflected in the structure and responsibilities that are assigned to public authorities.[1]
- Demonstrate an understanding of the risks related to geographic, economic and industrial development.
- Highlight the need for co-ordination and co-operation within, amongst and across public authorities, with industry and other stakeholders, as well as across the national authorities of all countries concerned, and among authorities at the national, regional and local levels.
- Establish the roles, responsibilities and expectations of all the stakeholders.
- Refer and take account of relevant international strategies such as the UN Framework for Disaster Risk Reduction[2] and the UN Sustainable Development Goals,[3] and international instruments such as the relevant OECD legal instruments related to chemical accidents, World Health Organization (WHO) International Health Regulations and UN Economic Commission for Europe (UNECE) Convention on the Transboundary Effects of Industrial Accidents.

The objectives and requirements established by public authorities should be applied fairly and uniformly to ensure that enterprises of all sizes and types, whether national or foreign, are obliged to meet the same overall safety objectives.

Decisions and actions taken in other fields of public policy can have an effect on accident risk. Public authorities should take this into account and be aware of the impact of their decisions. For example, decisions related to land-use planning, natural hazard control, emergency planning, emergency response or pollution control can affect the possibility of accidents or can aggravate the effects of accidents.

Public authorities within a country and across countries (involving international organisations as appropriate) should exchange information, consult and assist each other, to reduce the risk of chemical accidents and improve their capacities for prevention of, preparedness for and response to accidents.

Control framework

Recognise the elements of a clear and coherent control framework

Public authorities should develop a clear, and coherent control framework covering all aspects of the prevention of accidents and limiting their consequences. The control framework should:

- Consist of binding requirements (set out in, for example, laws and regulations).
- Include provisions for conducting inspections or audits to verify the safety of hazardous installations during all phases of their life cycle.
- Include provisions for the enforcement of requirements. Enforcement mechanisms should include suitable sanctions, with penalties applicable in the event of non-compliance.
- Allow flexibility in the methods used to meet the requirements. Public authorities should consider tiering requirements in proportion to the level of risk.
- Include standards, codes and guidance (such as codes of practice and quality assurance guides). These should be designed to enable each interested party to determine whether the safety objectives are being met.
- Give particular attention to ensuring that all enterprises undertake appropriate assessments of the range of possible accidents (including low-probability, high-consequence accidents) and appropriate emergency planning.
- Include mechanisms for collecting, managing and analysing information to better understand chemical accident risk.

In establishing the control framework, public authorities should consult with relevant stakeholders, for example:

- Other public authorities including, as appropriate, representatives from communities or public authorities of other countries of concern.
- Industry (management and other employees), professional and industry/trade associations, trade unions.
- Independent experts, interest groups.
- The public: special efforts should be made to provide the public with appropriate opportunities for input into decision making by public authorities.

Public authorities should consider which installations, or modifications to installations, are so potentially hazardous that the installations should not be allowed to operate without the prior and continuing approval of an identified public authority. In these cases, a form of licensing control could be utilised, which would require management to submit full details of all relevant aspects of the installation's projected activities to

the authority in advance of siting and start-up, and periodically thereafter. There should be an opportunity for public input into these licensing decisions.

Develop guidance to support enterprises in meeting regulatory requirements and achieving a higher level of safety

Public authorities should provide clear, easy-to-understand guidance on how regulatory objectives and requirements can be met by enterprises.

The requirements and guidelines established by public authorities should stimulate innovation and promote the use of improved safety technology and safety practices.

- The requirements should be considered the minimum; industry should be encouraged to achieve a higher level of safety than would be achieved by adherence to established standards and guidance alone.
- Public authorities should encourage industry to take measures to improve safety, for example by utilising the principles of inherently safer technology.

Public authorities should promote assistance activities (by authorities, industry or others) to improve safety programmes in enterprises. These activities should be conducted in a way that will not influence the impartial judgement of public authorities in their primary role of establishing and enforcing safety objectives and requirements. Assistance activities by public authorities should be undertaken separately from enforcement programmes.

Periodically review regulations and guidance

Regulations and guidance should be reviewed periodically to ensure that they are consistent with the objectives of minimising risk, do not hinder improvements in design and take into account changes in technology and experience gained.

- Requirements and guidance should, where necessary, be amended in a timely manner to take into account technical progress, additional knowledge and international developments.
- Amendments to the control framework that require changes in technology or management practice should allow industry reasonable time for implementation and compliance.

Establish a system for the identification and reporting of information on hazardous installations

Public authorities should establish criteria for identifying hazardous installations that can cause accidents. These criteria may be based on, for example, the specific substances and/or categories of substances present in the installation and their process conditions, and their potential to cause serious harm to health, the environment or property.[4]

Public authorities should establish an inventory of hazardous installations that fulfil the above criteria together with their geographic location. This will help to understand the risks posed individually and collectively and in relation to their surrounding environment, and their sensitivity to external risk factors such as natural hazards.

Public authorities should establish a system for obtaining and evaluating information concerning certain specified categories of hazardous installations, based on the established criteria.

Public authorities should focus on those reporting requirements that are most valuable for identifying risks and the means for dealing with them, or which are necessary for government functions (Box 3.1).

Box 3.1. Preparation of industry safety reports

Under such a system, management of the relevant installations can be required to submit a report describing the significant hazards at the installations and demonstrating that appropriate steps are being taken to prevent accidents and limit the consequences should an accident occur.

- Public authorities may establish different reporting requirements for different categories of installations, becoming more comprehensive for those installations regarded as presenting the greatest potential risk.
- The level of detail of such reports should be commensurate with the extent of hazard at the installation.
- The reports may consider harmonised formats and use agreed definitions.
- Public authorities should review the reports they receive by, for example, examining their completeness, assessing the risk control measures with regard to being effective and appropriate and, as appropriate, carrying out onsite inspections to verify information in the report.

For more information, see section on developing safety reports in chapter 2.

Establish accident reporting and dissemination of lessons learnt

Public authorities may establish a requirement that the management of hazardous installations reports certain incidents (accidents, significant releases or process safety concerns that could have resulted in an incident).

- Relevant information in these reports, in particular lessons learnt, should be made widely available, in accordance with applicable regulations, to help prevent similar incidents at other hazardous installations
- Public authorities may also establish a system for maintaining accident statistics, carrying out analyses of collected information, and for disseminating relevant information derived from the analyses.

Ensure a sufficient number of qualified and trained staff

Public authorities should have sufficient numbers of qualified and trained staff available to carry out their roles and responsibilities in the prevention of accidents and should ensure that staff are adequately educated and trained.

If the expertise necessary for public authorities to carry out their role and responsibilities is not available on staff, arrangements should be made for that expertise to be provided as needed, by external consultants for example.

Promote inter-agency co-ordination

Public authorities should promote inter-agency co-ordination to help ensure the most effective prevention, preparedness and response, and efficient use of resources.

- Chemical accident prevention, preparedness and response are, by nature, an inter-disciplinary activity involving authorities in different sectors and at different levels with relevant mandates such as environmental protection, public health, civil protection, emergency response, occupational safety and industrial development. Examples of such authorities include national, regional and local

regulatory authorities, government inspectors, civil protection agencies, public health authorities and health providers, city, county and provincial agencies responsible for public health and safety, response personnel, and elected officials at all levels.

- Where more than one competent public authority exists, a co-ordinating mechanism should be established in order to minimise overlapping activities and conflicts in the implementation of requirements from various public authorities.

Public authorities should endeavour to harmonise regulations among the various national and local authorities to the extent possible and eliminate duplicated requirements. Public authorities should co-ordinate among themselves to ensure that regulations, guidance and technical information provided to enterprises are complementary, not duplicated or contradictory.

Inspection and enforcement

This section provides more details on one particular aspect and a key element of the control framework: the inspection and enforcement programme. Inspections are a critical element in ensuring the overall safety of hazardous installations. It shows whether relevant regulations, standards and practices are being met, whether safety management systems are in place and function appropriately (with respect to technical, organisational and human factor issues) and whether safety documentation is valid. Another important benefit of inspections is that they provide a basis for public confidence in the safety of hazardous installations.

Recognise the elements of an inspection and enforcement programme

Public authorities should establish appropriate inspection and enforcement programmes for monitoring the safety of hazardous installations in all phases of their life cycle. This includes planning, siting, design, construction, operation (including maintenance) and decommissioning/closure/demolition.

To be effective, inspection programmes should have common elements:

- Clearly defined goals and an identified scope.
- A plan of action with timeframes (including for example reviews of appropriate documentation and interviews with key personnel).
- Appropriate expert(s) who are trained and qualified for the specific tasks and goals.
- A plan to recognise and document deficiencies and proper practices.
- A formal report of findings.
- A management review to clearly define responsibilities for follow-up actions.
- A means for ensuring that follow-up actions are carried out.

For monitoring to be effective and credible, the authorities responsible for inspections and related monitoring activities should be publicly accountable.

- Public authorities responsible for inspections and related monitoring activities should publicise the objectives, policies and procedures they follow in monitoring activities.
- In addition, public authorities may make the outcomes of their monitoring activities publicly available/available on demand.
- Public authorities (and industry) should make a concerted effort to make relevant information available to the public. This should be in a form that can be readily understood and provide an opportunity for dialogue amongst stakeholders (industry, public authorities and the public).

Public authorities should have the authority needed to fulfil their responsibilities, including the authority to enter installations, obtain information and enforce requirements as appropriate.

Define the goal and scope of an inspection

The goal and scope of an inspection should be defined in advance. The inspection should be focused and strategic:

- An inspection may not be able to examine all safety-related aspects of a hazardous installation in detail. It should choose technical, organisational and management system aspects relevant to the focus of the inspection. The focus of an inspection can be based on a particular installation or process, a particular part of a safety management system or a particular theme related to equipment or practices.
- In some cases, inspections will include reviews that are more detailed. This may occur as part of an overall inspection plan (e.g. where authorities establish specific priority areas from a strategy plan) or in response to poor performance at an installation or other identified concerns (e.g. where the inspection reveals potential problems or where there are issues based on the authorities' review of the safety report).

Establish programmes for inspections on an annual (or multi-year) basis

Public authorities should establish programmes for inspections on an annual (or multi-year) basis, setting goals and priorities and setting out timetables.

- In setting goals and priorities, authorities should take into account past performance of hazardous installations with respect to safety, as well as the nature and extent of hazards involved in the installations.
- Normally, inspection programmes would include provision for scheduled inspections, as well as unscheduled "spot checks", as appropriate. Unscheduled inspection may be triggered by accidents, complaints or information from other sources.
- An important benefit of setting out inspection plans well in advance is that it provides the opportunity for authorities to train and equip their inspectors to carry out the inspections effectively.

Develop a consistent, standardised approach for follow-up of inspections

Public authorities should develop a consistent, standardised approach for follow-up of inspections and ensure that follow-up actions are dealt with within an acceptable timeframe.

- All inspections should include documentation of the results, including recommendations for follow-up action and any enforcement action needed.
- The follow-up actions should be designed to ensure that identified shortcomings are addressed in an acceptable timeframe and that there is verification of actions taken.
- There are a number of different tools available to public authorities for follow-up action, depending on the severity of the concerns including, for example: notifications of changes to be made; identification of agreed actions and timetables; citations and fines; and, in the most severe cases, the shutdown of facilities.

Performance indicators should be used as a way to determine whether actions being taken are actually leading to reduced risk. Such indicators could also help focus inspection programmes on areas of the highest priority.

Ensure the appropriate role, expertise of inspection personnel and availability of resources

Inspections should be carried out by an inspector or inspectors supported by experts, as needed.

Third parties (independent of government and the enterprise) can be delegated to undertake technical or systems inspections on behalf of public authorities. Efforts should be made to ensure the quality of such third parties (for example, through certification or accreditation schemes).

- Even when third parties are involved, public authorities retain their legal responsibilities for the inspections; they cannot delegate their responsibilities to third-party inspectors.
- Where third parties are involved, care should be taken to avoid the potential for conflicts, in particular where such third parties engage in both consulting and inspection services.

Sufficient resources and trained personnel to carry out their inspection function should be provided to public authorities. Inspectors working for public authorities should receive the training and have the necessary expertise to determine, for example, whether the approaches taken in a hazardous installation will achieve legal requirements and should adhere to applicable industry good practices and standards.

Share information relating to inspection within a country and internationally

Public authorities should share information and experience, within countries and internationally, concerning methods and tools related to inspections, and also share the outcome of specific inspections. Efforts should be made to promote such activities on an ongoing basis and develop mechanisms that could be used to facilitate information sharing.

- Regional and national networks of inspectors should be established and exchanges with neighbouring countries and international networks of inspectors should be encouraged. These exchanges are an opportunity for improving the performance of inspections and can have outputs that feed back into the inspection programme.
- Co-operation and exchange allow development of synergies and common strategies across industry sectors and geographic areas.

Co-operate and co-ordinate with relevant public authorities and with industry

Public authorities involved with chemical accident prevention, preparedness and response (e.g. those responsible for health, safety, environment and civil protection, at the national, regional and local levels) should co-operate and co-ordinate in the area of inspections. Such co-operation should address the various phases of the inspection process, as appropriate. Co-operation provides a number of related benefits, including an opportunity to:

- Learn from each other and share resources, expertise and tools.
- Minimise the likelihood of different authorities giving conflicting advice or reaching conflicting conclusions; facilitate improvements of regulations/standards.
- Aid in conflict resolution (e.g. between safety and environment).
- Improve understanding and trust between authorities.
- Benefit industry through more targeted inspections, avoidance of duplication and consistency.

A co-ordinated inspection does not imply that the inspection is fully integrated. Rather, the objective should be to avoid duplication of effort and share the burden of the aspects of the inspections where there is a shared interest.

As part of the steps necessary for effective co-ordination, public authorities should establish:

- Procedures for joint inspections, as appropriate.
- A clear division of tasks, with identification of roles and responsibilities for various aspects of the inspections.
- Mutual understanding among the authorities of all relevant aspects of the authorities' culture, including their legal instruments, policies and procedures.
- Co-ordinated training activities.
- Clear lines of communication.
- An identified mechanism for dealing with conflicts.

Inspectors (public authorities) and the regulated industry should co-operate in the conduct of inspections. Such co-operation can take different forms, including improved co-ordination of activities and communication about areas of mutual interest and openness in discussing the results of audits and time schedules. Co-operation generally leads to a number of improvements including, for example:

- An increase in the efficiency of inspections, thereby allowing public authorities, industry and others to make the best use of limited resources (including workforce).
- A basis for the authorities to decrease the frequency or change the nature of inspections based on information provided to authorities.
- Improving the ability of the parties to learn from each other, with the result that they are better able to carry out their roles and responsibilities (e.g. the audit process can be improved based on the advice of the inspecting authority).

In undertaking to co-ordinate with industry, public authorities should ensure that this collaboration does not influence their ability to enforce the laws, nor should they be seen as having diminished their independence through such collaboration.

In order for collaboration to be successful, the management of hazardous installations should be competent and willing to address safety issues in a serious way.

Notes

[1] You can refer, for example, to the OECD Recommendation of the Council on Regulatory Policy and Governance (http://www.oecd.org/gov/regulatory-policy/49990817.pdf).

[2] Currently the 2015-30 Sendai Framework for Disaster Risk Reduction (https://www.unisdr.org/we/coordinate/sendai-framework).

[3] Currently the 2030 Sustainable Development Agenda (THE 17 GOALS | Sustainable Development (un.org)).

[4] See, for example, the relevant annexes of the Seveso III Directive and of the UNECE Convention on the Transboundary Effects of Industrial Accidents, the US Environmental Protection Agency (EPA) Risk Management Program and the US Occupational Safety and Health Administration (OSHA) Process Safety Management.

Part II
Emergency preparedness and mitigation

4 General principles for preparedness and mitigation

This chapter provides general principles for emergency preparedness and mitigation across stakeholders for onsite and offsite emergency planning. Industry has the primary responsibility for onsite planning and public authorities have primary responsibility for offsite planning. However, to be effective, the emergency planning process requires co-operation among the various stakeholders including, for example, management of hazardous installations, public officials, response personnel, health/medical personnel, representatives of the public and the media.

Establish emergency planning programmes

Public authorities (at all levels) and management of hazardous installations should establish emergency planning activities/programmes for chemical accidents.

The objective of emergency planning activities/programmes is to put into place the arrangements needed to localise any accidents that may occur and, if possible, contain them and minimise their harmful effects on health, the environment and property.

- A prerequisite for effective emergency planning is the identification of the hazardous installations located within the area and the identification of potentially affected populations, environment and property, including in all potentially affected countries, to be covered by the emergency plan.
- Onsite and offsite emergency plans should be prepared that include details of appropriate technical and organisational procedures to minimise the effects on health, environment and property (both onsite and offsite) in the event of an accident.
- Emergency planning should take into account potential complicating factors that could be associated with chemical accidents, as well as factors that may make emergency response more difficult. These include, for example, transport accidents, extreme weather conditions, other natural hazards, loss of power or water supplies, problems with communication and transportation systems, synergistic effects of accidents with multiple substances, “domino effects” and malicious acts.

Identification of possible scenarios, an assessment of potential environmental consequences of accidents and health consequences as well as of the potential risks should be part of the emergency planning process.

> Preparedness and mitigation of chemical accidents should be based on the principles of risk management. This builds on the principles of and uses the knowledge gained in chemical accident prevention.

Emergency plans should provide the necessary guidance to allow for flexible responses to a range of possible situations (from small accidents to worst-case scenarios). To avoid failure in their implementation, emergency plans need to take into account a number of aspects in their planning and preparation phases. These should include:

- The limited availability of information at the time of an accident.
- The need to train and practice the various elements of the emergency plan.
- The possibility that communication systems may fail.
- The notion that individuals are likely to be acting under increased levels of stress and therefore have limits in their performance and in the demands which can be placed on any one individual.
- The need to reduce and avoid complexity as far as possible in the emergency plan.

Emergency planning should take place at a local level to involve local stakeholders and communicate clearly with all parties, and so establish and maintain acceptance for and trust in emergency planning activities.

Countries of origin should inform all potentially affected countries of their emergency plans regarding hazardous activities that are capable of causing transboundary effects. All countries concerned should endeavour to make their offsite emergency plans compatible and, where appropriate, establish joint offsite emergency plans to facilitate adequate response measures.

Identify areas and populations potentially at risk

Areas and populations living and working in these areas potentially affected by a chemical accident should be identified with regard to the extent and severity of any consequences. These may arise from: direct contact with toxic or irritating substances; indirect exposure through ingestion of contaminated food or water or contact with soil and other sources; thermal radiation or overpressure; or indirect injuries from collapsing structures, projectiles or fire.

In carrying out this investigation, attention should be paid to the existence of critical infrastructure (including transport facilities and roads), environmentally sensitive areas and developments with sensitive populations (such as hospitals, nursing/retirement homes, shopping centres, schools or other areas where people congregate). In the case of developments with sensitive populations, it may be necessary to make direct contact with specific instructions in the event of an accident and the emergency plan should take this into account and set up processes to ensure that this takes place.

Within the risk assessment process, it may be useful to classify areas of similar adverse effects into zones to allow for the planning of warnings, evacuation and other response measures.

Co-ordinate onsite and offsite planning

The offsite emergency plan and all relevant onsite emergency plans should be consistent and integrated. This is necessary so that there is effective co-ordination and close co-operation between those responsible, interfaces between organisations are defined and responsibilities for various response functions are clear. In this regard, those involved need to be able to communicate effectively (i.e. common terminology and understanding).

Emergency plans (onsite and offsite) should identify the roles and responsibilities of all parties concerned and should indicate the chain of command, the lines of communication, the co-ordination among parties and the means for obtaining necessary information, resources and equipment.

All parties involved in an emergency response effort should be involved in the emergency planning process. This includes at least public authorities at different levels, management at the hazardous installations and first responders. Additional organisations may be involved as required, such as utility companies (electricity, water, gas, telecommunications), transportation, equipment or service providers.

Industry, public authorities and health/medical organisations should co-operate in order to ensure that health/medical personnel – who may be involved in an emergency response involving hazardous substances – are aware of the hazardous substances that are produced, used, transported or otherwise handled in significant quantities in their community. Health/medical personnel should also be aware of relevant aspects of local emergency plans and of their roles within these plans.

Warning systems should be developed to provide management of hazardous installations and local communities with warnings of natural hazards that can trigger Natural Hazard Triggered Technological Accidents (Natech, including, for example, floods, storms, high winds and extreme temperatures).

Communicate with the public

There should be opportunities for representatives of the public to provide input into the emergency planning process and their concerns should be taken into account in the process of developing the emergency plan. Representatives of the media should also be consulted during the development of emergency plans (e.g. the contacts and modes of information for warnings to the public) and involved in the awareness raising, communication and publicising of the plan.

Emergency plans should include processes to inform the potentially affected public of the correct response to an emergency, taking into account the unique communication situation within the relevant area. This communication should include guidance on what steps the public should take and cover amongst other information: a description of how the public will be warned; sheltering in place; requirements for evacuation; and emergency telephone numbers. Communication should be appropriate to the potential communities affected.

Emergency warning systems should be in place to warn the potentially affected public when a chemical accident occurs or if there is an imminent threat of a chemical accident. Suitable information explaining the purpose and use of early warning systems should be shared with the potentially affected public. The system chosen should be effective and provide timely warnings. Suitable warning systems could include one or a combination of, for example, sirens, automatic telephone messages and mobile public address systems, mobile telephone push services and smartphone applications. Systems should be regularly tested in advance so that their correct function can be ensured and their significance is fully understood by the public.

Spokespeople designated for emergency situations should be carefully chosen during the planning process so that they have the necessary knowledge, skills, authority and credibility to effectively communicate with the public.

- Spokespeople should be specifically selected and trained so that they understand how to develop information for target audiences and how to deliver information effectively.
- Since effective communication with the public during an emergency requires the co-ordinated involvement of a number of relevant parties – including, for example, local response officials, corporate spokespeople, employee representatives, community representatives, public authorities, technical experts and the media – the duties of these parties should be established during the preparation of emergency plans.

Review and test emergency plans

Onsite and offsite emergency plans should be tested and reviewed regularly. Tests should include both tabletop exercises and field exercises.

Emergency plans should be kept up-to-date taking into account, for example, changes in the nature of the risks, new residential and commercial developments in the area, changes in response technology and capabilities, lessons learnt from tests and from the application of plans during accidents and near misses, and changes in personnel.

Emergency plans should be reviewed to be sure they take into account preparedness for and mitigation of Natech, as well as the possible impacts of natural hazards and other natural hazards on infrastructure and response capabilities.

Exercises and testing increase the competency and confidence of response personnel in being able to deal with real emergencies. After testing, there should be a systematic review process to assure that the lessons learnt have been identified and the appropriate measures implemented. The process of reviewing and testing emergency plans should cover:

- Testing of emergency plans at appropriate intervals.
- Identifying needs for training (individuals, organisations and topics).
- Outlining goals and objectives:
  - Use of Specific – Measurable – Attainable – Realistic – Timely (SMART) goals
- Defining the scope of the test:

- Time, place, activities, scenarios, people and organisations.
- Assessing the need for cross-border activities and the requirements that this brings.
- Creating a learning and “no blame” atmosphere/environment throughout the process.

- Who should be involved:
  - Internal/external participants.
  - Different levels in the organisations from industry and public authorities.
  - Participation from the public.
  - Use of independent observers and evaluators.
- Selecting the most suitable methods for training (Figure 4.1).
- Evaluation – openness and transparency.
- Lessons learnt and improvements.
- Implementation of measures.

Figure 4.1. Examples of tests and training

Source: Adapted and translated from DSB (2016[1]), *Grunnbok: Introduksjon og prinsipper*, https://www.dsb.no/globalassets/dokumenter/veiledere-handboker-og-informasjonsmateriell/veiledere/grunnbok_oving.pdf.

Assess and ensure the availability of resources

During the emergency planning process, there should be a realistic assessment of the existing skills, equipment and other resources that are available for a response effort, and an assessment of the skills, equipment and other resources required based on the range of possible accident scenarios, including

worst-case scenarios. These assessments will provide insight into what additional skills, equipment and resources are needed.

All responsible parties should ensure that human resources, equipment (including communication equipment and personal protective equipment) and financial and other resources necessary to carry out emergency plans are readily available for immediate activation in the event or imminent threat of an accident.

- Public authorities in neighbouring communities (within a country or across borders) and neighbouring facilities may consider sharing (mutual aid) or pooling their resources (including equipment, expertise, health-related resources and information) in order to make the best use of response capabilities. Efforts should be made to ensure the compatibility of equipment and other relevant resources that are made available for sharing with other communities (e.g. hose fittings).
- In certain areas, it may be necessary for enterprises to provide response capabilities such as equipment and resources to respond to accidents originating at their installations to compensate for the lack of resources available to local authorities.

Emergency planning activities need to be transparent to stakeholders with regard to the resources and capabilities available and their limits. It is important to clearly communicate what response activities will not be possible and the expected behaviours to be adopted by the public in the event of an emergency.

Emergency plans should ensure that information, supplies and equipment are available in an event and mechanisms are available to collect data (e.g. metrological data, detection of hazardous substances).

The emergency plans should have in-built resilience. For example, alternative communication lines should be available, relief and recovery for responders should be assigned, sanitary facilities and feeding stations should be provided and an alternative command centre should be designated in the event that the primary centre cannot function properly.

Engage in international co-operation

Public authorities, industry and other stakeholders should be involved in multinational and regional co-operative activities related to emergency planning, where appropriate, in order to share experience, improve planning and facilitate appropriate co-ordination of emergency response in the event of an accident.

Countries, with the assistance of international organisations, should train those involved in response to chemical releases caused by chemical accidents in the principles of health risk communication, in particular in the context of malicious acts. Materials should be developed to strengthen the capacities and capabilities of a range of professionals, including public health professionals, emergency responders, medical professionals and others.

Prepare for cyber events

Industry should have plans in place to identify and respond to cyber events. These should cover roles and responsibilities, mitigation measures, information pathways and required resources.

Plan for events of (potential) international health concern

Emergency plans should address chemical events that are of (potential) international public health concern in accordance with international and transboundary regulations and agreements, in particular the World Health Organization (WHO) International Health Regulations (IHR) (Box 4.1).

Box 4.1. WHO International Health Regulations (IHR)

The IHR are an instrument of international law that is legally binding on 196 countries, including the 194 WHO member states. The IHR grew out of the response to deadly epidemics that once overran Europe. They create rights and obligations for countries, including the requirement to report public health events. The regulations also outline the criteria to determine whether or not a particular event constitutes a "public health emergency of international concern".

At the same time, the IHR require countries to designate a national IHR focal point, to establish and maintain core capacities for surveillance and response, including at designated points of entry. Additional provisions address the areas of international travel and transport such as the health documents required for international traffic.

Finally, the IHR introduce important safeguards to protect the rights of travellers and other persons in relation to the treatment of personal data, informed consent and non-discrimination in the application of health measures under the regulations.

Source: WHO (2023[2]), *International Health Regulations*, https://www.who.int/health-topics/international-health-regulations#tab=tab_1

References

DSB (2016), *Grunnbok: Introduksjon og prinsipper*, Direktoratet for samfunnssikkerhet og beredskap, https://www.dsb.no/globalassets/dokumenter/veiledere-handboker-og-informasjonsmateriell/veiledere/grunnbok_oving.pdf. [1]

WHO (2023), *International Health Regulations*, World Health Organization, https://www.who.int/health-topics/international-health-regulations#tab=tab_1. [2]

5 Emergency preparedness and mitigation: Principles to industry

This chapter addresses the specific tasks by industry to prepare onsite emergency planning and establish cooperation for offsite planning.

Develop an onsite emergency plan

All facilities should have a suitable onsite emergency plan, which covers all installations of that facility and is based on a complete range of accident scenarios, including most probable chemical accidents as well as scenarios with lower probability but high consequences.

Management of all hazardous installations – including enterprises that are not considered part of the chemical industry but use or handle hazardous substances – should identify and assess the full range of accidents that could arise at the installations as well as the appropriate response actions. This information should be available in safety reports or related reports, where such reports have been prepared (see section on risk assessment and safety reports in chapter 2).

An onsite emergency plan should contain:

- A scale plan of the site.
- A list of all hazardous substances handled, indicating the quantities involved, and their locations on the site.
- A description of the hazards involved, including information regarding each hazardous substance and the conditions under which it is processed, handled and stored.
- First aid needs in the event employees or the public are exposed to a hazardous substance.
- A description of the surrounding area and a description of the relevant population.

Onsite emergency plans should also provide for the emergency shutdown or bringing to, and keeping in, a safe state of operation. Procedures for doing this must be defined in the safety management system (see section on safety management system in chapter 2).

Emergency plans should contain clear criteria that establish when public authorities should be called in to respond to accidents with potential offsite effects.

- These criteria should make it clear at what stage to contact public authorities, and whom to contact.
- The fact that public authorities are involved in response does not change the fact that the enterprise remains responsible for the safety of its installations, including the adverse effects of any accidents.

Onsite emergency plans should identify the roles and responsibilities of all parties concerned so as to avoid conflicts. In doing so, chains of command and lines of communication should be defined, as well as the means by which necessary information should be obtained and transferred through these structures.

- As part of the onsite emergency plan, individuals should be nominated for the following roles, among others:
  - Onsite (enterprise) co-ordinators to take control of the scene in the event of an emergency.
  - Onsite main controllers from the emergency control centre of the enterprise to take overall control of an emergency and to communicate with public authorities.
  - A person responsible for initiating activation of the offsite plan.
  - A person responsible to assist response personnel with information, expertise and other resources, as needed.
- In establishing the responsibilities for various employees in the event of an accident, the onsite emergency plan should be flexible so as to manage foreseeable variations in staffing, taking account of such matters as absences due to sickness, holidays and periods of installation shutdown.
- The role of the onsite co-ordinator and site main controller in relation to external emergency response personnel should be clearly defined to avoid any potential conflicts. The onsite co-ordinator and controller may be subject to decisions made by the accident (on-scene)

co-ordinator of the public authorities. The onsite co-ordinator and controller need to co-ordinate with the accident co-ordinator of the public authorities. Mechanisms and protocols should be established within the emergency plan to facilitate this.

The preparation and implementation of the onsite emergency plan should be the responsibility of management in co-operation with other employees.

All employees, including sub-contractors, at a hazardous installation should be made fully aware of the relevant provisions of the onsite emergency plan. In particular, they should be made aware of what to do in the event of an emergency, such as taking action to limit the release of hazardous substances and/or evacuating the installation and gathering at a previously designated assembly point.

- All employees should be informed of the procedures for raising the alarm in the event of an accident or threat of an accident to ensure that the earliest possible action is taken.
- Onsite managers should ensure that appropriate employees are familiar with the capabilities and emergency response plans of the fire authorities and other emergency responders.

Visitors to a hazardous installation should be provided with relevant information concerning what they should do in the event of an emergency and they should generally be accompanied at all times by a facility employee.

Management of hazardous installations should ensure that sufficient quantities of appropriate emergency supplies are available. Management should be aware which supplies have a limited shelf life. It may be appropriate to develop plans on how to obtain supplies at very short notice, e.g. specialist firefighting foam and absorbent material.

Any hazardous installation that does not have all of the necessary knowledge and expertise to undertake emergency planning should seek assistance to meet this obligation. This could be from trade associations, consultants, neighbouring installations, suppliers or public authorities.

Facilities in the same geographic area (including, for example, facilities within port areas or facilities in an industrial park) should co-ordinate their onsite plans and response activities in order to ensure the plans are consistent, establish systems for mutual aid when needed and help avoid domino effects.

The onsite plans should be available for review by public authorities and provided to the appropriate public authorities for the development and co-ordination of offsite emergency plans.

Co-operate with the development of offsite emergency plans

Management should work with public authorities in the development of offsite plans to ensure that the people responsible for the preparation of offsite plans have all the necessary information for their plans, including information needed to assess hazards and to help ensure the compatibility of offsite and onsite plans.

As part of the emergency planning process, management should co-operate with emergency responders to consider response options to various accident scenarios and to agree on appropriate options for different scenarios.

For emergency preparedness, response and follow-up purposes, management should make available health-related information concerning the hazardous substance(s) it manufactures and/or distributes, stores, handles, processes, disposes of or otherwise uses in the workplace. This includes information on the composition and toxicological, eco-toxicological and other relevant properties of hazardous substances, including solvents and additives.

In addition to information concerning the installation and the chemicals onsite, management should co-operate with public authorities in the routing and identification of pipelines and transport routes outside the boundary fence of the hazardous installation that carry hazardous substances to and from the installation.

Management should never withhold information needed for the development of emergency plans. Thus, the claim that information is a trade secret or confidential business information should not be used as an excuse to withhold this information. However, arrangements should ensure that anyone who receives sensitive information maintains its confidentiality and security, as appropriate.

Industry should co-operate with public authorities to ensure that the potentially affected public has the appropriate information to understand potential chemical accidents which may occur and the appropriate actions to be taken in the event of an accident. Management and other employees at hazardous installations should maintain close relations with community leaders, education facilities and other members of their local population in order to help promote awareness and understanding of chemical accident risks.

6 Emergency preparedness and mitigation: Principles to public authorities

This chapter addresses the specific tasks by public authorities to ensure and support the development of onsite and offsite emergency plans.

Ensure and support the development of offsite and onsite emergency plans

Public authorities should ensure the development, implementation, testing and updating of offsite and onsite emergency plans wherever there is a hazardous installation. It is recognised that the responsibility for the actual development and implementation of such plans will differ between countries.

The responsibility for the development and implementation of offsite emergency plans will depend on the local laws and policies that are applicable. It may rest with local officials or with a designated group or committee and may include involvement by regional or national authorities. At all times it should be clear who has the decision-making responsibility.

Public authorities should ensure that all hazardous installations, including commercial users of hazardous substances, base their emergency planning on the full range of accident scenarios with consideration of potentially affected populations, environment and property (see Box 6.1 for the key elements of an emergency response plan).

As part of the emergency planning process, there should be an assessment of the potential environmental consequences of accidents and health consequences, and an assessment of the potential risks.

Public authorities at various levels have responsibilities related to offsite and onsite emergency planning:

- Central (national or regional) authorities should provide advice and assistance to local authorities, where appropriate, and ensure that officials at all levels are motivated to develop appropriate emergency preparedness and response capabilities.
- Public authorities at the local level should ensure that offsite and onsite emergency plans are co-ordinated and can be implemented consistently with the principles established at the central level.

Public authorities at all levels should integrate emergency planning for hazardous installations with emergency planning for natural disasters (such as floods, earthquakes and storms) and civil protection, as these activities involve many of the same requirements. This should result in co-ordinated and consistent emergency plans and include a co-ordinated command structure. It should be kept in mind that natural hazards can trigger accidents and can require adjustments in emergency response activities.

Public authorities should establish guidelines and standards for developing offsite and onsite emergency plans.

Box 6.1. Key elements of an emergency response plan

The key elements of an emergency response plan are as follows:

- Identification of hazardous facilities and information on the chemical risks associated with those facilities including identification of hazardous chemicals and the amounts of those chemicals, identification of events that can lead to uncontrolled releases, fire and explosion predicted consequences of the release and associated damages, and prevention measures in place at the facility.
- Emergency response procedures for facility owners and operators, as well as for local emergency, medical, public health and environmental protection personnel.
- Designation of an emergency co-ordinating officer (on-scene co-ordinator) and a facility emergency co-ordinator to implement the plan (including the necessary authority to mobilise and co-ordinate the emergency services).

- Procedures for notifying the public and the local emergency response team that a release has occurred.
- Templates for communicating information to the public and the media.
- Methods for determining the occurrence of a chemical release.
- Determination of the probable area and population affected by potential releases, including considerations of environmental justice, vulnerable residents, fenceline communities, etc.
- Identification of emergency response equipment in the community and at the facilities in the community, and the persons responsible for them (including identification of the response capabilities of regulated facilities).
- Evacuation plans (including evacuation routes and shelter-in-place procedures).

Identify all parties involved in emergency response

Public authorities should identify all parties who are expected to participate in emergency response, as part of the development of an offsite emergency plan. In addition, the roles and responsibilities, resources and capabilities of these participants should be realistically established and their commitment obtained. These participants may include:

- police, fire, medical (including hospitals), transport and welfare services
- emergency management or civil protection agencies
- public works and utilities
- the management of hazardous installations
- local officials
- public information/communication outlets
- public health and environmental agencies.

When establishing the emergency plan, it should be considered what capability is available on site within an enterprise to respond to potential accidents.

For cases where an accident at a hazardous installation may have effects on neighbouring communities, emergency planning and response should be co-ordinated among the potentially affected communities. Where an accident may have transboundary effects, emergency planning and response should be carried out in co-operation with all potentially affected countries and in line with international, regional and transboundary regulatory agreements.

Educate and train personnel involved in emergency response

All personnel involved in the emergency response process (including, for example, first responders such as police, fire and ambulance personnel) should be trained and educated with regard to the offsite emergency plan.

Emergency response training and education should, as a minimum, allow first responders to become familiar with:

- The local emergency plan(s).
- The hazardous installations in the community, including the results of the risk assessment of these installations.
- The personal risks posed to responders in an emergency.

- The need for protective measures when responding to chemical accidents, including the use of protective clothing and equipment.
- Important properties of different hazardous substances in their communities and the means for responding to accidents involving such substances.
- Contamination hazards and procedures for decontamination.
- Specific first aid measures.
- Possible adverse psychological effects on victims, emergency responders and the public.

Emergency response training and education should allow response personnel to take appropriate actions to minimise the adverse effects on health, the environment and property from chemical accidents. It should also allow them to improve their ability to gather information concerning possible adverse effects on health, the environment and property.

There should be joint training and exercises among stakeholders who may be involved in the emergency response (including, for example, response personnel and health/medical personnel).

Public authorities responsible for emergency response, including fire and rescue services, should familiarise themselves regularly with the relevant information concerning hazardous installations in their area, for example, access to the site, compatibility of emergency response equipment and onsite equipment, and communication between onsite emergency personnel and emergency responders.

Public authorities should ensure that emergency responders have access to sources of information (such as designated information centres) capable of providing the information needed in an emergency for the diagnosis, treatment and rehabilitation of persons injured by hazardous substances.

Communicate with the public and the media

When alerted to a chemical accident, response authorities should activate their emergency plans, including mechanisms for ensuring that the public is notified in a timely manner and informed about what actions to take to minimise adverse consequences.

As part of the emergency planning process, public authorities should ensure that systems are in place to provide information to the public following an accident and the immediate emergency response. During and after an accident, timely, credible, sensitive, informed, factual and accurate information should be provided openly and continuously to the public.

- Such information should cover the offsite effects of the accident, the risks of further adverse offsite effects, actions to be taken by the public and related follow-up information.
- To be effective and trustworthy, information provided to the public must be factual and simple.
- Communication with the public and media (social media, television, radio and print) during an accident demands special training and requires preparation. Templates and guidance should be developed as part of emergency planning. Contact between the media and the public should be developed and maintained as a long-term relationship.

Plan for response to health impacts

Emergency planning should take into account the range of possible health effects (acute, long-term and psychological effects) that could result from chemical accidents and the response actions that should be taken to address these effects on response personnel, employees and the community.

- Adverse effects may appear immediately or some time after the accident.

- Psychological effects, not necessarily related to exposure to hazardous substances, could appear during or after the accident. Emergency planning should take into account mechanisms for reducing stress and providing counselling services for those with responsibilities for crisis management and communication.

The emergency planning process should take into account the need to protect healthcare workers from exposure to hazardous substances.

- Such exposure could result from handling victims who have not been adequately decontaminated or from unexpected exposure at the site due to, for example, changes in wind direction.
- Healthcare providers normally should not enter contaminated areas, unless there are exceptional circumstances (e.g. for triage or life-saving procedures). In such cases, they should be fully protected, accompanied by rescue personnel and should not be allowed to exceed established exposure limits.

Hospitals and other treatment facilities, which may be called on during response to a chemical accident, should develop emergency plans (co-ordinated with the local offsite plan).

- These plans should describe systems/procedures for receiving and handling large numbers of patients at one time.
- These systems/procedures should address, for example: triage; arrangements for patient identification and documentation; and possible decontamination.
- Public authorities should ensure that these plans are in place and should assist in their development.

As part of the emergency planning process, there should be an assessment of the types of emergency medical resources needed to respond to different types of emergencies and to the range of possible casualties.

- Sharing and/or pooling of resources among public authorities and industries should be explored.
- In particular, the availability of oxygen as well as up-to-date antidotes and other pharmaceutical substances necessary for the treatment of persons injured by hazardous substances should be ensured.

As part of the emergency planning process, it should be ensured that adequate medical facilities are available, including transportation facilities.

- Decontamination equipment for onsite and hospital use and, as appropriate, protective equipment for medical emergency response personnel should be available.
- Public authorities, in co-operation with hospitals/treatment facilities, should establish backup procedures and systems for moving and treating a large number of victims if local hospitals and treatment facilities are inadequate (e.g. insufficient capacity or lack of specialised facilities).
- In order to accommodate emergency needs, provisions should be made for the rapid transformation of facilities normally used for other purposes. For example, when access to hospitals is limited, alternative premises such as schools, sports facilities and tents should be identified as places where temporary medical care could be provided to accident victims.
- Emergency plans should indicate the protective measures that should be taken in the event a hospital or other treatment facility is contaminated or otherwise threatened as a result of an accident (e.g. loss of electricity, structural damage or when the hospital is downwind from a release of hazardous substances).
    - Hospital/treatment facilities should make provisions for evacuating patients or for decontamination in the event the facilities become contaminated.

- Hospitals should also be aware that they may need to take special precautions if they have hazardous substances on site or if they receive contaminated patients.

Public health and education authorities should ensure up-to-date training of all relevant emergency medicine health/medical and paramedical professionals in emergency plans and arrangements, risks in the community, available resources and other relevant factors.

The organisation and planning of health-related response to accidents should involve veterinarians, biologists and others familiar with the care of livestock, pets and wildlife, both in order to protect the animals and to provide support to their owners/caretakers.

Plan for the protection of the environment

Public authorities should be aware of the potential risks to the environment due to a chemical accident. In particular, risks of contamination of the soil, watercourses and groundwater should be considered.

When developing emergency plans authorities should be aware of the need to manage the use of firefighting water, foam and other chemicals for example oil dispersants. Where possible, cooling water (usually lower contamination) should be separated from extinguishing water (higher contamination). Plans should be made to contain firefighting water on site and to prevent any escape into watercourses or groundwater. Plans should consider any potential release to the municipal wastewater treatment system and the necessary measures to retain and treat any contamination reaching the treatment works (Box 6.2).

Box 6.2. United Nations Economic Commission for Europe (UNECE) Safety Guidelines and Good Practices for the Management and Retention of Firefighting Water

The safety guidelines and good practices aim to support governments, competent authorities and operators in minimising the risk of fire and safely retaining firefighting water. They are intended to enhance existing practices and promote harmonised safety standards for firefighting water management and retention, in order to prevent accidental pollution of soil and water, including pollution that could cause transboundary effects. The guidelines were developed by the Joint Expert Group on Water and Industrial Accidents – a joint group between the Water and Industrial Accidents Conventions – in co-operation with the Expert Group on Fire-water Retention and supported by the UNECE secretariat.

Source: UN (2019[1]), *UNECE Safety Guidelines and Good Practices for the Management and Retention of Firefighting Water*, https://www.un-ilibrary.org/content/books/9789210042901.

Plans should be made to respond to any environmental contamination as soon as possible after it occurs. This may include barriers containing absorbent materials such as oil booms, for surface waters, sheet piling and pumps for groundwater and excavation of soil.

Public authorities should plan so as to be able to warn the relevant organisations and population in all affected areas in the event of environmental contamination with regard to the consumption of agricultural crops, produce from gardens and allotments, and the extraction of drinking water from groundwater or from surface waters.

Reference

UN (2019), *UNECE Safety Guidelines and Good Practices for the Management and Retention of Firefighting Water*, United Nations Economic Commission for Europe, https://www.un-ilibrary.org/content/books/9789210042901. [1]

Part III
Emergency response

7 General principles for response

This chapter provides general principles on the roles and responsibilities of industry and public authorities in responding to chemical accidents. Response activities should consist primarily of implementing the emergency plans, assuming that the planning process was complete and effective.

Systems should be in place to immediately alert response personnel in the event of a chemical accident or an imminent threat of an accident, which would require their involvement.

- This alerting of response personnel should trigger the implementation of the emergency plan.
- These systems should also inform the management that an accident or imminent threat of an accident has occurred.

In the event of a chemical accident, stakeholders should take all reasonable measures to minimise exposure of people and the environment to hazardous substances and to limit adverse effects on health, the environment and property. This shall include all hazardous substances involved, including those generated in the accident or resulting from the emergency response such as firewater.

In the event of an accident, systems should be activated to warn the members of the public who might be affected by the accident. Spokespersons designated to communicate to the public (including those from industry and public authorities) should have the necessary information, as far as it is available, skills, authority and credibility to effectively carry out this task.

- Official spokespersons should be as open as possible in providing information during and after an accident
- In this regard, they should, for example, be timely in presenting information, admit when information is not available, avoid making promises which cannot be fulfilled and ensure that the messages provided are consistent with actions taken.

Co-operation mechanisms should be established between responders at all levels of response. This should ensure that clear communication pathways and a common language between the response partners are defined.

Communication at a personal level, where possible, should be encouraged. This should involve commanders and their units who are to be expected to respond together in particular scenarios.

From the prepared response plan and early stages of the response, considerations should be made with regard to post-accident clean-up and recovery and the transition to these phases. During the transition between emergency response operations and clean-up and recovery activities, all those involved should co-operate and exchange information to maintain safety and protect and/or restore the environment and property.

Once an incident is under control and no longer presents an acute risk to human health, to the environment or of serious property damage then the emergency response will end. This should be a decision taken by the incident commander following consultation with all relevant response organisations.

- At this point, response organisations will begin to withdraw from the incident site and the site will be handed over to those responsible for the investigation, securing the site and initiating clean-up and restitution.
- The handover process should be documented as responsibilities move from one agency to the next. In particular, consideration should be given to the possibility that the overall responsibility for the site moves from emergency responders to authorities responsible for criminal investigations and other enforcement roles.

Following a chemical accident, the response should be reviewed and lead to feedback into the emergency response planning cycle.

8 Emergency response: Principles to industry

This chapter provides principles on the specific role of industry during the response to chemical accidents.

In the event of a chemical accident, management of the hazardous installation or designated official should immediately activate its onsite emergency plan.

In the event of a chemical accident that results or threatens to result in harm to health, the environment or property off site, or otherwise cannot be handled by onsite response resources, management or other employees of a hazardous installation should promptly alert local emergency response authorities. National or local regulations may require the emergency response authorities to be alerted to an incident, even if it can be handled by onsite response resources. This may be separate from a requirement to notify authorities that an accident has occurred.

Management should designate a responsible person to assist response personnel with information, expertise and other resources, as needed.

In the event of a chemical accident, the public authorities, in addition to the emergency responders, should be contacted in the manner and according to the mechanisms defined in the internal (onsite) emergency plan.

- These authorities may be responsible for the enforcement of labour protection, environmental protection or civil protection measures. Appropriate communication and co-ordination should be ensured at all times.
- All necessary information should be made available as far as possible.

9 Emergency response: Principles to public authorities

This chapter provides principles on the role of public authorities in the response to chemical accidents. The focus of the activities described here is primarily the local area where an accident has occurred; the public authorities addressed here therefore include local response authorities (e.g. fire, emergency medical and police) and local/regional government agencies, as well as health/medical facilities. If accidents escalate, authorities should be aware that regional, national and transboundary plans may need to be triggered.

Activate the offsite emergency plan

When alerted to a chemical accident, response authorities should activate their emergency plan.

- The objective is to put into place the arrangements needed to localise the accident and, if possible, contain it and minimise the harmful effects on health, the environment and property.
- Authorities should activate the measures in the emergency plan to alert the public who may be affected by the accident. Authorities should ensure that the public is informed about what actions they need to take and are kept updated as the situation changes.

The systems that have been defined in the emergency plan should be activated as required to obtain the equipment, specialists and other resources needed for the response. This could include obtaining assistance, as needed, from regional or national authorities, or from emergency responders in neighbouring or other appropriate communities, or the international community.

Public authorities, at the regional or national level, should support local response operations to the extent possible to help protect health, the environment and property. Such support could include but is not limited to:

- Providing technical, scientific, policy, meteorological and legislative information and advice to response personnel.
- Undertaking inspections and sampling to determine the extent of contamination.
- Identifying environmental resources and animals at risk, spill behaviour predictions, weather forecasts and priorities for protection.
- Providing guidance on the protection and clean-up of affected wildlife.

Call on the on-scene co-ordinator

The on-scene co-ordinator should decide on the immediate actions to take to avoid or limit exposure of humans to hazardous substances, both on and off site, including measures to avoid contamination of emergency responders. The on-scene co-ordinator should obtain information and advice from the management of the hazardous installation, as well as from other experts, concerning how best to protect health, environment and property from the hazardous substances involved in the accident.

> The site incident controller or on-scene co-ordinator is the person responsible for taking control at the scene of the incident. The person should have a thorough knowledge of the facility and the situation. A suitable job function to fill this role is the establishment manager, shift manager or shift supervisor.

For cases where the response requirements go beyond what was foreseen in the emergency plan, or other difficulties are encountered, the on-scene co-ordinator should seek assistance. This assistance could include information from outside specialists who may be able to provide fast reliable information. In the event an accident cannot be controlled using local response resources, requests should be made to get support from, as appropriate, neighbouring communities, regional or national authorities, other countries, industrial networks or the international community.

It is important that decisions concerning appropriate actions may change over time, in light of changes in the circumstances and availability of updated information. Any type of response (including limited intervention) requires appropriate monitoring and follow-up to ensure that all consequences are recognised and actions, where needed to protect health and the environment, are undertaken.

Establish systems to provide real-time information to assess response

Systems should be accessed to provide immediate, on-the-spot information that can be used to assess and respond to an emergency. In addition, systems should be used for the collection, dissemination and updating of information that is to be made available to health/medical personnel and other relevant parties as the emergency response progresses, including medical information or advisories given to the public via the media.

The information to support response actions includes:

- Information to be provided via the onsite co-ordinator (company) to the incident commander (emergency responder):
  - Information on the quantity and nature of the hazardous substance(s) involved in the accident.
  - Potential for further accidents or escalation of events.
  - Information on the expected number and types of patients, the nature of their injuries and the severity of exposure.
- Information to be made available through electronic databases or safety data sheets (SDS):
  - Physicochemical properties; the possible transformation of degradation products of the substance(s), such as when in contact with water or through pyrolysis; toxicological and eco-toxicological properties; clinical effects, including acute, delayed and long-term effects; and risk assessments.
  - Information on how to fight fires and/or manage the chemical spill.
  - Guidance concerning the levels of acute exposure to various hazardous substances, likely adverse effects, and methods for protecting against such effects.
  - Information on first aid and medical treatment; the nature of the information should be appropriate for the target audience including, for example, the lay (not medically qualified) person, the general practitioner and the specialised medical expert (such as an intensive care professional).
  - Means of transporting victims.
  - How and when to contact essential services, including central authorities, local authorities, police, fire and other rescue services.
    - Who has the local co-ordinating role in an emergency and the criteria that determine the transfer of command-and-control to a higher authority.
    - Lists of experts (from industry, public authorities, etc.) who can advise on particular hazardous substances or groups of hazardous substances.
    - The medical information or advisories provided to the public via the media.
- This information should be provided via the onsite co-ordinator (company) to the incident commander (emergency responder).

Establish zones at the accident scene

On the arrival of the emergency responders at the place of the accidents, danger/safety zones should be established. These zones are established primarily to reduce the accident's spread of hazardous substances and to delineate areas where emergency responders can operate without special protective equipment. A system of establishing *hot, warm and cold zones* should be defined in the external emergency plan together with the appropriate measures that must be adopted. This should be co-ordinated with the internal emergency plan. This system helps organise the response at the accident scene (Box 9.1).

Box 9.1. Hot zone, warm zone and cold zone

Hot zone

- The area where the risk for contamination and the probability of exposure to hazardous substances is highest. Possible life-threatening injury.
- The area closest to the accident/source of the leakage of hazardous substances.
- Only emergency responders with the right skills and the highest protective equipment can work in this zone.
- Evacuation of patients to a safe zone, stabilisation of the incident and necessary technical efforts.
- The size of the zone depends on the properties of the substances involved, sizes of leakage, related hazards and risks.

Warm zone

- Possible contamination and light symptoms/signs of illness.
- Treatment and decontamination of patients. At the first triage, life-saving intervention and then decontamination only if the patient is visibly contaminated.
- Requirements for respiratory protection and protective clothing for responders due to contamination from patients.
- Ambulance personnel with protective equipment and training can be a resource inside the warm zone and do triage and treatment of decontaminated patients.
- Establish decontamination station.
- Mass decontamination to be organised if needed.

Cold zone

- No specific demand for protective equipment.
- Possible place for incident commander centre.
- The zone marks the outer barrier of the scene of the accident.
- Demarcation towards activities outside the scene of the accident and the public.

Organise response for health impacts

Recognising that immediate response decisions tend to be primarily driven by the need to protect people from acute toxic effects, response decisions should also take into account the possible long-term or delayed effects on health from exposure to hazardous substances (direct and indirect) and possible environmental impacts. Information should be available to support decision-making concerning how to treat people who have been exposed to chemicals and may have long-term, delayed or unobserved adverse effects.

Hospitals and other treatment facilities should put their emergency plans and their part of the community emergency plan into effect as soon as they are alerted that there is a possibility of patients arriving as the result of a chemical accident.

Health/medical personnel and facilities should be part of the overall response team and part of the information chain, in order to provide and receive information as appropriate.

- Hospitals and other treatment facilities that may be involved in responding to an accident should be provided, as soon as possible, with information on the hazardous substance(s) involved, the type of accident (spill, fire, etc.), the likely number of victims and the nature of their injuries.
- For the appropriate treatment of exposed victims, health/medical personnel should have access to specialised information and should consult, as appropriate, with a variety of specialists (for example, toxicologists, lung and respiratory specialists, ophthalmologists, haematologists and occupational health physicians).

Following an accident, there should be psychological support at an early stage, where appropriate. Specifically, professionals/counsellors with psychiatric, psychological or psycho-social training should be available in a timely manner.

The planning process should take into account the role of other caregivers in providing emotional and psychological support (e.g. clergy, funeral directors), in particular in communities without access to adequate numbers of psychologists or psychiatrists.

In high-risk areas, epidemiological data and internationally accepted instruments for the assessment of mental health impacts should be available so that monitoring can take place following an accident.

When an accident results in death(s), any people handling the remains (such as response personnel, medical examiners and morticians) should be protected against possible contamination from the hazardous substances. Someone should be designated in the emergency plan with the responsibility for providing information and assistance to people handling human remains.

Document decisions and actions

The organisations involved in the response should document decisions and actions taken during the response to an accident in order to be able to review the effectiveness of the intervention, learn from experience, improve emergency plans, have input into an investigation and learn lessons for future response activities.

Part IV
Follow-up to incidents

10 Incident investigations

This chapter provides principles on how to conduct incident investigations. Incident investigations consist of identifying the underlying causes (sometimes called the “root” causes) in a chain of events leading to an accident, including initiating events and failure in the mitigation, the lessons to be learnt and ways to prevent similar accidents in the future. The investigation should not be limited to determining the immediate or apparent cause(s). Investigations can be conducted both by industry and by public authorities.

> *"Incident investigation is a process for reporting, tracking, and investigating incidents that includes a formal process for investigating incidents, including staffing, performing, documenting, and tracking investigations of process safety incidents and the trending of incident and incident investigation data to identify recurring incidents. This process also manages the resolution and documentation of recommendations generated by the investigations." (CCPS, 2022[1])*

General principles

These general principles apply to investigations by both industry and public authorities. Investigations by different parties may have different objectives (for example, public authorities might be doing an investigation for purposes of enforcement). Nevertheless, investigations by industry and public authorities have a number of common elements, in particular with respect to methodologies to be used. Generally, industry-initiated investigations will be conducted separately from those initiated by public authorities, although joint investigations may be possible.

Investigate all incidents

All incidents involving hazardous substances should be investigated (Box 10.1).

Identify the root causes, develop recommendations to prevent recurrence and ensure implementation of the recommendations

The emphasis in conducting investigations should be on identifying the "root" causes in a chain of events leading to an accident, including initiating events and failure in the mitigation.

Finding the "root cause" of an incident is going to the point of determining the cause(s), as far as this is possible, which, if corrected, will prevent the recurrence of events that could lead to the same or a similar accident/near miss.

The objectives of root cause investigations should be to:

- Determine why the incident(s) happened – what were the underlying cause(s), contributing cause(s) and chain of events.
- Develop plans for corrective action to be taken by management in order to prevent related or similar incidents. The recommendations from investigations should be specific so that they can lead to corrections of technology, procedures or management systems. Generally, an investigation will lead to multiple recommendations for actions (i.e. no individual action will usually be sufficient): these should be prioritised and balanced to achieve the best level of safety possible.
- Implement the plans. There should be an adequate follow-up to an investigation in order to verify that corrective actions have been taken and that they were implemented as intended.

Establish protocols for conducting investigations

Protocols should be established for conducting root cause investigations. The protocols should:

- Specify the steps in the investigation process.
- Identify the roles and responsibilities of the individuals involved in the investigation and how organisations will interact.

A team should be established for the investigation:

- All members of the investigation team should have the appropriate knowledge, competency and experience to carry out investigations and to fulfil their identified roles and responsibilities.
- The team should have a diverse membership with participants from different disciplines, with different skills, including members with human factors expertise and those with knowledge of the specific installation subject to the investigation. These could be employees involved with the operation and maintenance of the installation and their representatives.
- The leadership of the team should as far as possible be independent of the operational unit under investigation.
- Consideration should be given to the use of third parties, such as consultants, to manage or carry out the investigation or parts of the investigation, to evaluate the findings and help ensure the quality of the results as well as the recommendations set out in the report.

The appropriate point for stopping the investigation should be identified to help ensure that it is not stopped prematurely or unnecessarily lengthened.

Prepare an investigation report

Investigation reports should be prepared and should include, as a minimum, a factual chronology of the events leading up to the accident/near miss, a statement of the underlying (or root) causes and contributing causes, and recommendations for follow-up actions. The report should also document which theoretical causes of the accident have been discounted and why.

A basic agreed framework and use of common terminology for preparing investigation reports should be developed in order to facilitate sharing of information related to investigations. As far as practicable, terminology across sectors should be harmonised at an international level to allow improvements in data sharing, accident investigation techniques and communication of lessons learnt.

Review and improve the investigation process regularly

Following an investigation, there should be a review of the investigation process.

Methods and approaches used in investigations of incidents should be developed, improved and shared. This should include training in their application.

Box 10.1. Incident investigation

An investigation should be a fact-finding activity to learn from experience, not an exercise designed to allocate blame or liability. However, the conclusions of an investigation may lead to enforcement activities on the part of public authorities. Those involved should be made aware of this. There should be full co-operation between the operational staff at the installation and those involved in the investigation.

The emphasis when conducting investigations should be on identifying the underlying causes (sometimes called the "root" causes) in a chain of events leading to an accident, including initiating events and failure in the mitigation, the lessons to be learnt and ways to prevent similar accidents in the future. The investigation should not be limited to determining the immediate or apparent cause(s).

It should be recognised that accidents are generally the final stage of a long sequence of events in which there is a complex interplay between failures in technical, human and organisational systems.

Where "human factors" are involved, the cause should not simply be recorded as such. Rather, investigators should determine exactly what elements contributed to any human error. Such elements could include, e.g. boredom, stress, overwork or insufficient training. Other root causes could be: the system was not sufficiently error-tolerant; the operating procedures were not made available in written form or were not kept up-to-date; the procedures were not realistic, created difficult circumstances or called for illogical actions by the operator; there was poor ergonomic or system/technology design; the process design did not provide the operator with enough data or provided too much data to expect an appropriate response; staffing was insufficient; there was undue pressure on the operator or manager to sacrifice safety to higher productivity; or a reorganisation or a change in staff was not properly managed. Human factors are not limited to operator errors but may occur at different points in the hierarchy of the enterprise including, for example, at the level of those responsible for maintenance, management of change or permit-to-work systems, or at the level of supervisors and management. Examples of human factors, in addition to operator errors, can involve: problems with the transmission of knowledge, especially when experienced specialists retire; the complexity of the system, including process design and engineering; the ageing of plants and related repairs, without adequate maintenance and inspection; and the need to cope with changes in organisation or technology, including automation.

The procedure for root cause investigations of accidents should be systematic, thorough and fair. The procedures should consist of five main phases:

- The first phase is before there is access to the accident site when a number of steps can be taken to further the investigation including: organising the investigation team; interviewing eyewitnesses; organising an information and tracking system; organising lists of factors which might have influenced the event; developing the preliminary list of scenarios; co-ordinating with the emergency response team to ensure the preservation of evidence; undertaking investigations outside the restricted areas; preparing for large volumes of information; taking aerial photographs; and recovering and preserving evidence including electronic data and paper documents.
- The second phase consists of the initial site visit when it is important to document the condition of the site, revise investigation plans and identify time-sensitive evidence.
- The third phase is during the ongoing investigation when the focus will be on recovery of evidence, reconstruction, analysis, testing and simulation of scenarios, and systematically affirming or denying scenarios.
- The fourth phase involves the preparation of the investigation report and recommendations, which should be completed in a timely manner to avoid delays in the application of improvements.
- The fifth phase is about the dissemination and communication of results.

In designing and implementing investigations, efforts should be made to address possible constraints, or challenges, to conduct effective investigations, such as:

- The destruction or deterioration of evidence over time due to climatic and atmospheric conditions, the memory distortion of witnesses due to time, perception and other psychological

factors, and the fact that the investigation occurs under stressful circumstances and may last for a number of months.

- Limiting the possible scenarios examined and thereby biasing the collection of evidence to try to match the chosen scenarios.
- Laws designed to promote public access to information, as well as laws to protect confidential business information, that can present hurdles to the collection and sharing of relevant evidence.
- Constraints due to limited financial or human resources available, relative to the complexity of the investigation.
- Insufficient trust among parties involved.
- Insurance and liability issues.
- Taking actions to make the site safe.

Principles to industry

Management of a hazardous installation should ensure that there is a prompt investigation and thorough analysis of all accidents and near misses involving hazardous substances.

- Management of hazardous installations should adopt internal standards establishing clear guidance concerning the nature of the investigations that should be carried out, the individuals who should be involved and the criteria to be used to determine the extent of investigations for different types of incidents.
- Management should encourage the identification and disclosure of near misses by establishing an atmosphere of trust, where employees do not fear being blamed, and by sending consistent messages to all employees regarding the importance of such disclosures. Management should establish a simple procedure for reporting near misses when identified.
- The investigation and reporting process (either internal or third-party) should make recommendations to those individuals who have the authority and the resources to take any corrective actions.

Management should ensure that investigations are documented and the reports published.

The results of investigations of accidents and near misses (including recommendations and lessons learnt) should be shared throughout the enterprise, with other enterprises and with other relevant stakeholders, with due regard for the protection of confidential business information, in order to help avoid the same or similar problems in the future. Such reports can also be used in support of education and training activities.

Management should share relevant aspects of the investigation reports with public authorities. It is in the best interest of all parties to make the relevant aspects of the investigation reports publicly available, to the extent possible. Enterprises should seek to share key information about lessons learnt through available national and international databases or clearinghouses.

To help maintain a corporate memory, investigation reports and lessons learnt from incidents should be appropriately stored and easily available.

Management should seek out and use relevant experience of other enterprises with respect to investigations from sources such as accident reports, on the websites of enterprises, through national and international databases and in other accessible sources of information.

Principles to public authorities

Public authorities should ensure that accidents are investigated. The investigation may be carried out by different authorities depending on the legal regime.

- Accidents with significant adverse effects on health, the environment or property, as well as other accidents that have the potential to provide significant insights for reducing risks should be investigated.
- Investigations may also be carried out if it is suspected that a law or a regulation has been violated.
- Investigations carried out by public authorities should be unbiased and trustworthy so that the public can have confidence in the outcomes.
- Where more than one agency (national, regional and/or local) is involved in investigations, it is important that the activities of these agencies are co-ordinated as far as possible with a clear definition of responsibilities.
- Public authorities should consider which stakeholders should be involved in incident investigations and reviews of investigation reports.
- Where appropriate, particularly following significant accidents, the investigation may be conducted by a group of experts that includes different individuals than those responsible for inspection of the installation and enforcement of the control framework (for example, a specially designated commission).

Public authorities should establish the criteria by which they will determine priorities for investigations (i.e. which accidents should be investigated and to what extent), taking into account resource constraints.

- The selection criteria should be chosen to make the most effective use of resources and allow for timely action and results.
- In this regard, public authorities should consider such factors as the history of similar accidents, the extent of damage to health, the environment and property, the number of facilities that use the process(es) involved in the accident and the likelihood that new information will result in improvements in safety, as well as the level of public concern.

Investigations should be documented and relevant information from the reports should be published in a form that will protect confidential and legal information, to inform other relevant stakeholders of the lessons learnt so that the safety of hazardous installations can be improved.

- The reports should include sufficient background information to enable the investigation results to be useful in other situations.
- The reports should include conclusions resulting from the analysis of accident data.
- Public authorities should disseminate such reports to the industrial organisations within their country that might benefit from the lessons learnt from the investigation.
- Public authorities should facilitate the sharing of investigation reports with industry and in an international context using for example chemical accidents databases (Box 10.2) and, in particular, to improve information sharing concerning causes of accidents.
- Public authorities should actively communicate the results and lessons learnt with the affected local population and community representatives.

Public authorities should be responsible for ensuring that appropriate action is taken in light of the recommendations set out in investigation reports.

Adequate resources should be provided to public authorities to carry out their responsibilities with respect to accident investigations and the dissemination of related information.

Box 10.2. Examples of chemical accidents databases

eMARS (https://emars.jrc.ec.europa.eu/)

The European Major Accident Reporting System (eMARS) database is maintained by the European Commission at the European Union Joint Research Centre (JRC), Major Accident Hazards Bureau. The database is the implementation of Article 21, No. 4, of the Seveso III Directive.

eNatech (https://enatech.jrc.ec.europa.eu/)

The aim of this database is to systematically collect information on Natural Hazard Triggered Technological Accidents (Natech) that occur worldwide and allow the searching and analysis of Natech accident reports for lesson-learning purposes.

ZEMA (http://www.infosis.uba.de/index.php/en/site/13947/zema/index.html)

The ZEMA database is the central reporting system for the German Major Accidents Ordinance.

ARIA (https://www.aria.developpement-durable.gouv.fr/)

The ARIA database is maintained by BARPI – an office of the French Ministry for Ecological Transition and Solidarity (i.e. Environment Ministry). It contains more than 50 000 entries. These cover a wide range of technological accidents from within France and elsewhere.

TUKES VARO (http://varo.tukes.fi/)

The current web version of the VARO register was published in 2013. The VARO register contains information collected by the Finnish Safety and Chemicals Agency (Tukes) from various sources on accidents that have occurred in Finland.

Failure Knowledge Database (http://www.shippai.org/fkd/en/index.html)

The Failure Knowledge Database has been developed by the Japan Science and Technology Agency (JST) and is available in Japanese and English. It covers a range of technologies and the accident reports are classified according to these technologies.

Relational Information System for Chemical Accidents Database (RISCAD) (https://riscad.aist-riss.jp/)

RISCAD is a Japanese database developed by the National Institute of Advanced Industrial Science and Technology (AIST) and the JST. The interface and content are provided in Japanese and English. The reports cover not only the chemical industry but also other technologies such as coal mining.

United States Chemical Safety Board (CSB) (http://www.csb.gov)

The U.S. CSB does not run a database in the strict sense of the word. However, from its website, it is possible to find information including investigation reports, videos and animations of accidents investigated by the CSB.

Source: IChemE (2020[2]), "Accidents Databases – A review", *Loss Prevention Bulletin*, No. 275.

References

CCPS (2022), *Introduction to Incident Investigation*, Center for Chemical Process Safety, https://www.aiche.org/ccps/introduction-incident-investigation. [1]

IChemE (2020), *Accidents Databases – A review*. [2]

11 Incident documentation and reporting

This chapter provides principles to industry and public authorities for incident documentation and reporting.

Principles to industry

Management should comply with all regulatory and procedural requirements for notifying/reporting incidents to public authorities.

Enterprises should establish procedures and requirements for the reporting of incidents. They should ensure that the local management of a hazardous installation reports all significant incidents (i.e. accidents and near misses) as well as other "reportable" events as determined within the enterprise.

The safety culture at an enterprise should promote and all interested parties should encourage reporting of accidents and near misses to appropriate managers in the enterprise so that the causes of such incidents can be established.

Efforts should be made to co-ordinate reporting by industry at the national and international levels in order to facilitate information sharing.

Principles to public authorities

Following the initiation of the emergency response, notification to the public authorities of the occurrence should be required. The first notification should be followed by further written information and more detailed reports as information becomes available.

Public authorities should establish and publish appropriate minimum criteria, requirements and procedures for documentation of all significant incidents involving hazardous substances, including Natural Hazard Triggered Technological Accidents (Natech).

- This may include both documentation by emergency response personnel as well as documentation by the management of the installation where the accident occurred.
- Public authorities should ensure that, where possible, the reporting procedures under different legal frameworks do not lead to unnecessary duplication, e.g. environmental protection, labour protection, fire protection and civil protection.
- Reports should include, where appropriate, photographs, drawings, plans and other illustrations, to improve the understanding and quality of the communication beyond a text-based document.
- Efficient documentation by industry and public authorities can make an important contribution to the safe operation of hazardous installations. Incident documentation also helps to instil public confidence that proper actions will be taken to avoid similar incidents or incidents with similar consequences in the future.
- Documentation should not be limited to significant accidents but should also address important near misses.
- The initial notification of an incident should provide a basis for determining whether a more intensive investigation is warranted. More intensive investigation may be indicated for example, by the extent and impact of the consequences, the type of occurrence, operator or site history or similarity to past incidents. The authorities should determine the processes and procedures by which a more intensive investigation is instigated.
- The final, completed documentation of an incident should be the basis for deriving lessons learnt which should be disseminated and shared as widely as possible so that appropriate measures may be taken to avoid a recurrence of the incident. In particular considerations with regard to changes in technology, operating practices, inspection and maintenance activities or oversight by public authorities.
- Reports of past accidents submitted by industry to authorities should include information on the environment, as well as the health effects of accidents. Economic impacts of accidents should also

be assessed to the extent relevant information is available (with economic impacts broadly defined to include, for example, both direct and indirect costs).

Public authorities should establish a structured national system for maintaining statistics and information on accidents involving hazardous substances and providing public access. Such a system should: facilitate improved decision-making; provide insights for better regulations and guidance; assist in establishing priorities; aid in the preparation of analyses; and facilitate the dissemination and exchange of information and lessons learnt.

12 Sharing lessons learnt from accidents

This chapter provides principles to support the sharing of lessons learnt from accidents. Industry, public authorities and other stakeholders should improve efforts to promote sharing of lessons learnt from accident reports and investigations, and to facilitate communication of these lessons learnt as quickly as possible.

Sharing the lessons learnt from incidents is the responsibility of all stakeholders. This includes academia involved in the training of students and research, industry associations, non-governmental organisations (NGOs), the insurance industry including brokers, intergovernmental organisations (IGOs) as well as industry and public authorities.

Lessons from accidents need to be identified and disseminated and the appropriate actions implemented. This needs to become a process of continuous improvement for all involved (Box 12.1).

Efforts should be made to promote sharing of lessons learnt and facilitate communication as quickly as possible.

- It is important to avoid repeating accidents by paying particular attention to lessons that have already been identified from accidents or incidents that occurred, either inside the enterprise or elsewhere.
- It should be recognised that it may not be enough to simply publicise “lessons learnt”; efforts should be made to understand how to communicate the information in a way that will result in appropriate actions being taken. In this regard, lessons learnt can form an extremely important part of education and training programmes.
- Efforts should be made to identify barriers to sharing information about investigations and lessons learnt including possible concerns about legal issues and protection of confidential business information, and finding ways to minimise these.

Box 12.1. Improving the sharing of lessons learnt

Industry, public authorities and other stakeholders should improve efforts to promote sharing of lessons learnt from accident reports and investigations and to facilitate communication of these lessons learnt as quickly as possible.

- Lessons from accidents need to be identified, disseminated and the appropriate actions implemented.
- Management of hazardous installations, as well as industry associations, public authorities and other stakeholders, should consider how to create a climate that fosters trust and encourages voluntary sharing of information concerning accidents and near misses, including lessons learnt.
- Leadership, from the highest levels in enterprises and public authorities, is essential to ensure that lessons are learnt from incidents and that appropriate actions are taken as a result.
- Public authorities should facilitate the sharing of accident reports within industry and, as appropriate, with other interested parties.

There is a need to better understand how to communicate lessons learnt in a way that will result in appropriate actions being taken to reduce the likelihood of similar accidents occurring in the future.

- Efforts should be made to identify barriers to sharing information about lessons learnt and to find ways to minimise these.
- Efforts should be made to develop a basic agreed framework and use common terminology for preparing investigation reports in order to facilitate sharing of information related to investigations.

13 Assessment of consequences

This chapter provides principles to industry and public authorities relating to the establishment of criteria and methods for gathering data, assessing the consequences and analysing the impacts of a chemical accident.

Both industry and public authorities should establish criteria and methods for gathering data and assessing the consequences and analysing the impacts of a chemical accident.

In particular, authorities should establish strategies for the collection of data over a longer period following a chemical accident, ensuring that the resources and expertise for carrying out environmental and epidemiological studies can be made available should the need arise.

The consequences that are most easily identified are those with immediate effects such as death, acute health effects, fire and explosion damage to property, acute environmental effects on watercourses and visible deposition of chemical substances. Community disturbances (e.g. evacuation or shelter-in-place) and temporary or permanent business interruptions may also take place.

Public authorities in particular should be aware that some consequences have medium- and long-term effects and their impacts can only be assessed over time. Therefore, there should be plans in place to facilitate gathering data and analysing impacts over a period of time. The plans should foresee the allocation of sufficient resources and expertise and prescribe cost recovery mechanisms in line with the polluter pays principle.

Medium- and long-term effects may cover a range of consequences:

- **Human health**: Chronic or repeated exposure to hazardous substances may occur, in particular, if the food chain or drinking water has become contaminated and appropriate monitoring is not adopted. Psychological and mental health effects may become long-term. In particular, traumatic events may lead to flashbacks, depression or other related consequences. These effects may occur not just in those immediately affected but also among family, friends and the general community.
- **Environmental consequences**: Pollution to water or soil events may take some time to become apparent. Pollution at the ground surface may percolate down to contaminate groundwater. This may lead to a great separation of time and place between the source of the pollution and the identification of the effects. This can have an effect on the drinking water supply. The release of a hazardous substance into the soil may lead to them being dispersed in the ecosystem by being taken up by organisms and rising through the food chain. This can also lead to an impact on human health where agricultural products or fruit and vegetables from household gardens are affected.
- **Economic impacts**: The economic impacts can be significant following a chemical accident. It may take years for property damage insurance claims to be regulated. A large explosion that causes widespread breakage of window glass may mean that due to the extent of damage, there are delays until all of the windows are repaired.

  Closure of an industrial facility or reduced production capacity can have knock-on effects in the community due to unemployment, reduction in the economic demand in the community, etc. These effects can be especially significant when the facility is a major employer and thus the economic focus of a community. There can also be supply chain effects in the larger economy if the site produces a speciality product or a product in high demand that takes time to source elsewhere.
- **Social impacts**: A serious chemical disaster may also lead to long-term distrust within the community of the industry's good faith and willingness to invest sufficiently to prevent chronic and acute effects from their operations. Likewise, the community may no longer have faith that the government will protect them from capitalist interests. These attitudes can discourage economic progress or expansion of certain industries in the regional or national economy. They can also result in long legal battles against both government and industry, particularly if there are perceived long-term health effects. The population may also lose general confidence in the government's ability and willingness to protect them in other arenas. In some cases, perceived inequities associated with the surrounding populations may also be fuelled by an industrial disaster.

A data collection and analysis strategy for the longer-term effects should be agreed upon and launched as soon as possible following the accident. The strategy should establish clear objectives for the study and emphasise reliance on a wide range of sources.

- These sources typically include medical and epidemiological data, environmental data from spot measurements and measurement networks, and financial and economic data. Systems for collating and analysing the data should aim to include geographic information systems (GIS) and computer databases as well as text and photographic archives.
- Having numerous sources and types of data can give diverse perspectives to the analysis but also strengthen certain findings or reduce uncertainty by giving information not covered by other data sources.

Long-term data collection and analysis should be structured to generate reports of findings at regular intervals, preferably benchmarked against reference criteria as much as possible. There should be scheduled reviews to determine if the studies are achieving their objectives and if the process of data collection can be improved.

Where potential effects cross boundaries of jurisdictions, whether within a country or across international boundaries, protocols and procedures should be agreed to ensure that the data and information are collected and analysed in as uniform a manner as possible. Where the potential effects may cross an international boundary, provision should be made for access to the data and the results of the analysis to be made available to both sides of the boundary, taking account of any language requirements as appropriate.

Part V Special issues

14 Land-use planning

This chapter provides general principles for the development and implementation of land-use planning arrangements, which contribute to the prevention and mitigation of chemical accidents. This is a standalone chapter as land-use planning can be viewed as a preventative measure in that it can help to ensure that hazardous installations are separated by appropriate distances from other installations and developments, thereby preventing adverse effects; or it can be viewed as a means to mitigate the adverse effects of releases, fires, explosions and other accidents that occur.

Develop and implement land-use planning arrangements

It is important to recognise that land-use planning applies not only to the zoning and siting of hazardous installations but also to significant modifications of existing installations. It is also very important to use land-use planning considerations when making decisions concerning proposals for developments in the vicinity of an existing hazardous installation (including, for example, homes, schools, shops and other commercial properties, and public infrastructure such as railroad stations).

While land-use planning is an essential element in the strategy for controlling risks associated with chemical accidents, it is not a substitute for other prevention and mitigation measures. In some countries, land-use planning is done at a national level in co-operation with local authorities, whereas in other countries it is strictly a local concern.

A number of guidance documents have been developed to support countries in land-use planning such as the United Nations Economic Commission for Europe (UNECE) *Guidance on Land-Use Planning, the Siting of Hazardous Activities and Related Safety Aspects* (2017[1]) (Box 14.1).

Establish land-use planning systems for new hazardous installations, changes to existing ones and proposed developments near an existing installation

Public authorities should establish land-use planning systems that should address the following elements:

- General zoning, which includes the establishment of specific areas for hazardous industrial activities, taking into account all aspects of protecting health, the environment and property.
- Case-by-case decision-making concerning the siting of a specific new installation, significant changes to an existing installation or proposed development(s) near an existing installation.

Different types of approaches can be used for land-use planning. These include, for example:

- *A consequence-based approach*: identifying areas where serious injuries will occur based on an assessment of the impacts of a number of possible event scenarios for a specific site/installation.
- *A risk-based approach*: identifying areas where there is a given probability of a specified level of harm based on an assessment of both consequences and probabilities of possible event scenarios for a specific site/installation.
- *A generic approach*: establishing safety distances based on the type of activity rather than a detailed analysis of a specific site/installation.

Public authorities should thoroughly evaluate environmental and social inequities when making land-use planning decisions to avoid unintentionally increasing the risk of individuals potentially being affected in the event of an accident.

Decisions in land-use planning should be transparent and, while they may primarily aim to achieve economic and social objectives, the achievement of these objectives should also be compatible with achieving a high level of safety.

The public should be given the opportunity to provide input into decision-making processes related to siting of hazardous installations. The potentially affected public should also be provided with notification of applications for siting as well as licensing of hazardous installations. Decisions concerning such applications should also be publicised.

Prepare a risk assessment when considering a proposal for new hazardous installations or development(s) near existing ones

Public authorities should, when considering a proposal for new hazardous installations or development(s) near existing installations, take account of the risks posed by an accident. The risk assessment should be developed by or on behalf of the public authorities in accordance with applicable requirements. The enterprise should make the necessary information available to the public authorities.

- The risk assessment should take into account the full range of implications and the advantages and disadvantages of the particular location proposed for the new installation or development. This should be done for proposals for new hazardous installations, for significant modifications to existing installations and for other developments in the vicinity of hazardous installations.
- Land-use planning authorities should be provided with (and take into account) technical information concerning the risk of the hazardous installation being considered (for example, from a notification provided to public authorities or from a safety report). Information should be made available by the enterprise concerned. The planning authorities should also take into account other information that may be available including, for example, reports prepared by academic institutions or non-governmental organisations (NGOs).
- A systematic approach to the identification, estimation and evaluation of hazards and risks is useful for providing guidance to public authorities when they make land-use planning decisions. For example, a systematic approach could allow for a relative ranking of hazards and risks.
- In making decisions concerning land-use planning, risk assessments inform the decision-making process but are often not the sole decisive influence. Such decisions are also a matter of socio-political judgment at the local level. In this regard, public authorities should make explicit all the criteria used to guide land-use planning decisions, including the criteria for analysing the tolerability/acceptability of risks and the decision-making process, and conclusions should be transparent.

Take into account the cumulative risk of all hazardous installations in the vicinity

Land-use planning decisions by public authorities related to hazardous installations should take into account the cumulative risk to the community of all hazardous installations in the vicinity. In some cases, it may be preferable from a safety perspective to centralise hazardous installations in one location, while in other cases it may be preferable to keep hazardous installations apart.

- Land-use planning decisions should take into account the possibility of a domino effect, where a chemical accident in one site could cause an accident in neighbouring site(s).
- Decisions should consider keeping suitable distances between a hazardous installation and other developments, populations and sensitive environments, in order to reduce the risks of adverse effects in the event of an accident.
- Decisions should take into account the natural hazards in the area in order to reduce the risks of a chemical accident and the adverse effects in the event of an accident.

Ensure co-operation and co-ordination within, across and amongst relevant public authorities

The land-use planning activities of local, state/regional and national public authorities should be co-ordinated.

- State/regional and national authorities should develop the overall objectives to be met (with supporting technical information and guidance) to achieve consistency in criteria at the local level.
- Local authorities, at an appropriate level, are usually in the best position to make specific planning decisions, taking into account local social and economic factors.

There will likely be multiple authorities involved in decisions related to land-use planning. Good co-operation and co-ordination should be a priority. Decisions and actions taken in other fields of public policy can have an effect on accident risk.

Develop control mechanisms for enforcement of land-use planning decisions

Land-use planning arrangements should consider developments in an area in totality, to prevent unintended consequences of piecemeal development increasing the overall level of risk.

Land-use planning processes and arrangements, as well as related control mechanisms, should provide a clear indication of the standards to be met and of the evaluation procedures used by public authorities.

Box 14.1. UNECE *Guidance on Land-use Planning, the Siting of Hazardous Activities and Related Safety Aspects*

The UNECE *Guidance on Land-use Planning, the Siting of Hazardous Activities and Related Safety Aspects* aims to assist in more effectively mitigating the effects of possible industrial accidents and the consequences on human health, the environment and cultural heritage within countries and across borders.

The general guidance (Part A) shares examples and points to good practices of countries' efforts in the UNECE region to integrate industrial safety considerations into environmental assessment and land-use planning processes. It also highlights the important interlinkages, synergies and complementarities between these and other instruments, including the UNECE Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters, aiming to assist competent authorities and practitioners in applying the provisions. This is supplemented by the technical guidance (Part B), which focuses on the risk aspects.

Source: UNECE (2017[1]), *Guidance on Land-use Planning, the Siting of Hazardous Activities and Related Safety Aspects*, https://unece.org/fileadmin/DAM/env/teia/images/1735403E_Final_ENG_web.pdf.

Reference

UNECE (2017), *Guidance on Land Use Planning, the Siting of Hazardous Activities and Related Safety Aspects*, United Nations Economic Commission for Europe, https://unece.org/fileadmin/DAM/env/teia/images/1735403E_Final_ENG_web.pdf. [1]

15 Communication with the public for prevention, preparedness and response

This chapter draws principles to facilitate the implementation of programmes and policies to ensure that the potentially affected public is well informed about existing or planned hazardous installations and to facilitate the opportunities for the public to provide input, as appropriate, into decision making by public authorities concerning such installations.

The following principles do not prejudice public authorities from instituting more extensive requirements related to the provision of information to the public or public participation. They focus on objectives to be achieved with respect to the provision of information to the public and public participation, and not on the procedural approaches which should be followed. It is recognised that countries allocate responsibility differently between the public and private sectors and among national, regional and local governments, and that countries have different legal and administrative frameworks with regard to the prevention of accidents and development of community emergency plans. In implementing these principles, countries should give consideration to the protection of confidential information, as defined under domestic law, including both proprietary data and information protected for reasons of national security.

Responsibilities of industry and public authorities

Industry and public authorities each have responsibilities to the public concerning prevention of, preparedness for and response to chemical accidents, including in the case of a chemical accident-causing transboundary effects.

Industry and public authorities should co-operate to ensure that the potentially affected public has the appropriate information to understand the risks they face and what they should do in the event of a chemical accident.

Industry is a primary source of information. It has the responsibility to provide this information to public authorities and, directly or indirectly, to the public. Industry should also be prepared to work with public authorities which develop emergency plans. Industry should maintain close relations with community leaders, education facilities and other members of their local population in order to help promote awareness and understanding of chemical accident risks. Industry should have an open attitude in its relations with the public.

Public authorities have the responsibility of ensuring that adequate and timely information is provided to the potentially affected public and that appropriate opportunities are available for public participation in certain decision-making processes. Public authorities also have the responsibility of ensuring that adequate emergency plans are in effect. They should also have a reactive role in responding to specific public concerns and monitoring reactions from the public following an accident (for example in social media).

Provision of information to the public

Members of the public who might be affected in the event of a chemical accident, including a chemical accident-causing transboundary effects, have a right to appropriate information so that they can be aware of the hazards and risks arising from the hazardous installations in their community. They should know where to obtain information concerning the installations and its hazards and understand what to do in the event of an accident.

Communicate on the risk of chemical accidents with the potentially affected public

The potentially affected public should be provided with information about the hazardous installations in their vicinity, without their having specifically to request it. This information should address:

- The types of industries in their area and the chemicals that are produced and used in these installations (the common names or, if more appropriate, the generic names or general danger classification of the substances involved at the installation that could give rise to an accident

capable of causing serious offsite damage, with an indication of their principal harmful characteristics).

- The name(s) of the enterprise(s) responsible for the installation(s) and the address(es) of the installation(s).
- Information relating to the types of possible accidents, including an indication of the likelihood of each, that could cause serious offsite damage and their potential effects on health, the environment and property.
- Information about known natural hazards that might trigger a Natural Hazard Triggered Technological Accidents (Natech) (such as the fact that the installation is on a fault line or in a flood risk zone).
- Relevant information from inspections and other monitoring activities at hazardous installations available to the public. This should be in a form that can be readily understood and provide an opportunity for dialogue.
- The preventive measures that have been taken to minimise the likelihood of accidents.
- A reference to the offsite emergency plan.
- Point(s) of contact, where further explanatory information and clarifications can be obtained and feedback can be provided to rescue services and other authorities.
- Information concerning expected activities at the installation that may raise the concerns of neighbours (e.g. flares, odours).

Public authorities, along with industry, communities and other stakeholders should address the question of how to balance the need to provide information to the public and the need to protect information due to security concerns.

Communicate with the potentially affected public on how to prepare and react in case of a chemical accident

The information provided to the potentially affected public should include specific guidance on what to expect in the event of an accident and how they should react, including:

- Details about how they will be warned of an accident or imminent threat of an accident.
- Guidance concerning the actions to be taken and the behaviour to be adopted in the event of an accident (this guidance should be adapted to meet the needs of different groups, including sensitive groups, e.g. in hospitals, schools and homes for the aged).
- An explanation of why they should behave/act as described in the guidance so that they understand how this will result in a mitigation of adverse effects.
- The source(s) of post-accident information (e.g. radio, television, Internet).
- The source(s) for additional explanations/information.
- Point(s) of contact, where members of the public can provide public authorities with information related to a possible accident (i.e. if someone notices something unusual at the installation).
- How they will be informed when the emergency situation is over.

The members of the public potentially affected by a chemical accident should be carefully described and the information targeted so that all potentially affected people have adequate and appropriate information presented in an easily understandable manner.

Information should be provided in a timely fashion, be reissued periodically as appropriate and be updated as necessary. It should be clearly indicated that this information should be read immediately when it is received and be kept in a convenient place for reference in the event of an accident.

Communicate with the public in the case of a chemical accident

When alerted to a chemical accident, response authorities should activate their emergency plans that include mechanisms for ensuring that the public is notified of an accident and informed about what actions to take.

During and after an accident, timely, credible, sensitive, informed, factual and accurate information should be provided openly and continuously to the public.

- Such information should cover the offsite effects of the accident, the risks of further adverse offsite effects, actions to be taken by the public and related follow-up information.
- Communication with the public and media (social media, television, radio and print) during an accident demands special training and requires preparation. Templates and guidance should be developed as part of emergency planning. Contacts between media and the public should be developed and maintained as a long-term relationship.
- The media should have ready and continuous access to designated officials with relevant information, as well as to other sources, in order to provide essential and accurate information to the public throughout the emergency and to help avoid confusion.
- The media should facilitate response efforts by providing means for informing the public with credible information about chemical accidents, including guidance on actions to be taken by those potentially affected.

Ensure suitable messaging

It is important to recognise that the public is not homogeneous and, therefore, consideration should be given to whether there is a need to design different messages for different groups based on age, culture/language, educational background and level of risk for example.

The information provided to the public should be generally comprehensible (i.e. to individuals without technical knowledge or training) and be provided in a format and/or language that is easily read and understood. Members of the community should be consulted to help ensure that the message developed and the language used are appropriate for the community.

Those responsible for designing communication programmes should recognise that messages will be interpreted by the recipients, filtered based on individual experience and evaluated based on levels of trust and other factors (such as whether there have been conflicting messages). It is important to understand these influences and shape the messages accordingly. The communication messages should take into account foreseeable actions that conflict with the required behaviour (e.g. not collecting children from school; observing the accident from a dangerous location; ignoring instructions from emergency responders).

The information should permit all relevant individuals to understand their responsibilities (for example, teachers in the vicinity of a hazardous installation require special information and training in view of their responsibilities in the event of an accident and to assure parents that their children will be safeguarded).

Develop mechanisms for communication

In order to avoid confusion and facilitate information exchange, the mechanisms for obtaining and delivering information should be as clear as possible and, as far as possible, use known and existing channels.

- Those designing means for providing information to the public should take into account experience obtained in risk communication in other, related fields (e.g. natural disasters).
- There should be co-ordination of the different communication channels used.
- Members of the community should be consulted when the process for communicating with the public is being designed and implemented. Professional advice on communication should be sought.

In order to enhance individual recall and help ensure that all target audiences are reached, the messages should be repeated periodically and different methods/channels of communication should be used.

As the media are a channel of information to the general public, media input should be encouraged in the development and implementation of the communication process related to emergency planning.

- There should be clearly identified media source(s) for obtaining information in the event of an accident and the public should be informed about these sources.
- Industry and public authorities should provide representatives of the media with relevant information concerning hazardous installations so that the media have the necessary background to be an effective and reliable source of information for the public should an accident occur.

In cases where a hazardous installation is located near a border or transboundary watercourse or international lake and is as such capable of causing transboundary effects, in case of an accident, mechanisms should be in place to ensure that information is provided to and understood by all stakeholders on both sides of the border potentially affected in the event of an accident. The country receiving the information should ensure that this information is provided to all stakeholders within its jurisdiction that may potentially be affected.

Box 15.1. Public awareness and community preparedness

Awareness and education of all community members

Low public awareness of the need for preparedness can undermine local governmental support for preparedness programmes, can foster lower attention to individual safety at home and in public spaces and can decrease safety precautions in the workplace. The point of preparedness is to minimise the impact of a chemical accident through the actions of all community members, rather than the actions of only facility and response agencies.

- Preparedness includes awareness and education for all community members that could be impacted by a chemical accident and creates expectations for the actions of all community members should an accident occur.
- Support is needed from all levels of government in providing tools and assistance to heighten public awareness of the importance of preparedness.
- All levels of government need to have high expectations for the participation of the general community members in their own preparedness. Success requires education on risks and the expectations of the community on general preparedness capabilities.

- There is a great potential benefit to facilities, communities, emergency planners and emergency responders in developing a common understanding of the chemical hazards and accident preparedness capabilities present in their communities.

Preparedness is based on:

- The community developing a broad awareness and understanding of the risks that are present, locally.
- A community-wide evaluation of which community members are most vulnerable to risks, the mechanisms or pathways of risks, and the existing capabilities to address those risks should an accident occur.

Understanding the response capabilities

In most communities there is a lack of understanding regarding risks and the capabilities of the community to respond to those risks, often because emergency response agencies have not educated the public on the limitations of their capabilities. Members of the public are entitled to know whether or not emergency response authorities are capable of effectively responding to chemical accident risks in their communities. If not, then filling this capability gap becomes a process of educating the public on the steps they must take to protect lives and property.

Since all communities have capability gaps when evaluated against the risks present in the community, the subsequent step is strategic planning to fill those capability gaps with prioritisation for these efforts developed by the community members.

Filling capability gaps requires the use of all the regulatory and social tools available to the community and its partners. Addressing the identified capability gaps can include a broad range of options such as accident prevention and the creation of expectations for the actions of community members to be able to shelter, evacuate and provide aid to others.

Stakeholders involved

Accomplishing these tasks is a community-level activity. While it should be led by an emergency manager or local emergency planning committee, the key to successful preparedness planning is broad co-ordination and co-operation involving all community members. Management of facilities must be part of the preparedness effort because of their greater expertise on the properties of the hazardous chemicals present at their plants, knowledge of their operating systems and procedures, hazard assessments, their emergency plans and emergency response capabilities.

Public participation

Whenever possible and appropriate, the potentially affected public should be given the opportunity to participate, by providing their views and concerns, when decisions related to siting and licensing of hazardous installations and the development of emergency plans are being made by public authorities. In all cases, adequate information about the opportunity to participate should be given.

As appropriate, a variety of mechanisms for public participation in decision-making processes can be used. These mechanisms can include those for direct public participation, such as open public hearings, and those for indirect public participation by means of, for example, open consultative procedures.

In some countries, local safety committees have been established with representatives of the installation, local authorities and local residents which, among other things, facilitate the flow of information from the installation to persons who live and work in the area and co-ordinate local participation in appropriate decision-making processes.

The mechanisms for public participation and the scope of participation should be adapted to the nature of the decision being made and to who may be affected by the decision while taking into account applicable law and practice.

In determining who should be given the opportunity to participate in decision-making processes, public authorities should consider which persons are seriously threatened by a potential accident and the nature of the decision being made. For example, in the case of the development of a community emergency preparedness plan, the local community near the hazardous installation might have the opportunity to participate. In the case of a siting decision for an installation which could have serious adverse effects on a watershed, national park or natural resources of more than local concern, the provision might be made for broader participation, for example by allowing comments from representatives of public-interest organisations (e.g. environmental, agricultural or forestry groups).

Providing an opportunity for public participation should not affect the ultimate responsibilities of the public authorities with respect to decision making in this area.

16 Transport interfaces, port areas, pipelines and marshalling yards

This chapter addresses limited aspects of the transport of hazardous substances. Specifically, it provides guidance related to transport to the extent it involves fixed facilities. This includes transport interfaces in general (e.g. railroad marshalling yards, road terminals, airports, loading and unloading facilities), port areas, pipelines and marshalling yards. It also provides guidance on the roles and responsibilities of stakeholders which, in addition to the stakeholders addressed generally in the Guiding Principles, here include the owners/operators of the transport interfaces and pipelines, the owners/operators of the transport means (ships, trucks, trains) and the labour involved in the transport and loading/unloading operations.

This chapter takes into account that a prerequisite for the safe transport and handling of hazardous substances is the proper identification of their hazards as well as proper containment, packaging, packing, cargo separation, securing, marking, labelling, placarding and documentation. Each country/jurisdiction should decide the point where substances are covered by regulations relating to transportation and where they are covered by other requirements to ensure that there are no gaps. The allocation of responsibility can differ among countries but in no case should there be gaps in regulation.

Transport interfaces

For purposes of this publication, a "transport interface" is defined as fixed (identified) areas where hazardous substances are: transferred from one transport mode to another (e.g. road to rail, or ship to pipeline); transferred within one transport mode from one piece of equipment to another (e.g. from one truck to another); transferred from a transport mode to a fixed installation or from the installation to a transport mode; or stored temporarily during transfer between transport modes or equipment. Thus, transport interfaces involve, for example, loading and unloading operations, transfer facilities, temporary holding or keeping of hazardous substances during cargo transfer (e.g. warehousing) and handling of damaged vehicles or spilt goods. Examples include railroad marshalling yards, port areas, receiving/loading docks at hazardous installations, terminals for roads and for intermodal transport between road and rail, airports and transfer facilities at fixed installations.

Box 16.1. International regulations for the transport of dangerous goods

An international set of regulations has been created for the transport of "dangerous goods", which basically guarantees the safe transport of these sensitive goods.

The United Nations have developed mechanisms for transport conditions for all modes for transport. They should be considered when operating and managing transport interfaces. The United Nations Economic Commission for Europe (UNECE) administers regional agreements for the effective implementation of these mechanisms for road, rail and inland waterways transport of dangerous goods (ADR/RID/ADN).

Note: ADR - Agreement concerning the International Carriage of Dangerous Goods by Road; RID - Regulation concerning the International Carriage of Dangerous Goods by Rail; ADN - Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways.
Source: UNECE (2023[11]), *Dangerous Goods*, https://unece.org/transport/dangerous-goods.

Chemical accident prevention, preparedness and response at transport interfaces should be addressed in an integrated way, taking into account chemical safety at the interface itself and the safety of all modes of transport that utilise the interface (e.g. high-speed trains passing through marshalling yards) as well as the public, environment and property potentially affected in the event of an accident.

The geographical boundaries of transport interfaces that handle hazardous substances should be clearly defined and should include areas where hazardous substances are handled, transported and/or kept temporarily.

- Areas where hazardous substances are kept should be clearly marked, properly supervised and regularly inspected for leakage or damage.
- Access to transport interfaces should be clearly regulated with regard to people and vehicles.

- Appropriate arrangements should be in place to maintain the security of transport interfaces where hazardous substances are located to minimise the possibility of security breaches due to, for example, terrorist activities, sabotage, vandalism or theft of such substances.

Land-use planning arrangements should be applied to transport interfaces to minimise the risks of adverse effects in the event of an accident and to prevent the placing of inappropriate developments near the interface. Planning and construction of new and expanded facilities at transport interfaces should take into account the requirements for the prevention of and response to chemical accidents. This involves preparing an assessment of the risks to determine the probability of accidents and their possible effects on health, the environment and property and incorporating appropriate safety features and equipment.

Box 16.2. Relevant characteristics of transport interfaces

There are a number of characteristics that differentiate transport interfaces from fixed installations for purposes of chemical accident prevention, preparedness and response.

- Different modes of transport meet at the interface, with different supervisory bodies and possibly different safety practices due to different safety goals which must be reached.
- There are changing amounts and types of hazardous substances at the interface, including bulk and packaged cargo.
- There are continuous transfer and handling operations.
- There may be differences between the way hazardous substances are classified and labelled within fixed facilities and within the transportation regime.
- Packaging, labelling and documentation are likely to be carried out in remote locations, outside the control of those responsible for safety in the interface.
- The stakeholders concerned are both different and more numerous.

The various parties involved with handling hazardous substances at transport interfaces should co-operate to help ensure the safe operation of transport interfaces and to provide for emergency preparedness and response. The roles and responsibilities, with respect to chemical accident prevention, preparedness and response, of all parties involved in and around a transport interface should be clearly defined.

All parties involved in the transport of hazardous substances should ensure that they have access to information necessary to fulfil their responsibilities for the safe handling of cargo containing hazardous substances and to provide information to others concerning the substances.

- Those responsible for the shipping, packing, packaging, repackaging, marking, securing, labelling, placarding and documentation of hazardous substances at the hazardous installation should ensure that all relevant information is passed on to those involved in the transport chain. This information should allow for the tracking of cargo containing hazardous substances and should, amongst other things, address the substances being handled, as well as provide guidance for safe handling, emergency preparedness and response to accidents.
- The guidance should be in a form and in a language that can be understood by those that might need to take emergency action, including drivers and response personnel.
- All parties in the transport chain should ensure that their employees (including contractors) are competent and adequately trained to handle hazardous substances under both normal and abnormal conditions.

Operators should prepare “safety reports” for transport interfaces where there are risks of significant chemical accidents, with the reports tailored to the level of the hazard potential of each site.

Operators should develop and enforce a safety management system and procedures necessary for the safe handling of hazardous substances at the transport interface. The safety management system should address all of the modes of transport using the interface, not just the primary mode (e.g. operators of railroad marshalling yards should also be concerned with trucks that transport hazardous substances to the yards.)

Operators should ensure that the equipment and safety systems (including hardware and software) used at transport interfaces are suitable for their purposes and are compatible with current technical standards.

- One of the most common risks at transport interfaces involves loading/unloading operations. Particular attention should be paid to equipment for such operations including, for example, cranes, pumps, flexible hoses and pipes, as well as instrumentation for monitoring equipment, automatic overflow indicators and automatic shutdown systems especially for unloading from ship to shore.
- Operators of transport interfaces should ensure that all equipment and safety systems used in connection with loading/unloading operations and with other handling of hazardous substances are appropriately constructed and maintained. In this regard, it should be recognised that the equipment and systems may be owned by different contractors.
- Operators should ensure that the equipment and safety systems are designed and operated in a way that minimises the risk of human error and that employees are trained in the safe operation of the equipment and systems (recognising that there often are (sub)contractors or short-term workers at transport interfaces).
- Operators should apply the best available safety technologies where appropriate and replace dated and aged equipment as soon as possible.
- Operators should also:
    - Ensure that they have adequate information for the safe handling of hazardous substances and have systems for being notified in advance of the arrival and departure of hazardous substances intended for transit, handling or temporary holding at transport interfaces.
    - Keep records of hazardous substances arriving at transport interfaces, including their quantities and classification, and their location.
    - Establish mechanisms to ensure that all relevant contractors are competent for the work to be undertaken.
    - Set standards for the competency of carriers and equipment and assess compliance with these requirements.
    - Have equipment and procedures in place for dealing with damaged cargo involving hazardous substances.
    - Be empowered to refuse cargo if it is considered to endanger health, the environment or property. In addition, this should cover instances where incomplete or incorrect information and documentation are available.

Cargo interests (including, e.g. cargo manufacturers, consignors/shippers, forwarders, consolidators, packers, brokers and traders) should:

- Ensure that information necessary for the safe handling of hazardous substances and emergency preparedness and response is available to the operators and managers of transport interfaces and, as appropriate, to public authorities.
- Establish standards and systems for screening/reviewing the competency of carriers and equipment to be used.

Carriers/transporters should:

- Maintain an inventory of hazardous substances being transported.

- Ensure the selection and maintenance of appropriate equipment.
- Ensure that all paperwork is properly passed along for, or to, the next responsible party in the transportation chain and that the handover of goods is well documented when loading, unloading or transferring hazardous substances.

Customers (with respect to the transport interface at the delivery point) should:

- Ensure that they have the types of information needed for the safe handling of hazardous substances and for emergency preparedness and response.
- Have procedures and equipment/facilities in place for handling leaking or damaged cargo, and collect and move the substances to safe storage areas as quickly as possible.
- Be empowered to refuse cargo if the state of the cargo is considered to endanger health or the environment, including property. In addition, this should cover instances where incomplete or incorrect information and documentation are available.

Special consideration should be given to the storage of hazardous substances at transport interfaces.

- In this regard, regulations concerning the storage of hazardous substances should apply to the storage of such substances at transport interfaces.
- The extent of storage of hazardous substances (in terms of their quantity, hazardous nature and length of time stored) at transport interfaces should be minimised to the extent consistent with increased safety (reducing the overall likelihood or consequences of accidents involving hazardous substances).

Public authorities should ensure that their control framework and enforcement activities (including monitoring and inspection) address transport interfaces. There should be a clear delineation between jurisdictions and communication protocols that allow the exchange of information and co-operation between different authorities. This control framework should for example:

- Address the competency of managers and carriers to handle safely the hazardous substances that will be at the interfaces.
- Determine the classes and quantities of hazardous substances that may be permitted to be handled or in transit at a transport interface and the conditions under which they are to be handled.

There should be emergency planning at transport interfaces handling hazardous substances that is co-ordinated with the offsite emergency plan.

Operators and public authorities should make a concerted effort to ensure that information concerning potential hazards and the appropriate actions to be taken in the event of an accident is provided on a continuing basis to the potentially affected public. Transport interfaces may have special characteristics, in particular their proximity to transport routes that make communication with any affected public difficult.

Systems should be in place for the timely notification/reporting of incidents (accidents and near misses) at a transport interface.

- Specifically, cargo interests, carriers/transporters and customers should notify the operators of the interface in the event of an incident involving hazardous substances (e.g. leaking or damaged containers) and, when appropriate, should notify the public authorities (including response personnel) and the manufacturers of the substances.
- Further efforts should be made to share experiences both within a country and among countries, concerning incidents at transport interfaces and lessons learned from them.

At the national level, public authorities should have a consistent approach with respect to the laws and policies – including mechanisms for oversight and co-ordination – relating to all modes of transport. This helps to ensure that there are no gaps or inconsistencies in regulatory requirements or in the allocation of

responsibilities as hazardous substances move from one transport mode to another. Care should be taken to avoid any contradictions in the various laws and policies that may apply to transport interfaces (which might include national and international rules for transport, legislation concerning hazardous installations and local laws for land-use planning).

Efforts should be made to adopt internationally accepted standards.

Operators of hazardous installations should endeavour to choose the safest practicable means of transport and the safest practicable routing of hazardous substances being taken from, or delivered to, an installation. This will help to, for example, minimise the number of people potentially affected in the event of an accident.

- Risk assessments should be used as one input into the decision-making process to compare various modes of transport and alternative routing of dangerous goods traffic.
- The choice of transport mode should be case-specific, as studies indicate that no one mode is generically safer than another. Safety is dependent on a number of factors, such as the substance involved, the route used and local management practices.
- To the extent that management of a hazardous installation can choose between transport modes and routes for hazardous substances, the decisions should take into account broader environmental and health considerations.
- Operators should co-operate with public authorities (including authorities at the local level) when making transport and routing decisions concerning the transport of hazardous substances.

Port areas

This section focuses on issues that specifically concern port areas. For purposes of this document, “port areas” are defined as the land and sea area established by legislation, including the fixed facilities and vessels (ships and others) in the area. Hazardous substances may be in port areas: to be loaded or unloaded from ships, inland barges, trains, trucks or pipelines; or to be held as cargo in ships without being handled in the port; or as packaged goods handled for consolidation or dispersal. Because port areas have certain additional characteristics as well as additional stakeholders that differentiate them from other transport interfaces, further guidance is appropriate. These characteristics include:

- Ports are inherently international in nature, with operators, ships and cargo coming from different countries.
- Ports are large, complex entities involving sea-going traffic and inland (river, rail and road) transport of hazardous substances. They may contain a number of fixed installations including terminals, warehouses and repair/maintenance facilities where hazardous substances are transferred, used, handled or stored. Port areas may also include (hazardous) installations not directly involved in transport activities.
- The complexity of port areas complicates land-use planning decisions related to developments both within and outside these areas.
- For historic reasons, ports tend to be located near large, densely populated areas and waterfront locations often attract housing and other developments.
- The ship-shore interface creates the potential, on an operational level, for a conflict of interest between environmental protection and marine safety.
- Stakeholders at ports, in addition to those involved in other transport interfaces, include, for example, port authorities, ships agents, flag state administrations of ships using the port, berth operators and ship and cargo surveying agents.

In addition, reference is made to the UNECE *Safety Guidelines and Good Industry Practices for Oil Terminals* (2015[2]). The guidelines are intended for application at land-based oil terminals. Oil terminals within the meaning of the principles and recommendations set forth in these safety guidelines and good industry practices are facilities for storing oil and its derivatives, including loading, unloading and transfer activities, functioning either alone or within bigger industrial activities, e.g. oil refineries.

Port authorities should develop and enforce local port rules, consistent with relevant laws and regulations, to address the safety of hazardous substances in port areas.

- All operators in a port area should co-ordinate with the port authorities and with relevant public authorities to help ensure that the actions of different operators do not increase the risk of accidents (e.g. through domino effects) and to facilitate emergency planning and response.
- Port authorities are responsible for being aware of the activities of each operator in their port areas and for ensuring appropriate co-operation and communication with public authorities.

Box 16.3. The International Maritime Organization

The International Maritime Organization (IMO) is the UN's specialised agency responsible for the safety and security of shipping and the prevention of marine and atmospheric pollution by ships. The IMO has 175 members states and 3 associate members. Under its auspices, over 50 conventions, protocols and numerous codes, as well as several guidelines and recommendations, have been prepared. Some of those instruments cover the handling and transport of hazardous substances.

Some of the main IMO instruments are: the International Convention for the Safety of Life at Sea (SOLAS); the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocols of 1978 and 1997 (MARPOL); and the International Maritime Dangerous Goods (IMDG) Code. In particular, from the IMO legal instruments, the Recommendations on the Safe Transport of Dangerous Cargoes and Related Activities in Port Areas (MSC.1/Circ.1216, 26 February 2007) apply to dangerous cargoes in port areas as part of a transport chain, in which case land-use planning and other specifics pertaining to the temporary storage and regular checks of dangerous goods are taken into account.

Port authorities should ensure that all users of their ports (such as berth operators) establish operational procedures for activities and events that could increase the risk of an accident involving hazardous substances.

An international body should develop parameters for the safe operation of ships entering and manoeuvring in ports, which can be adapted to the circumstances of an individual port.

An international system should be developed for the reporting of ship deficiencies affecting accident potential and for the dissemination of these reports to port authorities.

Port authorities should establish procedures for proper maintenance and repair operations on ships that carry hazardous substances.

Prior to entering a port area, the master of a ship carrying hazardous substances should check the material condition of the ship and cargo for their readiness to safely enter the port and engage in cargo handling operations.

- The master should inform the port authority of any relevant deficiency of the ship, its machinery, equipment or appliances, or any leakage of hazardous substances or damage to their containment that may present a risk of a chemical accident.

- The master should ensure that, upon entering the port area, any safety requirements, including those pertaining to the proper stowage, packaging and segregation of hazardous substances, are carefully followed.

Berth operators should ensure that:

- Adequate and safe mooring facilities are provided and adequate safe access is provided between the ship and shore.
- A list of all hazardous substances in their facilities, with their locations and safety-related information, is readily available.
- Hazardous substances entering their premises have been duly certified or declared by the relevant cargo interests as being properly identified, packed, marked, labelled and placarded.
- No person, without reasonable cause, opens or otherwise interferes with any container, tank or vehicle containing hazardous substances.

Berth operators should co-ordinate with the ship's masters and the individuals responsible for other transport modes to ensure that all relevant regulations and codes are followed for proper cargo transfer and storage of hazardous substances.

Cargo interests should ensure that containers, tanks and vehicles used for carrying hazardous substances have current safety approval. Cargo interests should ensure that the physical condition of each freight container, tank container, portable tank or vehicle is checked for obvious damage potentially affecting safety.

Cargo interests and berth operators should ensure that every necessary support will be given to the port authority or any other person or institution entitled to carry out inspections or audits.

Public authorities should ensure that all emergency plans in the port area are mutually consistent and are operationally controlled by a designated party or authority.

- Emergency plans should take into account that port operations typically involve a large number of diverse public and private entities.
- Whenever possible, port emergency planners should use internationally recognised and accepted methodologies to ensure compatibility of approach and commonality of terms.

Ship's masters should be informed of how the port emergency response is organised and how their ship and crew fit into this system. The port authority should be informed of a ship's response plan so that actions can be co-ordinated. At each cargo transfer site, the ship's master and the berth operator should agree on the appropriate emergency procedures.

Port emergency plans should take into account that hazardous substances may be carried into the port area by ships and other modes even if they are not to be (un)loaded there. Emergency plans should also take into account the possibility of shipboard emergencies involving hazardous substances posing a threat to the port or the marine environment.

Port emergency response forces should be available and ready to respond to accidents wherever they occur in a port area. In this regard, they should be able to effectively respond and support operations from the quayside to ship, on the quay, on land and ship to ship.

Pipelines

While the provisions of all of the Guiding Principles generally apply to pipelines, this section addresses special concerns with respect to pipelines transporting hazardous substances. For purposes of this publication, pipelines are defined as a conduit made from pipes connected end-to-end for long-distance

fluid or gas transport to include all equipment used for pipeline operation, such as pumping, branching, transfer, shut-off and relief stations, as well as compressor, control and measuring systems. Pipelines are not part of an industrial installation.

Pipelines are recognised as an increasingly important option for transporting a variety of hazardous substances in addition to petrochemicals. Experience indicates that they are generally safe and, for certain substances, a vital means of transport. Among the advantages of pipelines is that they can move large quantities of hazardous substances quickly, relatively inexpensively and reliably, with relatively few associated impacts on the environment (as compared with other transport modes that involve vehicular exhaust, aesthetic impacts, noise and congestion).

The disadvantages of pipelines include infrastructure costs associated with construction, the delays inherent in making a pipeline operational, the problems associated with soil protection and the lack of flexibility in regard to delivery points and quantities that can be transported.

Regulatory approaches to pipelines differ significantly among countries although there are common elements in most approaches (including a general obligation to operate safely). Despite the differences in regulatory approaches, industry appears to have similar safety practices in different countries in order to maintain the integrity of pipeline networks.

In recognition of the hazards from pipeline accidents and their potential impacts, the parties to the UNECE Convention on the Transboundary Effects of Industrial Accidents (Industrial Accidents Convention) and the UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) drew up and published safety guidelines and good practices for pipelines. These take the form of a set of recommendations that will assist national authorities and operators to ensure an adequate safety level for pipelines and the hazards they pose. The guidance document contains principles and key elements for the safe transport of hazardous substances by pipeline, whether transboundary or not. The guidelines and practices set out are designed to prevent incidents and limit accidental consequences for human health and the environment (2015[3]).

Pipelines for transporting hazardous substances should be designed, constructed, operated, maintained and monitored so as to reduce the frequency of accidents and mitigate the consequences of accidents that do occur.

- Pipelines should be designed, constructed and operated consistent with recognised national and international codes, standards and guidance, as well as company specifications.
- Consideration should be given to various aspects which could have an impact on the safety of a pipeline including, e.g. design and stress factors, material quality, wall thickness, depth of burial, external impact protection, markings, route selection and monitoring.
- Pipelines should be constructed with the most suitable materials available to ensure their integrity initially and throughout their lifecycle. Appropriate safety technology should be used such as automatic shutdown systems (in the event of a leak or accident) or safety release systems.
- Adequate safety signs should be installed along the pipeline route.

Land-use planning considerations and risk assessments should be taken into account both in the routing of new pipelines (e.g. to limit proximity to populated areas to the extent possible) and in decisions concerning proposals for new developments/building in the vicinity of existing pipelines.

- Environmental impact assessment for geological and other natural hazards should also be taken into account in order to avoid (to the extent possible) hazardous environments, such as areas susceptible to mining, sinkholes, seismic activity and floods.
- Routing of pipelines should be chosen to minimise adverse impacts in the event of an accident and to facilitate access for maintenance and emergency response personnel.

- Safety distances should be considered to protect the pipeline and protect housing areas against impacts from the pipeline.
- Risks of domino effects in operation and during maintenance work must be considered when pipelines are bundled in one route or laid close together.

Industry should develop safety management systems to meet safety objectives during the design, construction, operation, maintenance and decommissioning of pipelines.

- Elements of safety management systems for pipelines include: clear objectives and policies; a suitable organisation with clear definitions of asset ownership and related responsibilities; competent staff and effective education and training; adequate standards and procedures; performance monitoring and suitable audit/review procedures to identify shortcomings and make corrections; emergency response procedures which are regularly tested and reviewed; and accident investigations.
- Industry should continue to share its experience with respect to the use of safety management systems for pipelines and improve the efficiency of individual elements/techniques of these systems, with the aim of further reducing pipeline accidents.

The integrity of pipelines should be maintained through adequate maintenance, inspection and monitoring and management.

- Means for inspection and monitoring include the use of “intelligent pigs”, patrolling and aerial surveillance.
- In addition to regular maintenance, the objective of continuous improvement in safety performance can be achieved by inspection and monitoring, a wider exchange of information among operators, taking into account lessons learned from reported incidents and utilisation of new technologies and other developments.
- As pipelines age, guidance on the management of ageing and lifetime management[1] should be applied. Additional monitoring may be necessary to continue to ensure their integrity. Consideration should be given to reviewing and revalidating pipelines and their operating conditions once they reach the end of their originally intended design life. In principle, however, continuous inspection and monitoring measures should always indicate irregularities at an early stage regardless of the age of the pipeline.
- Policies should be in place for replacing pipelines or parts of pipelines that may not meet safety standards or have reached the limits of their design life.

While the general principles applicable to emergency planning for hazardous installations also apply to pipelines, it may be necessary to make further efforts, taking into account the specific situation of pipelines including, for example, the hazards associated with the substance they transport.

- Emergency planning for pipelines should consider the special characteristics of pipelines including, for example: the fact that pipelines are normally unmanned; the length and location of pipelines; the high volumes between shut-off devices; the need to be able to shut off or depressurise the flow of materials; and the need to ensure access by emergency response personnel even at remote locations. In addition, an account should be taken of nearby developments. For example, where pipelines cross or parallel rail lines, it is important to interface with plans of the rail industry.
- Emergency planning should take into account a risk assessment of the pipeline system.
- In light of these complexities, it is important to get input from emergency response personnel when preparing, reviewing and revising emergency plans related to pipelines.
- Emergency planning should always be co-ordinated and regularly tested with external emergency services.

Industry responsible for pipelines should review and, as necessary, develop and implement systems to reduce third-party interference, as this is a major cause of accidents.

- This should be done in co-operation with public authorities in all regions/countries.
- Systems for reducing third-party interference involve ensuring that proper information is circulated among interested parties concerning the locations of pipelines in a given area. In addition, it is important to facilitate communication between the pipeline operator and third parties, such as through “one call” systems that provide information about pipelines at one, well-publicised source.
- Construction work on pipeline routes should be avoided.
- Care should be taken, so that heavy vehicles (mobile cranes, tanks, caterpillars) are not crossing depressurised pipelines.

In order to facilitate learning from experience, industry responsible for pipelines (as well as public authorities and other stakeholders) should improve sharing of information on improving the safety of pipelines and on accidents/near-miss case histories.

- This should include information concerning pipelines that reach the end of their intended use or design life. Options for dealing with pipelines that are no longer in use include removal, outright abandonment or abandonment with additional actions. Care should be taken to properly assess the associated risks of each option, on a case-by-case basis, recognising that the best solution in a given situation may be a combination of methods.
- Information should also be pooled and shared on the extent of pipeline systems, the amount of materials they convey and on statistical analyses of the use of pipelines to transport hazardous substances.
- Information should be collected and made available concerning the relationship between failure and the characteristics of the pipeline, in order to better understand the nature and causes of accidents (e.g. relating to age, size, location and construction of the pipeline).

Technical and operational measures should be taken to ensure that water, soil and explosion protection continue to be provided when a pipeline is decommissioned.

- The pipeline system to be decommissioned must be drained and hydraulically separated from the pipeline systems to be operated further.
- Depending on the medium, the pipeline system should be cleaned, e.g. by cleaning pigs, and, if necessary, subsequently dried. The pipeline system should be made free of products and, if necessary, of vapours. In the case of flammable liquids, it should be checked that the pipeline is free of vapours and, if necessary, it should be cleaned/dried again. The pipeline system should be sealed.
- Underground and above-ground plant components should be secured: if necessary, the pipeline should be secured in sections or completely for structural reasons, e.g. by grouting at railroad, tramway or road crossings. Securing measures are also important for hydraulic engineering reasons, e.g. to prevent an unintended drainage effect or upwelling. Above-ground plant components should either be dismantled or secured against erroneous use and misuse.

Marshalling yards

This section focuses on issues that specifically concern marshalling yards.[2] For purposes of this publication, a marshalling yard is defined as a place in transit and a link in the transport chain; railway marshalling yards are a special sort of station. They have a number of sets of sidings for receiving and preparing (shunting) freight trains and for sorting the rail wagons to their destination, with the aim of forming

new trains and dispatching these to their destinations. No loading or unloading of hazardous substances takes place at marshalling yards.

Marshalling yards are a subset of transport interfaces and, therefore, all the provisions of the Guiding Principles apply to marshalling yards. However, because marshalling yards have some special characteristics, as compared to transport interfaces more generally, further guidance is appropriate.

Procedures should be established to improve safety at marshalling yards by taking action such as separating incompatible substances, limiting the number of wagons that are shunted and using speed controls when shunting.

- The safety of high-speed train carriages through marshalling yards or railway stations, railroads and other modes of transport should be taken into account.
- If tracks for passenger and high-speed trains are separate from others, marshalling yards should be separate from these tracks and from railway stations as well.

All parties involved in the management and regulation of marshalling yards should have a clear understanding of who is responsible for taking action with respect to chemical accident prevention, preparedness and response, recognising the special characteristics of marshalling yards.

Cargo interests should agree on what is needed for rail cars to be fit for their purpose, specifically with respect to safety standards, maintenance and end-of-life timing and procedures.

References

UNECE (2023), *Dangerous Goods*, United Nations Economic Commission for Europe, https://unece.org/transport/dangerous-goods. [1]

UNECE (2015), *Safety Guidelines and Good Industry Practices for Oil Terminals*, United Nations Economic Commission for Europe, https://unece.org/sites/default/files/2021-01/TEIA_ENG_OilTerminals.pdf. [2]

UNECE (2015), *Safety Guidelines and Good Practices for Pipelines*, United Nations Economic Commission for Europe, https://unece.org/environment-policy/publications/safety-guidelines-and-good-practices-pipelines-0. [3]

Notes

[1] See https://one.oecd.org/document/env/jm/mono(2017)9/en/pdf.

[2] See http://www.oecd.org/env/ehs/risk-management/41945344.pdf.

17 International and transboundary co-operation

This chapter covers the role of intergovernmental organisations in the prevention, preparedness and response to chemical accidents. International organisations have an important role to play in assisting in the development and implementation of policies, regulations and practices for sound chemical management and chemical accident prevention, preparedness and response, and in encouraging the use of and facilitating access to tools and guidelines to help in this process. They can support the sharing of lessons learnt and help ensure that countries are able to take advantage of the many resources and expertise that exist in the area of chemical accident prevention, preparedness and response. The prevention of chemical accidents is also a critical element toward achieving major international frameworks, such as the United Nations 2030 Agenda for Sustainable Development with the Sustainable Development Goals (SDGs) and the Sendai Framework for Disaster Risk Reduction (2030 Agenda).

International frameworks and programmes

Depending on adherence and membership, countries should ensure the application of/compliance with international legal and policy instruments and regulations for the prevention of, preparedness for and response to chemical accidents. They should pursue multilateralism to effectively implement such international legal and policy instruments, including through consensus-building within respective intergovernmental organisations for actions that need to be taken at the national, regional and international levels.

Countries should seek support and guidance from those international organisations, as appropriate, with a programme relating to the prevention, preparedness and response to chemical accidents:

- Each organisation's programme has its specificities that will support countries in particular areas (Box 17.1). Interested parties should contact the organisations through national contacts and focal points.
- Countries should consult with organisations in addressing emerging issues such as climate change, which might impact the future occurrence and intensity of accidents, as well as issues with global impact, such as pandemics.
- Countries should consult with organisations in seeking to understand and address the transboundary effects of chemical accidents, which could be far-reaching, through both air and water paths.
- Organisations are closely working together to strengthen international co-operation and improve co-ordination of their programmes. They do so, for example, through two mechanisms: the Inter-Agency Coordination Group on Industrial/Chemical Accidents and the Inter-Organization Programme for the Sound Management of Chemicals (IOMC) (Box 17.2).

Countries should use international organisations as mechanisms to develop co-operation, including research and development, and to exchange experiences across countries, aiming to identify and seek to facilitate the application of good practices.

Countries should seek to understand and consider the application of international good practices by making use of the Guiding Principles and other safety guidelines and good practice compilations prepared by international organisations.

Countries should consider the prevention of chemical accidents as a key element for achieving sustainable development worldwide and progressing toward enhanced disaster risk reduction in line with the United Nations 2030 Agenda.

Box 17.1. International agencies with a programme relating to chemical accidents

- **European Commission**: In Europe, the accident in the Italian town of Seveso in 1976 prompted the adoption of the Seveso Directive, legislation to address major accident hazards. It is based on four main pillars (prevention, preparation, response and lesson learning). As the EC's scientific support to the Seveso Directive, the Joint Research Centre (JRC) Major Accident Hazards Bureau plays a vital role. For example, it maintains the Major Accident Reporting System (eMARS) that has for objective to facilitate the exchange of lessons learnt from accidents and near misses involving dangerous substances. eMARS is a public database with over 900 reports of chemical accidents and near misses reported by EU, European Economic Area (EEA), OECD and UNECE countries.
  http://ec.europa.eu/environment/seveso; https://minerva.jrc.ec.europa.eu/en/minerva

- **International Labour Organization**: The ILO has more than 50 legal instruments for the protection from chemical hazards of workers but also the public and the environment. In addition to legally binding instruments, the ILO also offers technical assistance programmes and provides training and guidance tools to stakeholders. The ILO issued the Prevention of Major Industrial Accidents Convention (No. 174) and Recommendation (No. 181). It also developed a *Code of Practice: Major Industrial Accidents* as complementary practical guidance to Convention 174, which aims to provide information for setting up an administrative, legal and technical system for the control of major hazard installations.
  https://www.ilo.org/skills/pubs/WCMS_107829/lang--en/index.htm
- **Joint Environment Unit**: The JEU assists countries requesting assistance to address the environmental impacts of sudden-onset disasters and accidents by co-ordinating international preparedness and response activities. In the first hours after a chemical accident, the JEU can mobilise experts and analysis equipment to the affected area. These experts work together with national and local authorities to conduct rapid assessments, test for the presence of hazardous materials, analyse the possible effects on communities and assist with the development of response and monitoring strategies. The JEU created the Environmental Emergencies Centre (EEC – www.eecentre.org) and the Flash Environmental Assessment Tool (FEAT).
- **Organisation for Economic Co-operation and Development**: The OECD's programme on Chemical Accidents aims to share experiences amongst governments and other stakeholders and recommends policy options for enhancing the prevention of, preparedness for and response to chemical accidents. It has developed key guidance documents on topics such as performance indicators, corporate governance, change of ownership, Natural Hazard Triggered Technological Accidents (Natech) as well as the present Guiding Principles. There is also the OECD Decision-Recommendation of the Council concerning Chemical Accident Prevention, Preparedness and Response, updated and consolidated in 2023. Very importantly, it provides a forum for countries and stakeholders to exchange good practices, challenges and lessons learnt from accidents.
  https://www.oecd.org/chemicalsafety/chemical-accidents/
- **Organisation for the Prohibition of Chemical Weapons**: Chemical Safety is one of the primary activities related to the implementation of Article XI of the Chemical Weapons Convention. Through industry-outreach activities, the convention seeks to meet the needs of OPCW member states and their chemical industries in the field of chemical safety. The programmes of the International Cooperation Branch of OPCW are designed to address specific safety management issues related to chemical processes safety and chemical risk management that have a direct bearing on the effective implementation of the convention. It contributes to the exchange and sharing of experiences on the practical implementation of safety and security management programmes.
  https://www.opcw.org/
- **United Nations Economic Commission for Europe**: The UNECE Convention on the Transboundary Effects of Industrial Accidents aims to protect human beings and the environment against the effects of industrial accidents. Its provisions oblige parties to prevent, prepare for and respond to industrial accidents, in particular those capable of causing transboundary effects. The convention promotes international co-operation among states, before, during and after an accident and provides a framework for parties to assist each other in the event of an accident, co-operate on research and development and exchange information and technology. UNECE and its partners have developed guidelines, good practices and checklists to strengthen the implementation of the convention, as a legal instrument for technological disaster risk reduction under the Sendai Framework and support the implementation of the SDGs. The convention's Assistance and Cooperation Programme, operational since 2004, enhances the capacities of countries of Eastern and South Eastern Europe, the Caucasus and Central Asia in implementing the convention.

https://unece.org/environment-policy/industrial-accidents

- **United Nations Environment Programme**: UNEP aims to raise awareness and build capacities of communities, industry and governments for emergency prevention and preparedness with a special focus on chemical and industrial accidents. The Awareness and Preparedness for Emergencies at Local Level (APELL) programme aims to raise awareness about hazards and risks, improve preparedness planning and prepare co-ordinated emergency plans. The Flexible Framework for Addressing Chemical Accident Prevention and Preparedness methodology supports governments to develop, improve or review chemical accident prevention and preparedness programmes at the national level. It encompasses the collection of laws, regulations, policies, guidance and other instruments developed by a country. https://www.unenvironment.org/explore-topics/disasters-conflicts/what-we-do/preparedness-and-response/awareness-and-preparedness; https://www.unenvironment.org/pt-br/node/653
- **United Nations Office for Disaster Risk Reduction**: The UNDRR brings governments, partners and communities together to reduce disaster risk and losses and to ensure a safer, sustainable future. The Sendai Framework for Disaster Risk Reduction 2030 focuses on managing risks with a wide scope covering all types of disaster risks and hazards, caused by natural or manmade hazards including biological, technological and environmental hazards. The UNDRR has developed the *Words into Action Guidelines: Implementation Guide for Man-made and Technological Hazards* that take a practical approach in addressing manmade and technological hazards in the context of disaster risk reduction. https://www.undrr.org/publication/words-action-guideline-man-made/technological-hazards
- **World Health Organization**: The WHO works to raise awareness about the public health impact of chemical incidents, strengthen national capacities, provide international alerts and responses, and maintain international networks for the public health management of chemical incidents. The WHO has developed the International Health Regulations (IHR) that require countries to develop adequate capacities for the surveillance, detection and response to chemical-related outbreaks that may have international public health impacts. https://www.who.int/health-topics/international-health-regulations

For more information on each of the agency's programmes, see https://www.oecd.org/chemicalsafety/chemical-accidents/Brochure-International-efforts-for-industrial-and-chemical-accidents.pdf.

Box 17.2. Mechanisms for inter-agency co-operation and co-ordination

Inter-Agency Coordination Group on Industrial/Chemical Accidents

The Inter-Agency Coordination Group is an informal forum that brings together international organisations and institutions working on the prevention of, preparedness for and response to industrial and chemical accidents. It aims to:

- Strengthen international co-operation for improving the prevention of, preparedness for and response to chemical and industrial accidents.
- Improve the use of resources and avoid potential duplication of work across the agencies.
- Facilitate understanding and co-ordination of the programmes of each agency.

- Carry a common message to the international community on the importance of the prevention of, preparedness for and response to chemical accidents as being among the key elements associated with the sound management of chemicals.

Inter-Agency Coordination Group regular participants include representatives of the European Commission (and it JRC Major Accident Hazards Bureau), the International Labour Organization (ILO), the Joint Environment Unit (JEU) of the United Nations Environment Programme/United Nations Office for the Coordination of Humanitarian Affairs, the Organisation for Economic Co-operation and Development (OECD), the Organisation for the Prohibition of Chemical Weapons (OPCW), the United Nations Economic Commission for Europe (UNECE), the United Nations Industrial Development Organization (UNIDO), the United Nations Environment Programme (UNEP), the United Nations Office for Disaster Risk Reduction (UNDRR) and the World Health Organization (WHO).

Source: OECD (2017[1]), *International Efforts for Industrial and Chemical Accidents Prevention, Preparedness and Response (brochure)*, https://www.oecd.org/chemicalsafety/chemical-accidents/Brochure-International-efforts-for-industrial-and-chemical-accidents.pdf.

Inter-Organization Programme for the Sound Management of Chemicals (IOMC)

The programme has the goal of promoting co-ordination of the policies and activities, pursued, jointly or separately, to achieve the sound management of chemicals in relation to human health and the environment. The participating agencies are the Food and Agriculture Organization of the United Nations (FAO), the ILO, United Nations Development Programme (UNDP), UNEP, UNIDO, the United Nations Institute for Training and Research (UNITAR), the WHO, the World Bank and the OECD.

One of the main achievements of the IOMC in relation to chemical accident prevention, preparedness and response is the IOMC Toolbox. The IOMC Toolbox is a tool enabling countries to identify the most appropriate and efficient actions to solve specific national problems related to chemical management. It identifies the available IOMC resources that will help the country address the identified national problem(s) or objectives. Special focus is given to identifying simple cost-effective solutions to national chemicals management issues. A special section in the IOMC Toolbox has been developed to address specifically major hazard prevention, preparedness and response. This section aims to provide support for countries in setting up or improving a chemical accident prevention, preparedness and response management scheme. The chemical accident scheme of the toolbox is accessible at https://iomctoolbox.org/node/50036/steps.

Transboundary co-operation

Chemical accidents can have a transboundary dimension and there are specific international guidance, frameworks and regulations to support the prevention of, preparedness for and response to transboundary chemical accidents. As such, the following principles should be applied consistent with the OECD Decision-Recommendation of the Council concerning Chemical Accident Prevention, Preparedness and Response, and where applicable with the UNECE Conventions on Transboundary Effects of Industrial Accidents and on the Protection and Use of Transboundary Watercourses and International Lakes.

This section contains particular requirements for the potential effect of chemical accidents with transboundary impacts. All of the other sections of the Guiding Principles apply where relevant. For the purposes of this section, transboundary covers land and water frontiers.

On both sides of a boundary, a country should treat the other country (its population and the environment), as far as possible, in the same way regarding the potential impact of chemical accidents.

- Countries of origin and potentially affected countries should exchange information and consult each other, with the objective of preventing accidents capable of causing transboundary damage and reducing adverse effects should such an accident occur.
- To this end, a country where a hazardous installation is located or planned (country of origin) should provide all potentially affected countries with relevant information concerning existing or planned hazardous installations, and the potentially affected countries should provide the host country with relevant information concerning the area under its jurisdiction that could be affected by transboundary damage in the event of an accident.

Countries of origin and potentially affected countries should co-operate with respect to Natech prevention, preparedness and response because natural hazards, which may trigger Natech risks, may be transboundary or the impacts of Natech may be transboundary.

Countries of origin and potentially affected countries should consult one another with a view to co-ordinating offsite emergency planning related to hazardous installations capable of causing transboundary damage. They shall inform one another of the communication systems to be used, the main features of the emergency plans and the means available for emergency response in the event of an accident capable of causing transboundary damage.

Countries of origin and potentially affected countries should inform one another of the instructions given to their respective populations on how to respond in the event of an accident capable of causing transboundary damage, and on any evacuation or protection measures to be taken in the event of such as an accident or imminent threat of such an accident.

Countries of origin and potentially affected countries should establish procedures for the rapid and effective transmission of information related to an accident (or imminent threat of an accident) that might cause transboundary effects, and should set up systems for the communication of pertinent information following an accident.

In the event of a chemical accident (or imminent threat of an accident) capable of causing transboundary effects, public authorities in the country of origin should ensure that appropriate authorities in potentially affected countries are notified without delay and are given appropriate information. In addition, the host country should endeavour to co-ordinate response measures with affected countries.

Representatives of potentially affected countries/communities should have an opportunity to participate in licensing or siting procedures for hazardous installations or their significant modifications that might have transboundary effects in their countries.

To the extent practicable, public authorities should attempt to provide assistance to other countries that have requested help related to the preparedness for or response to chemical accidents.

Public authorities should develop procedures to facilitate the transit through their territory of personnel and equipment to be used for mutual aid in the event of a chemical accident.

Countries' bilateral and multilateral collaboration

Bilateral and multilateral co-operation should be strengthened in order to increase the institutional capability of governments with respect to the safety of hazardous installations.

- Co-operation can engage countries at a similar stage of advancement in the prevention, preparedness and response to chemical accidents that are looking to improve their programmes

or exchange on specific issues, or they can engage countries that are seeking assistance to develop and run a chemical accident programme.

- Countries should make efforts to improve co-operation related to research and development and the exchange of information in the field of preventing chemical accidents and ensuing preparedness for and mitigation of their consequences.
- Countries can, for example, seek support from and exchange with other countries or propose their help through the relevant programmes of international organisations. This can include activities that provide assistance, capacity building and support for the strengthening of the implementation of legal and policy instruments.

Reference

OECD (2017), *International Efforts for Industrial and Chemical Accidents Prevention, Preparedness and Response (brochure)*, OECD, Paris, https://www.oecd.org/chemicalsafety/chemical-accidents/Brochure-International-efforts-for-industrial-and-chemical-accidents.pdf. [1]

Annex A. Explanation of terms used

Acceptability of risk: Risk acceptable to everyone, which everyone would agree without reservation to take or have imposed on them.

Affiliate: An enterprise in which another enterprise has minority voting rights and no effective operational control.

Audit: A systematic examination of a hazardous installation to help verify conformance with regulations, standards, guidelines and/or internal policies. This includes the resultant report(s) but not subsequent follow-up activities. Audits can include examinations performed either by or on behalf of management of a hazardous installation (self or internal audit) or an examination by an independent third party (external audit).

Chemical accident: Any unintentional event, such as a release, fire or explosion at a hazardous installation, involving hazardous substances that has the potential to cause harm to human health, the environment or property. This also covers chemical accidents triggered by the effects of natural hazards.

Chemical or industrial park: A group of two or more sites, facilities or establishments with different operators and in close proximity. They may share infrastructure and some services such as a fire brigade, cooling systems, nitrogen supply, wastewater treatment and electrical supply. The potential for domino effects should be considered.

Community(ies): Individuals living/working near hazardous installations who may be affected in the event of a chemical accident.

Enterprise: A company or corporation (including transnational corporations) that has operations involving the production, processing, handling, storage, use and/or disposal of hazardous substances.

Hazard: An inherent property of a substance, agent, source of energy or situation having the potential to cause undesirable consequences.

Hazardous installation: Fixed installation at which hazardous substances are produced, processed, handled, stored, used or disposed of in such a form and quantity that there might be a risk of occurrence of a chemical accident. This also covers pipelines and transport interfaces such as marshalling yards and port areas, with the exclusion of military installations and the hazard arising from ionising radiation at nuclear installations.

Hazardous substance: Element, compound or mixture which, by virtue of its chemical, physical or toxicological properties, has the potential to cause harm to human health, the environment or property.

Incident includes:

- A chemical accident that has a significant impact on human health, company operations, the environment, the community or society at large.
- A near miss that does not have a serious impact but might have had under different circumstances, that is if the sequence of events had not been interrupted by a planned control measure or by chance.

Inspection: A control performed by public authorities. There may be other parties involved in the inspection, acting on behalf of the authorities. An inspection includes the resultant report(s) but not subsequent follow-up activities.

Local authority: Government body at the local level (e.g. city, county, province). Individual responsibilities within local authorities vary from country to country.

Monitor (or) **monitoring:** Use of checks, inspections, sampling and measurements, surveys, reviews or audits to measure compliance with relevant laws, regulations, standards, codes, procedures and/or practices; includes activities of public authorities, industry and independent bodies.

Natech: A chemical accident, including spills of oil and oil products, triggered by a natural hazard or natural disaster (such as extreme temperatures, high winds, floods, storms, earthquakes or wildfires).

Operator: The legal or natural person who, under applicable law, is in charge of the installation and is responsible for its proper operation. The concept of operator is defined in the law applicable in the country of the installation, in which attention may be given to criteria such as ownership of certain hazardous substances or possession of a license or permit.

Performance indicator: A means for measuring the changes over time in the level of safety (related to chemical accident prevention, preparedness and response), as the result of actions taken.

Programme: Any legislation, policy, regulation and implementation mechanisms for the prevention of, preparedness for and response to chemical accidents.

Risk communication: The sharing of information, or dialogue, among stakeholders about issues related to chemical accident prevention, preparedness and response including, for example: health and environmental risks and their significance; policies and strategies aimed at managing the risks and preventing accidents; and actions to be taken to mitigate the effects of an accident. For purposes of this document, risk communication includes dialogue and sharing of information among the public, public authorities, industry and other stakeholders.

Risk management: The management policies, procedures and practices used in the activities of communicating, consulting, establishing the context and identifying, analysing, evaluating, treating, monitoring and reviewing risk.

Site, facility or establishment: The whole location under the control of an operator where hazardous substances are present.

Tolerability of risk: A willingness by society as a whole to live with risk so as to secure certain benefits in the confidence that the risk is one that is worth taking and that it is being properly controlled.

Transboundary damage: Any serious damage to human health, the environment or property, suffered by an affected jurisdiction in the event of a chemical accident originating in a different jurisdiction.

Annex B. For further reading

This annex provides a list of websites and publications that might be of interest to the readers of the Guiding Principles. It contains a list of relevant legal instruments, many of which are referenced in those principles. In addition, this annex contains a full list of the OECD workshops and special sessions that have provided input for these Guiding Principles. These lists are NOT intended to be comprehensive. The purpose is to indicate materials that are relevant (especially those that give further guidance on implementing the Guiding Principles) and that are easily available to the public.

OECD legal instruments related to chemical accidents

OECD (2023), *Decision-Recommendation of the Council concerning Chemical Accident Prevention, Preparedness and Response*, https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0490.

OECD (1989), *OECD Recommendation of the Council concerning the Application of the Polluter-Pays Principle to Accidental Pollution*, https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0251.

OECD guidance documents

OECD (2018), *Guidance on Change of Ownership in Hazardous Facilities*, Series on Chemical Accidents, No. 31, OECD, Paris, https://www.oecd.org/chemicalsafety/chemical-accidents/oecd-guidance-on-change-of-ownership-in-hazardous-facilities.pdf and https://one.oecd.org/document/env/jm/mono(2018)31/en/pdf.

OECD (2012), *Corporate Governance for Process Safety: Guidance for Senior Leaders in High Hazard Industries*, Series on Chemical Accidents, No. 24, OECD, Paris, https://www.oecd.org/env/ehs/chemical-accidents/corporate%20governance%20for%20process%20safety-colour%20cover.pdf and https://one.oecd.org/document/ENV/JM/MONO(2012)39/en/pdf.

OECD (2008), *Guidance on Developing Safety Performance Indicators for Industry related to chemical accident prevention, preparedness and response - second edition, 2008*, Series on Chemical Accidents, No. 19, OECD, Paris, https://www.oecd.org/env/ehs/chemical-accidents/41269710.pdf and https://one.oecd.org/document/g1g48576/en/pdf.

OECD (2008), *Guidance on Developing Safety Performance Indicators for Public Authorities and Communities/Public related to chemical accident prevention, preparedness and response - second edition, 2008*, Series on Chemical Accidents, No. 18, OECD, Paris https://www.oecd.org/env/ehs/chemical-accidents/41269639.pdf and https://one.oecd.org/document/g1g48575/en/pdf.

OECD workshop reports and other publications

OECD (2022), *Chemical Accidents Involving Nanomaterials: Potential Risks and Review of Prevention, Preparedness and Response Measures – Project Report*, Series on Chemical Accidents, No. 34, OECD, Paris, https://one.oecd.org/document/env/cbc/mono(2022)19/en/pdf.

OECD (2021), *Good Practices for the Management of Inspections at Hazardous Installations: Project Report (Case Studies)*, Series on Chemical Accidents, No. 33, OECD, Paris, https://one.oecd.org/document/env/cbc/mono(2021)2/en/pdf.

OECD (2020), *Natech Risk Management: 2017-2020 Project Results*, Series on Chemical Accidents, No. 32, OECD, Paris, https://one.oecd.org/document/env/jm/mono(2020)4/en/pdf.

OECD (2018), *Workshop Report: Developing a Methodology to Quantify the Benefits of Regulations for Chemical Accidents Prevention, Preparedness and Response*, Series on Chemical Accidents, No. 30, OECD, Paris, https://one.oecd.org/document/env/jm/mono(2018)3/en/pdf.

OECD (2017), *Ageing of Hazardous Installations*, Series on Chemical Accidents, No. 29, OECD, Paris, https://one.oecd.org/document/env/jm/mono(2017)9/en/pdf.

OECD (2016), *Synthesis Report: Special Session on Facilities Handling Hazardous Substances with Ownership Change*, Series on Chemical Accidents, No. 28, OECD, Paris, https://one.oecd.org/document/env/jm/mono(2016)10/en/pdf.

OECD (2015), *2nd Addendum to the OECD Guiding Principles for Chemical Accident Prevention, Preparedness and Response (2nd ed.) to Address Natural Hazards Triggering Technological Accidents (Natech) Risk Management*, Series on Chemical Accidents, No. 27, OECD, Paris, https://one.oecd.org/document/env/jm/mono(2015)1/en/pdf.

OECD (2013), *Carbon Capture and Long-Term Storage: Analysis of 2010 Survey*, Series on Chemical Accidents, No. 26, OECD, Paris, https://one.oecd.org/document/env/jm/mono(2013)9/en/pdf.

OECD (2013), *Report of the Workshop on Natech Risk Management (23-25 May 2012, Dresden, Germany)*, Series on Chemical Accidents, No. 25, OECD, Paris, https://one.oecd.org/document/env/jm/mono(2013)4/en/pdf.

OECD (2012), *Report of the Conference on Corporate Governance for Process Safety*, Series on Chemical Accidents, No. 23, OECD, Paris, https://one.oecd.org/document/env/jm/mono(2012)38/en/pdf.

OECD (2011), *Addendum to the OECD Guiding Principles for Chemical Accident Prevention, Preparedness and Response (2nd ed.)*, Series on Chemical Accidents, No. 22, OECD, Paris, https://one.oecd.org/document/env/jm/mono(2011)15/en/pdf.

OECD (2009), *Report of the Workshop on Safety in Marshalling Yards*, Series on Chemical Accidents, No. 21, OECD, Paris, https://one.oecd.org/document/ENV/JM/MONO(2008)34/en/pdf.

OECD (2008), R*eport of the OECD-CCA Workshop on Human Factors in Chemical Accidents and Incidents*, Series on Chemical Accidents, No. 20, OECD, Paris, https://one.oecd.org/document/ENV/JM/MONO(2008)6/en/pdf.

OECD (2008), *Report of Survey on the Use of Safety Documents in the Control of Major Accident Hazards*, Series on Chemical Accidents, No. 17, OECD, Paris, https://one.oecd.org/document/ENV/JM/MONO(2008)4/en/pdf.

OECD (2006), *Report of the OECD-EC Workshop on Risk Assessment Practices for Hazardous Substances Involved in Accidental Releases, 16-18 October 2006, Varese, Italy*, Series on Chemical Accidents, No. 16, OECD, Paris, https://one.oecd.org/document/ENV/JM/MONO(2007)29/en/pdf.

OECD (2005), *Integrated Management Systems (IMS)-Potential Safety Benefits Achievable from Integrated Management of Safety, Health, Environment and Quality (SHE&Q)*, Series on Chemical Accidents, No. 15, OECD, Paris, https://one.oecd.org/document/ENV/JM/MONO(2005)15/en/pdf.

OECD (2004), *Report of the OECD Workshop on Lessons Learned from Chemical Accidents and Incidents, 21-23 September 2004, Karlskoga, Sweden*, Series on Chemical Accidents, No. 14, OECD, Paris, https://one.oecd.org/document/ENV/JM/MONO(2005)6/en/pdf.

OECD (2003), *Report of the OECD Workshop on Sharing Experience in the Training of Engineers in Risk Management, Montreal, Canada, 21-24 October 2003*, Series on Chemical Accidents, No. 13, OECD, Paris, https://one.oecd.org/document/ENV/JM/MONO(2004)4/en/pdf.

OECD (2003), *Report of the Workshop on Communication related to Chemical Releases Caused by Deliberate Acts, Rome, Italy, 25-27 June 2003*, Series on Chemical Accidents, No. 12, OECD, Paris, https://one.oecd.org/document/ENV/JM/MONO(2004)3/en/pdf.

OECD (2002), *Report of CCPS/OECD Conference and Workshop on Chemical Accident Investigations, Orlando, Florida, United States, 2, 5, and 6 October 2000*, available online at: https://www.oecd.org/env/ehs/chemical-accidents/1947162.pdf.

OECD (2002), *Report of the OECD Workshop on Integrated Management of Safety, Health, Environment and Quality, Seoul, Korea, 26-29 June 2001*, Series on Chemical Accidents, No. 9, OECD, Paris, https://one.oecd.org/document/ENV/JM/MONO(2002)21/en/pdf.

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OECD (2002), *Report of the Special Session on Environmental Consequences of Chemical Accidents, Paris, France, 28 November 2000*, Series on Chemical Accidents, No. 7, OECD, Paris, https://one.oecd.org/document/ENV/JM/MONO(2002)24/en/pdf.

OECD (2001), *Report of the OECD Expert Meeting on Acute Exposure Guideline Levels (AEGLs)*, Series on Chemical Accidents, No. 6, OECD, Paris, https://one.oecd.org/document/ENV/JM/MONO(2001)2/en/pdf.

OECD (2001), *Report of the OECD Workshop on New Developments in Chemical Emergency Preparedness and Response, Lappeenranta, Finland*, Series on Chemical Accidents, No. 5, OECD, Paris, https://one.oecd.org/document/ENV/JM/MONO(2001)1/en/pdf.

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UNEP (1988), Awareness and Preparedness for Emergencies at Local Level (APELL), United Nations Environment Programme, https://wedocs.unep.org/handle/20.500.11822/8051.

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About the OECD Chemical Safety and Biosafety Programme

The Environment, Health and Safety Division publishes free-of-charge documents in twelve different series: Testing and Assessment; Good Laboratory Practice and Compliance Monitoring; Pesticides; Biocides; Risk Management; Harmonisation of Regulatory Oversight in Biotechnology; Safety of Novel Foods and Feeds; Chemical Accidents; Pollutant Release and Transfer Registers; Emission Scenario Documents; Safety of Manufactured Nanomaterials; and Adverse Outcome Pathways. More information about the Environment, Health and Safety Programme and EHS publications is available on the OECD's World Wide Web site (www.oecd.org/chemicalsafety/). More publications in the Series on Chemical Accidents are available at https://www.oecd.org/chemicalsafety/chemical-accidents/.

The Inter-Organisation Programme for the Sound Management of Chemicals (IOMC)

This publication was developed in the IOMC context. The contents do not necessarily reflect the views or stated policies of individual IOMC Participating Organisations.

The Inter-Organisation Programme for the Sound Management of Chemicals (IOMC) was established in 1995 following recommendations made by the 1992 UN Conference on Environment and Development to strengthen co-operation and increase international co-ordination in the field of chemical safety. The Participating Organisations are FAO, ILO, UNDP, UNEP, UNIDO, UNITAR, WHO, World Bank and OECD. The purpose of the IOMC is to promote co-ordination of the policies and activities pursued by the Participating Organisations, jointly or separately, to achieve the sound management of chemicals in relation to human health and the environment.

IOMC

INTER-ORGANIZATION PROGRAMME FOR THE SOUND MANAGEMENT OF CHEMICALS

A cooperative agreement among **FAO, ILO, UNDP, UNEP, UNIDO, UNITAR, WHO, World Bank and OECD**

Series on Chemical Accidents

OECD Guiding Principles for Chemical Accident Prevention, Preparedness and Response - Third Edition

Chemical accidents with serious consequences continue to happen in OECD Member countries and worldwide. Over the past decades, successive major accidents have caused deaths, injuries, significant environmental pollution and massive economic losses – from the hydrogen fluoride leak in Gumi (Korea) in 2012, the ammonium nitrate explosion in West, Texas (United States) in 2013 or, recently, the blow-up of a chemical facility in Tarragona (Spain) and the explosion at the port of Beirut (Lebanon) in 2020, and the blast in Leverkusen (Germany) in 2021. This third edition of the OECD Guiding Principles for Chemical Accident Prevention, Preparedness and Response provides guidance for the safe planning and operation of hazardous installations. It aims to support public authorities and industry in taking appropriate actions to prevent chemical accidents and to mitigate impacts of accidents that do nevertheless occur. These guiding principles apply to fixed installations at which hazardous substances are produced, processed, handled, stored, used or disposed of, in such a form and quantity that there might be a risk of occurrence of a chemical accident. These guiding principles constitute the technical guidance supporting the implementation of the Decision-Recommendation of the Council concerning Chemical Accident Prevention, Preparedness and Response adopted in 2023.

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