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Prevention of accidental water pollution

Draft safety guidelines and good practices for the management and retention of firefighting water: general recommendations

Prepared by the Joint Ad Hoc Expert Group on Water and Industrial Accidents, in cooperation with the secretariat

Summary

In 1986, as a result of a fire at the Sandoz pharmaceutical company near Basel, Switzerland, 30 tons of toxic chemicals were released into the Rhine River owing to the lack of firefighting water retention. This caused extensive transboundary water pollution, suspended drinking water supplies, devastated fish stocks in Switzerland, France and Germany and had effects reaching as far as the Netherlands (approximately 700 kilometres downstream).

At a seminar held on the occasion of the 25th anniversary of the accident (Bonn, Germany, 8–9 November 2011), Parties to the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) and the Convention on the Transboundary Effects of Industrial Accidents (Industrial Accidents Convention) noted with concern the continuing lack of guidance for preventing similar accidents in the future. In order to address this need, in 2016, the Bureaux of the two

Conventions tasked the Joint Ad Hoc Expert Group on Water and Industrial Accidents (Joint Expert Group) with developing safety guidelines and good practices for the management and retention of firefighting water. This proposal was endorsed by the Conference of the Parties to the Industrial Accidents Convention at its ninth meeting in November 2016 (see the workplan and resources for the Convention for 2017–2018, contained in the report of the Conference of the Parties (ECE/CP.TEIA/32/Add.1)) and by the Working Group on Integrated Water Resources Management at its eleventh meeting in October 2016 (see ECE/MP.WAT/WG.1/2016/2).

The objective of the safety guidelines is to enhance existing practices with regard to firefighting water retention and to promote harmonized safety standards in the United Nations Economic Commission for Europe (ECE) region. The safety guidelines and good practices are divided into two parts: general recommendations (contained in this document) and technical and organizational recommendations for the management and retention of firefighting water (ECE/MP.WAT/ 2018/10-ECE/CP.TEIA/2018/13).

The Joint Expert Group, in cooperation with the Expert Group on Fire-water Retention and supported by the ECE secretariat, developed the draft safety guidelines, which were shared for comments with the focal points of the Water Convention, the Industrial Accidents Convention, international organizations, industry associations and other partners in the last quarter of 2017. Their comments, inputs and feedback were considered by the Expert Group and, where feasible, included or otherwise addressed during the process of finalizing the guidelines. At their second joint meeting (Geneva, 28–30 May 2018), the Working Group on Integrated Water Resources Management and the Working Group on Monitoring and Assessment took note of the draft safety guidelines and entrusted the secretariat with the task of including the comments received and submitting them to the eighth session of the Meeting of the Parties (ECE/MP.WAT/WG.1/2018/8-ECE/MP.WAT/WG.2/2018/8) (see the report of the second joint meeting of the Working Group on Integrated Water Resources Management and the Working Group on Monitoring and Assessment (ECE/MP.WAT/WG.1/2018/2-ECE/MP.WAT/WG.2/2018/2, forthcoming)). At its thirty-eighth meeting (Bern, 26–27 June 2018), the Bureau of the Industrial Accidents Convention took note of the draft safety guidelines.

The Meeting of the Parties to the Water Convention, at its eighth session (Astana, 10–12 October 2018), and the Conference of the Parties to the Industrial Accidents Convention, at its tenth meeting (Geneva, 4–6 December 2018), are invited to take note of the safety guidelines and to recommend their use and implementation by countries in order to prevent accidental pollution of soil and water, including pollution causing transboundary effects.

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I. Executive summary

1. Contaminated firefighting water can cause severe environmental harm when released into the soil and water, not only within but also across countries. The Sandoz accident in 1986 was a tragic reminder of this fact when, owing to the lack of firefighting water retention during an emergency response to a major fire in an agrochemical warehouse at the Sandoz pharmaceutical company site near Basel, Switzerland, 30 tons of toxic chemicals were released into the Rhine River. This caused vast transboundary water pollution, suspended drinking water supplies, devastated fish stocks in Switzerland, France and Germany, and reached as far as the Netherlands (approximately 700 kilometres downstream).

2. The management and retention of firefighting water is therefore crucial to prevent the pollution of the environment with contaminated firefighting water, which — as demonstrated by the Sandoz accident — can quickly affect other countries, even those which may initially appear to be far away from the accidental release. As such, it is evident that the management and retention of firefighting water is highly relevant in a transboundary context, and countries need to work together to prevent accidental (water) pollution with contaminated firefighting water.

3. Although the Sandoz accident triggered many improvements in United Nations Economic Commission for Europe (ECE) countries in the area of industrial safety and transboundary cooperation, the issue of firefighting water retention has until now not been thoroughly addressed. In many ECE countries, including European Union countries, there are gaps in the national legislation, and size requirements for firefighting water retention basins remain unclear. International and subregional regulations for the management and retention of firefighting water are lacking.[1] In addition, near-misses and accidents leading to the production of huge amounts of firefighting water for which insufficient retention volumes were available (see annex) demonstrate the urgency for more regulation and additional preventive measures in this area. The threat is still real and Sandoz-like accidents could still happen in the ECE region today.

4. To avoid another such disaster, guidelines for the management and retention of firefighting water are strongly needed within the ECE region to prevent transboundary pollution, notably water contamination. To this end, the present Safety Guidelines and Good Practices for the Management and Retention of Firefighting Water were developed to support governments, competent authorities and operators in applying measures and improving existing practices to prevent the accidental pollution of soil and water, including pollution that could cause transboundary effects. The key recommendations from both the general and the technical and organizational parts of the safety guidelines and good practices are summarized below:

(a) Firefighting water is hazardous to waters irrespective of the material burned. This means that, for example even burned packaging material, fire foams and combustion products from building materials can contaminate firefighting water by turning it into a water-endangering agent. The development of huge amounts of firefighting water should therefore be avoided in the first instance. Firefighting water must be retained completely

[1] From a regulatory perspective only Directive 2012/18/EU of the European Parliament and of the Council of 4 July 2012 on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC (Seveso III Directive) explicitly mentions fire-water retention as a major element to restrict the effects of a major accident (annex II, para. 5 (a)). However, no concrete regulation is outlined, either within the European Union and its member States or in other ECE countries, with the exception of Switzerland, which has developed an inter-cantonal guideline for firefighting water retention for hazardous activities (see footnote 4).

and disposed of adequately in order to prevent the contamination of water and soil, both within and across countries;[2]

(b) Governments should provide leadership and create suitable administrative and legal frameworks to introduce mandatory requirements for firefighting water management and retention in case of emergencies at all hazardous activities (i.e., not only at storage facilities);

(c) Retention capacities for firefighting water should be established at all hazardous facilities. They should be subdivided into fire compartment areas that are as small as possible. As an example for determining the retention capacities for firefighting water, the German VdS 2557 guideline[3] or the Swiss inter-cantonal guidelines[4] can be used in industrialized countries. For less industrialized countries, a quick, rough estimation based on a direct proportionality of the firefighting water retention volume needed compared with the largest fire-compartment area can be undertaken. Even a complete burn-down should be taken into account, if there is not sufficient retention capacity for firefighting water;

(d) These guidelines focus on water-based extinguishing strategies; however, differing firefighting strategies should also be considered. In general, the retention volume for firefighting water can be drastically reduced by implementing efficient measures to prevent fires from spreading, by using automated fire detection in combination with automatic extinguishing systems (sprinklers, deluge systems, high expansion foams and extinguishing gases) and by applying efficient firefighting techniques;

(e) These safety guidelines and good practices are intended to support governments, competent authorities and operators in applying measures and improving existing practices to prevent accidental pollution of soil and water, including pollution that could cause transboundary effects. Joint bodies, international organizations and other relevant actors could support this work by raising awareness about these guidelines and assisting competent authorities and operators in their implementation. The use of these safety guidelines will help develop a common safety level across the ECE region. It will also support the implementation of the 2030 Agenda for Sustainable Development (notably the achievement of Sustainable Development Goal 6 on ensuring the availability and sustainable management of water and sanitation for all) and the four priorities of the Sendai Framework for Disaster Risk Reduction 2015–2030.

II. Background and acknowledgements

5. On the occasion of the twenty-fifth anniversary of the Sandoz accident, an ECE seminar was held in Bonn, Germany, on 8 and 9 November 2011.[5] The event was organized under the leadership of the Government of Germany, with the support of the secretariat of the ECE Convention of the Transboundary Effects of Industrial Accidents[6] (Industrial

[2] In accordance with the obligations under the Convention on the Protection and Use of Transboundary Watercourses and International Lakes and the Convention on the Transboundary Effects of Industrial Accidents to prevent accidental water pollution and its transboundary effects, contaminated firefighting water must be retained and disposed of adequately.

[3] Verband der Schadenversicherer e.V. (Association of Non-Life Insurers) (VdS), *Planning and Installation of Facilities for Retention of Extinguishing Water: Guidelines for Loss Prevention by the German Insurers*, No. VdS 2557 (Cologne, Germany, VdS Loss prevention GmbH, 2013). Available at https://vds.de/fileadmin/vds_publikationen/vds_2557en_web.pdf.

[4] Switzerland, Konferenz der Vorsteher der Umweltschutzämter der Schweiz (Conference of Chiefs of Environmental Protection Services), *Löschwasser-Rückhaltung – Leitfaden für die Praxis* (Firefighting Water Retention: A Practical Guide), 1st ed. (Zurich, October 2015). Available in French, German and Italian from www.kvu.ch/de/arbeitsgruppen?id=190.

[5] For more information, please see http://www.unece.org/index.php?id=25376.

[6] United Nations, *Treaty Series*, vol. 2105, No. 36605.

Accidents Convention) and the Convention on the Protection and Use of Transboundary Watercourses and International Lakes[7] (Water Convention). The objectives of the seminar were mainly the following:

(a) To reflect on the work carried out and progress achieved in the area of prevention of accidental water pollution in the ECE region;

(b) To examine existing deficits in the prevention of water pollution by chemical substances, and formulate the way forward to address these deficiencies.

6. Following the presentations by the seminar participants, it became evident that 25 years after the Sandoz accident a number of countries were facing significant challenges regarding fire protection and the containment of firefighting water to prevent the contamination of transboundary rivers. These challenges were faced not only at storage facilities but at all other on-site activities, in particular processing plants. Most countries lacked specific legislation and regulations regarding the retention of firefighting water and size requirements for retention basins remained inadequate. Several fire accidents or near-misses in recent years supported those findings. It was therefore recommended to address the issue jointly through the development of related guidance. To that end, the Bureaux to the Water Convention and the Industrial Accidents Convention endorsed a proposal for the Joint Ad Hoc Expert Group on Water and Industrial Accidents (Joint Expert Group) to develop safety guidelines and good practices for firefighting water retention.

7. As a first step, a questionnaire was sent to all focal points of the two conventions to identify needs and available expertise in this area. Under the leadership of the Joint Expert Group, a small group of international experts on firefighting water retention was then established and tasked with the elaboration of safety guidelines and good practices for the retention of firefighting water in the biennium 2017–2018. The present document contains these safety guidelines and good practices, which were developed by the Joint Expert Group in cooperation with the Expert Group on Fire-water Retention and supported by the ECE secretariat. The Expert Group on Fire-water Retention held four meetings in 2017 and 2018.[8] Previous versions of the safety guidelines were discussed at an international seminar on fire-water retention (Slubice, Poland, 5 September 2017)[9] and shared for comments with the focal points of the ECE Water Convention and Industrial Accidents Convention, international organizations, industry associations and other partners in the last quarter of 2017. Their comments, inputs and feedback were considered by the expert group and, where feasible, included or otherwise addressed during the process of finalizing the guidelines.

8. In the period during which the guidance was elaborated, the Joint Expert Group was co-chaired by Mr. Peter Kovacs (Hungary) for the Water Convention and Mr. Gerhard Winkelmann-Oei (Germany) for the Industrial Accidents Convention. In addition to the Co-Chairs, the following experts actively supported the development of the safety guidelines by providing inputs: Mr. Claes-Hakan Carlsson (Sweden); Mr. Pavel Dobes (Czechia); Mr. Jesper Hansen (Switzerland); Mr. Lukasz Kuziora (Poland); Ms. Leighanne Moir (United Kingdom of Great Britain and Northern Ireland); Ms. Cornelia Sedello (Germany); Ms. Maarit Talvitie (Finland); Ms. Tuuli Tulonen (Finland); Mr. Bert van Munster (Netherlands); and Mr. Wolfram Willand (Germany).

[7] United Nations, *Treaty Series*, vol. 1936, No. 33207.

[8] More information on these meeting is available at: www.unece.org/index.php?id=44842, www.unece.org/index.php?id=45437, www.unece.org/index.php?id=45435 and www.unece.org/index.php?id=48199.

[9] For more information, see www.unece.org/index.php?id=45431.

A. Introduction to the management and retention of firefighting water and its transboundary dimension

9. Two ECE treaties — the Industrial Accidents Convention and the Water Convention — together provide a legal framework for addressing the risk of transboundary water pollution arising from industrial accidents. The Industrial Accidents Convention helps protect human beings and the environment against industrial accidents, especially those with transboundary effects, by preventing such accidents as far as possible, reducing their frequency and severity, and mitigating their effects. The Water Convention aims to prevent, control and reduce transboundary impacts by facilitating cooperation. Both conventions share a number of common principles and obligations, for example, the polluter pays principle[10] and obligations to prevent accidental pollution,[11] to inform potentially affected countries if an accident has happened[12] and to ensure joint contingency planning.[13] Issues related to the prevention of accidental water pollution are addressed under the Industrial Accidents Convention in close cooperation with the Water Convention through the Joint Expert Group.

10. More than 30 years after the Sandoz accident, many countries still face a number of significant challenges with regard to the management and retention of firefighting water. An exchange on the legislative frameworks in those countries represented in the Joint Expert Group and the Expert Group on Fire-water Retention revealed that countries often lacked specific laws and regulations on firefighting water retention. Even in countries with basic regulations in place, these were often rather general and incomplete, e.g., only covering storage facilities but not production and processing plants.

11. In recent years, a number of accidents have occurred that led to a huge production of firefighting water, not necessarily at storage plants but, more frequently, at processing and production plants. Examples of some major accidents and near misses regarding firefighting water retention issues in ECE countries, including their financial costs and a short description of what happened, are presented in an annex to these guidelines. The potential damages of such accidents can be severe and costly, not only within a country but also across borders. Often the companies involved are bankrupted by such accidents, and governments are left to take over the remaining costs for the accident and aftercare management, causing a huge financial burden for many years.

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[10] The polluter pays principle contained in the Industrial Accidents Convention (ninth preambular para.) and Water Convention (art. 2, para. 5 (b)) is a general principle of international environmental law that aims to ensure that the final costs of pollution control and reduction are borne by the polluter.

[11] According to the Water Convention (art. 3, para. 1 (l)), “the Parties shall develop, adopt, implement and, as far as possible, render compatible relevant legal, administrative, economic, financial and technical measures” in order to minimize the risk of accidental pollution. According to the Industrial Accidents Convention (art. 6, para. 1, and annex IV), “the Parties shall take appropriate measures for the prevention of industrial accidents, including measures to induce action by operators to reduce the risk of industrial accidents”.

[12] The Water Convention obliges Parties to inform each other about any critical situation that may have a transboundary impact and, if appropriate, establish joint warning and alarm systems (art. 14). In accordance with the Industrial Accidents Convention (art. 10, para. 2, and annex IX), in the event of an industrial accident, or imminent threat thereof, which causes or is capable of causing transboundary effects, the Party of origin shall ensure that affected Parties are, without delay, notified at appropriate levels through the industrial accident notification systems.

[13] Parties to the Water Convention are obliged to take all appropriate measures to prevent, control and reduce pollution of waters causing or likely to cause transboundary impact (art. 2, paras. 1–2). Parties to the Industrial Accidents Convention have committed to establishing and maintaining adequate emergency preparedness to enable them to respond to industrial accidents (art. 8 and annex VII).

12. In order to avoid this financial burden arising from the negative effects of such accidents on human health and the environment, prevention is indispensable. Prevention is not only better than cure, it is also cheaper. To prevent accidental water pollution from happening, to minimize the risks of such accidents and to ensure an effective response in case such accidents should happen requires high quality work and coordination among all the relevant stakeholders at the national and cross-border levels. Only if all parties work together is prevention, minimization and effective response possible.

13. Operators should thus be encouraged to take measures to prevent any damage for which they will be held liable. Governments and competent authorities should put in place stringent regulatory frameworks to ensure that operators implement the necessary safety measures to prevent such accidents from happening. Emergency planners and responders should use these safety guidelines and good practices when developing a fire protection concept and on-site and off-site contingency plans that mitigate environmental harm (e.g., through an appropriate firefighting strategy). Joint bodies play a crucial role in cooperation in transboundary basins to reduce pollution, prevent accidental water pollution and ensure the sustainable and equitable use of waters by, among others, providing a platform for the implementation of harmonized safety standards and transboundary warning and alarm procedures.

14. The use of these safety guidelines will help develop a common safety level across the ECE region. It will also support the implementation of the 2030 Agenda for Sustainable Development, notably the achievement of Sustainable Development Goal 6 on ensuring the availability and sustainable management of water and sanitation for all, and the four priorities of the Sendai Framework for Disaster Risk Reduction 2015–2030.

1. Definitions and terminology

15. Some general definitions, mainly based on the ECE Industrial Accidents Convention and Water Convention, are listed below for the purpose of the present document:

(a) "Competent authority" means one or more national authorities designated or established by a country for the purpose of the Industrial Accidents Convention or the Water Convention;

(b) "Effects"[14] means any direct or indirect, immediate or delayed adverse consequence caused by an industrial accident on, inter alia:

(i) Human beings, flora and fauna;

(ii) Soil, water, air and landscape;

(iii) The interaction between the factors in (i) and (ii);

(iv) Material assets and cultural heritage, including historical monuments.

(c) "Firefighting water" means water that is used to extinguish a fire, including sprinkler and non-sprinkler water; this can also include fire foams and firefighting additives;

(d) "Hazardous activity"[15] means any activity in which one or more hazardous substances are present or may be present in quantities listed in annex I to the Industrial Accidents Convention and that is capable of causing transboundary effects;

[14] In accordance with the ECE Industrial Accidents Convention.
[15] Ibid.

(e) "Industrial accident"[16] means an event resulting from an uncontrolled development in the course of any activity involving hazardous substances either:

(i) In an installation, for example during manufacture, use, storage, handling, or disposal;

(ii) During transportation as it is covered by paragraph 2 (d) of article 2 of the Industrial Accidents Convention.

(f) "JEG model" is the easy method used to roughly calculate the firefighting water retention volume (one square metre (m^2) fire compartment area requires one cubic metre (m^3) firefighting water retention volume);[17]

(g) "Joint body"[18] means any bilateral or multilateral commission or other appropriate institutional arrangements for cooperation between the riparian countries;

(h) "Operator"[19] means any natural or legal person, including public authorities, in charge of an activity, for example, supervising, planning to carry out or carrying out an activity;

(i) "Advanced JEG model" is based on the JEG model (see (f) above) but takes into account advanced fire protection strategies (e.g., sprinklers). The retention volume calculated according to the JEG model can be reduced by 90 per cent owing to the reduced firefighting water needed;[20]

(j) "Riparian countries"[21] means countries bordering the same transboundary waters;

(k) "Transboundary effects"[22] means serious effects within the jurisdiction of a country as a result of an industrial accident occurring within the jurisdiction of another country;

(l) "Transboundary waters"[23] means any surface waters or groundwaters that mark, cross or are located on boundaries between two or more countries. Wherever transboundary waters flow directly into the sea, these transboundary waters end at a straight line across their respective mouths between points on the low-water line of their banks.

16. While further terms and definitions related to the management and retention of firefighting water exist (e.g., in International Organization for Standardization standard ISO/TR 26368:2012,[24] etc.), these have not been included as the document serves as a guideline and national definitions may vary within and beyond the ECE region.

[16] Ibid.
[17] For more information, see the annex to the technical and organizational recommendations of these safety guidelines (ECE/MP.WAT/ 2018/9-ECE/CP.TEIA/2018/13).
[18] In accordance with the ECE Water Convention.
[19] In accordance with the ECE Industrial Accidents Convention.
[20] For more information, see the annex to the technical and organizational recommendations of these safety guidelines.
[21] In accordance with the ECE Water Convention.
[22] In accordance with the ECE Industrial Accidents Convention.
[23] In accordance with the ECE Water Convention.
[24] Environmental damage limitation from firefighting water run-off. May 2012.

2. Scope

17. These safety guidelines and good practices are intended for application at all hazardous activities, according to annex I to the Industrial Accidents Convention, including manufacture, production, storage and other activities. These safety guidelines and good practices could also be applied to hazardous activities outside the scope of the Convention.[25]

18. These safety guidelines and good practices focus on hazardous activities that have primarily water-based fire protection concepts. Alternative firefighting strategies using, for example, gas or carbon dioxide, can also reduce the dimensioning of firefighting water retention but are not considered in this document. The guidelines aim to protect people and the environment from fire accidents which may cause water and soil pollution.

19. Firefighting water can cause considerable damage if it enters surface water, infiltrates the ground, or contaminates groundwater. Substances or objects that are not harmful under normal conditions, like ammonium fertilizers, polyvinyl chloride (PVC), automobile tyres or elementary sulphur, can produce large amounts of toxic gases when burned, and cause highly contaminated firefighting water. Even burned packaging materials, fire foams and combustion products from building materials can contaminate firefighting water. Therefore, as adverse effects on the properties of water bodies cannot be excluded, firefighting water should be prevented from entering surface water and groundwater as it is potentially hazardous to the environment irrespective of the substances involved in the fire.

20. These Safety Guidelines and Good Practices for the Management and Retention of Firefighting Water are derived from operational industry and firefighters' experience. This includes learning from history and the details of past major accidents and the remedial and prevention measures designed to prevent their recurrence or eventually to minimize their consequences.

21. These safety guidelines have been developed to minimize the risk of fire and to safely retain firefighting water. Cooling water that is unlikely to be contaminated and can be segregated may be treated differently, i.e., it can be used to prevent domino effects on neighbouring equipment, the facility or installations. However, cooling water is difficult to segregate and often picks up contamination from the site and should be contained where possible.

22. These guidelines recognize that different safety standards may already exist worldwide and that different approaches to safety exist with regard to production, storage and other activities, including the modes of transport and transport interfaces.

23. These safety guidelines constitute a minimum set of good practices and recommendations to ensure a basic safety level. They aim at facilitating a harmonized level of major accident prevention, including firefighting water management and retention, and an acceptable level of risk within and beyond the ECE region. These guidelines are intended to support existing requirements and recommend enhancement of practices, wherever appropriate.

3. Basic safety principles

24. Operators of hazardous activities have the primary responsibility for ensuring operational and process safety, the personal health of the operating staff and the prevention of contamination of the environment through released firefighting waters.

25. Technical and organizational measures in the case of an accident should be ensured. Therefore, contingency plans should be established by operators (on-site contingency plans)

[25] In accordance with its article 5, the scope of the Industrial Accidents Convention can be expanded.

and by authorities (off-site contingency plans). These plans should be compatible with one another and regularly tested and updated. They should also include measures necessary for fire prevention, firefighting strategy and the management and retention of firefighting water to limit their potential consequences for human health and the environment.

26. Good storage practice for hazardous materials should be applied to minimize the risk of fire spreading, such as separation of combustible and non-combustible goods and the use of stable and water-resistant packaging materials to avoid the release of hazardous substances into firefighting water.

27. The accidental release of firefighting water can pose a potential risk to neighbouring countries sharing transboundary waters. In case of an accident, the Governments concerned should inform each other of the measures taken or planned to be taken to retain and/or dispose of the firefighting water.

28. Past experience shows a high risk of groundwater and surface water contamination through the use of firefighting foams containing mixtures of perfluorinated and polyfluorinated Carbons (PFCs) or other persistent compounds with firefighting water. If there is a need to use such extinguishing agents, the potential environmental consequences should be carefully considered for each hazardous activity.

29. Regular exchange of information between operators, authorities and relevant stakeholders (e.g., firefighters, land-use planners, industry associations, insurance institutions, etc.) regarding good practices, improvement of safety, past accidents and near misses — including firefighting water management and retention issues — should be ensured.

30. Two independent power sources are required to provide for the power supply of automatically triggered firefighting water delivery systems, e.g., pumped deluge systems. For self-acting systems, e.g., systems that are operated pneumatically, hydraulically, or by gravitational force, a second independent power supply is not required.

31. A reliable high-integrity fire detection and suppression system should be installed to ensure the earliest possible detection and extinguishment of a fire. Account should be taken of factors that can influence rapid fire detection, such as the height of the room, subdivisions of the roof area (e.g., height of roof trusses), the condition of the environment and all possible sources that can result in false alarms.

32. An assessment of the required firefighting water quantity and the supply of the respective firefighting water must be undertaken.[26] During this assessment, the influence of differing firefighting strategies (controlled burn versus extinguishment, water sprays versus jets and fixed systems, etc.) should be considered.

33. The retention of any potentially contaminated firefighting water, including water that was not in contact with burning material but contains foam or wetting agents or released chemicals, is an essential component of an integral fire protection and safety concept.

34. For the retention of firefighting water, preference should be given to passive as opposed to active retention systems, i.e., self-acting, permanently installed, structural systems providing the required retention volume without any supplementary measures and being liquid-tight. A central or separately located retention system for firefighting water should be preferred over a local retention of firefighting water (e.g., in the building itself or at the point where the fire starts), to avoid hindrance to firefighters. However, where

[26] In accordance with the obligation under the Industrial Accidents Convention to undertake an analysis and evaluation of the hazardous activity to be able to take measures to prevent an industrial accident, including accidental water pollution and its transboundary effects.

flammable liquids that are immiscible and less dense than water are involved, local containment may be required to reduce the risk of fire escalation.

35. Components of facilities for retention of firefighting water that could be exposed to a fire should be designed in such a way as to be resistant to the temperatures and heat radiation to be expected. Moreover, they should provide sufficient durability and resistance to other physical and chemical attacks during fire. Installations that penetrate a firefighting water retention basin should be avoided (e.g., plastic tubes) or otherwise designed so that they are able to withstand a major fire.

36. If firefighting water has the potential to mix with flammable liquids or if ignitable gas can be emitted, requirements for fire prevention and explosion protection (e.g., technical ventilation and air extraction) are to be met. Should a corresponding risk potential exist, it is strictly forbidden to use underground parts of the building, property sewerage systems (e.g., company-owned drainage systems), or other unprotected drains and shafts for retention and drainage of contaminated firefighting water.

37. All of the components of the retention system should ensure complete impermeability[27] until the disposal of any firefighting water retained. The requirement also applies to pipelines or other pipes leading to the retention reservoirs if they are also used for other purposes (e.g., for wastewater). Ensuring impermeability should take into account aggressive substances that may be present at hazardous activities or may occur in case of fire.

B. Recommendations for the management and retention of firefighting water

38. These safety guidelines and good practices for firefighting water retention at hazardous activities contain recommendations and key elements for Governments (i.e., national governments), competent authorities and operators to take action to ensure a minimum level of safety for the prevention of an uncontrolled release of firefighting waters.

39. The safety guidelines are designed to prevent fire incidents at hazardous activities from happening and to limit the consequences for human health and the environment. They are based extensively on accepted and published good practice procedures to ensure conformity with international standards.

40. For the Parties to the ECE Industrial Accidents Convention the need to take actions can be derived from their obligations under the Convention as well as from the general duty clause.[28] Non-Parties are also encouraged to take the necessary actions.

41. When using these guidelines, competent authorities and operators must ensure that national requirements are met. These guidelines constitute a minimum set of good practices to ensure a basic level of safety in this respect. Alternative approaches by applying different policies, measures and methodologies are possible, provided they achieve at least an equivalent level of safety.

[27] Impermeability criteria according to national requirements should be used as a basis.

[28] The general duty clause aims to establish the principle, as a matter of law in most countries, that operators of hazardous activities have the responsibility for the safe operation of their facility. Further information about the general duty clause can be found in the United Nations Environment Programme flexible framework guidance: *A Flexible Framework for Addressing Chemical Accident Prevention and Preparedness: A Guidance Document* (Milan, Italy, 2010).

1. Recommendations to governments

42. Governments should provide leadership and create suitable administrative and legal frameworks to establish the need for firefighting water management and retention in case of emergencies at all hazardous activities.

43. Governments should adopt policies for the safety of hazardous activities, including concepts for fire protection and the retention of firefighting waters. They should raise awareness and share experience and good practices through educational or training programmes and other means.

44. Governments are responsible for initiating the development and subsequent implementation of technical rules for firefighting water retention. Such firefighting water protection plans should be obligatory in relevant facilities.

45. Governments should encourage operators to provide details of the fire protection measures when applying to operate a hazardous activity.

46. Governments should set up policies on insurance, civil liability and compensation for damage caused by the local and/or transboundary effects of industrial accidents. The ECE Protocol on Civil Liability and Compensation for Damage Caused by the Transboundary Effects of Industrial Accidents on Transboundary Waters[29] could be used as a reference.

47. National legislation regarding fire protection should be clear, enforceable and consistent with the requirements of the Industrial Accidents Convention in order to facilitate international cooperation in, for example, the development and implementation of off-site contingency plans.

48. One or more competent authorities dealing with the management and retention of firefighting water should be designated. Governments should aim at designating such authorities at the national level and, where feasible, at the appropriate regional or local levels so that they have the necessary competence to ensure adequate monitoring and control of hazardous activities. The independence and objectivity of the competent authorities should be ensured.

49. Governments should ensure that the competent authorities are legally empowered and adequately resourced to be capable of taking effective, proportionate and transparent enforcement action, including, where appropriate, to cease operations in cases of unsatisfactory safety performance and environmental protection.

50. Governments should establish a system to ensure that information about fire incidents is evaluated on the national level and, if appropriate, basin level, to follow-up on lessons learned. Descriptions of lessons learned should be freely available to all stakeholders.

51. Governments should create joint bodies where these do not exist already for jointly managing their transboundary watercourses (in accordance with article 9 of the Water Convention). They should also establish international warning and alert systems in the framework of existing joint bodies to be able to cope with and counteract industrial accidents occurring in transboundary river catchments, including those with firefighting water emissions.

52. Governments should work, including through joint bodies, to raise awareness about the risks of accidental water pollution posed by firefighting water emissions, including the

[29] This joint protocol to the Industrial Accidents Convention and the Water Convention was adopted and signed by 22 countries at the Environment for Europe Ministerial Conference in Kyiv, Ukraine, on 21 May 2003. Two more countries signed the Protocol later in 2003. The Protocol has been ratified by Hungary and is not in force.

potential transboundary consequences, and to support the implementation of harmonized safety standards and approaches between riparian countries to prevent accidental pollution through firefighting emissions.

53. Governments should inform potentially affected riparian countries without delay in case of an accident that could cause transboundary effects, including through firefighting water emissions, using their bilateral or multilateral agreements, if any, and early warning systems according to their national regulations.[30]

2. Recommendations to competent authorities

54. Competent authorities should ensure within their organization that they have expertise related to:

(a) Accident prevention (i.e., fire protection), emergency preparedness and response;

(b) Inspection and audit;

(c) Permitting requirements for the operation of hazardous activities (fire compartment areas).

55. Competent authorities should carefully consider the fire risk and firefighting water management when issuing a licence for operating a hazardous activity. The licensing or permitting authority should thoroughly examine the capability of the operator to ensure the continuous, safe and effective operations under all reasonably foreseeable conditions.

56. Competent authorities should require the operator to ensure that its analysis and evaluation of the hazardous activity considers also retention capabilities for firefighting waters and a firefighting strategy. The competent authority should thoroughly assess the operator’s analysis and evaluation before approving it. It may also require the operator to provide any additional information necessary to enable it to fully assess potential accidents. The competent authority’s approval of the analysis and evaluation does not imply any transfer of responsibility for the control of major hazards from the operator or the owner to the competent authority.

57. Competent authorities should set up a system of inspections or other control measures in order to ensure that operators meet the legal requirements.

58. Competent authorities should be empowered to conduct legal inspections. They may also set up a system for certified, independent experts to undertake the inspections of facilities. When competent authorities use independent experts for inspections, they remain responsible for assessing the competence and accountability of the experts and for the effectiveness of the inspection process.

59. The inspection regime of hazardous activities, as defined by the competent authorities, should include at least the following:

(a) The hazard potential;

(b) The operator’s analysis and evaluation of the hazardous activity;

[30] In accordance with article 10 of the Industrial Accidents Convention, the Parties must provide for the establishment and operation of compatible and efficient accident notification systems at appropriate levels to inform neighbouring countries. This can be ensured by using the ECE Industrial Accident Notification (IAN) System, the European Union Common Emergency Communication and Information System (CECIS) and the alert systems of river basin commissions. The Parties to the Water Convention, in accordance with article 9, paragraph 2 (g), are required to establish warning and alarm procedures. This is assured in several international river basin commissions by their jointly established and regularly tested warning and alarm plans.

(c) The potential effects and the proximity and pathways to sensitive environments or communities;

(d) A fire protection concept,[31] including the respective equipment and installations for the retention of firefighting water,

(e) The previous inspection and performance records of the operator;

(f) The historical accident and incident record at the hazardous activity.

60. Competent authorities should ensure that operators:

(a) Draw up on-site contingency plans, including a fire-brigade response plan, and put them into effect without delay when an accident occurs;

(b) Supply them with the necessary information to enable the competent authorities to draw up off-site contingency plans.

61. Competent authorities should ensure that the operator provides training to the on-site personnel on how manually activated firefighting systems work and should be used (including systems for firefighting water retention). Training on this issue should be undertaken on a regular basis and at least one a year in cooperation with the fire brigade in charge.

62. Competent authorities are responsible for establishing permit conditions based on international accepted safety standards and sound fire protection systems.

63. The competent authorities should approve remediation plans for fire and explosion scenarios for hazardous industries.

3. Recommendations to operators

64. The operator is liable not only for its operational risks following the polluter pays principle but can also be held responsible as a proprietor for consequential loss due to the fire brigade action and potential emissions of firefighting waters.

65. The operator must ensure the safe performance of the hazardous activity and is responsible for the implementation of a safety management system. In case of damage or an accident, it is the operator’s responsibility to assess the situation and to initiate emergency measures and countermeasures as required.

66. All parts of a facility for the retention of firefighting water and its triggering devices (e.g., automatically shutting valves) should be installed so that they will not be damaged by operational activities. The devices should be installed in such a way to ensure their accessibility at any time for maintenance purposes and in the case of danger, such as a fire. This may include the need for remotely activated systems.

67. Should parts of the sewerage system or other pipelines be used for the discharging of firefighting water into collecting facilities, the impermeability,[32] in particular the chemical resistance, of the corresponding section of the sewer or pipeline should be proven and ensured through long-term control and maintenance by the operator.

68. If the section for the sewerage system used to drain firefighting water into a retention facility also serves for the drainage of operational wastewater, this should be taken into account in the design and dimensioning of connected volumes of retention. The inlet into the pipeline or the sewer should be designed in such a way that burned material or

[31] The fire protection concept should include a firefighting strategy and a firefighting water retention concept. For further information and specific recommendations and good practices, see the technical and organizational recommendations of the safety guidelines.

[32] Impermeability criteria according to national requirements should be used as a basis.

other coarse debris do not block the inlet pipe or enter into the pipe. Immersion tubes or inlet structures with coarse screens can be installed to this end.

69. Firefighting water and combustible liquids may be mixed in the on-site sewerage system only if appropriate measures have been taken to ensure that this will not result in an explosive atmosphere in the sections of the sewers used. Appropriate measures should be taken to prevent the ignition of liquids in the retention system.

70. The locations of installation and triggering devices for the firefighting water retention facilities are to be marked on the ground plans for use by the operator's fire brigade and the public fire brigade.

71. Firefighting water retention facilities that need to be started manually should be inspected at least monthly to prove their functionality and ensure their operability in case of emergency. Inspections of all fire and retention systems should be carried out as laid down in the maintenance instructions by the manufacturer and/or installer. The operator is responsible for the observance of the inspection and maintenance intervals.

72. Firefighting equipment for open-air facilities should be constructed in such a way as to ensure its operability under the most severe expectable meteorological conditions (extreme temperatures, strong wind, heavy rain, flood, etc.).

73. The personnel should be instructed and trained on how the firefighting water retention systems work and how they should be used. Instruction and training should be repeated regularly, and at least yearly for all systems (automatic and manual).

74. The facility for the retention of firefighting water should be inspected regularly to ensure its proper structural condition and integrity. This will include at least a visual inspection of the surface of all parts and areas that will be exposed to firefighting water. Should defects be detected, e.g., separation in the area of joints, more detailed inspections will be necessary.

75. Operators should apply good housekeeping practices and ensure that their premises are kept clean to avoid, for example, the blockage of sewers or other retention facilities. Regular checks for potential blockages should be carried out.

76. Connections, seals, and other wear parts are to be exchanged or replaced to the standard and at least as frequently as recommended by the manufacturer. All inspection and maintenance work, including the details observed are to be recorded. All defects are to be remedied immediately.

77. The operator should perform a periodic control of the impermeability[33] and the operational reliability of the safety equipment. The periodic control should be mainly focused on:

(a) Visual inspection of the retention basins;

(b) Control of the pollution control valves in terms of impermeability at least once a year;

(c) Control of the operational reliability of valves, pumps, alarms and additional devices.

78. In addition, the staff need to be instructed about the actions and behaviour that should be employed during a fire.

79. Operators should work out a firefighting water retention concept as part of the on-site contingency plan, containing also measures for the timely disposal of firefighting

[33] Impermeability criteria according to national requirements should be used as a basis.

water. These plans should be developed in cooperation with the competent authority and the responsible fire brigade.

Annex

Examples of major fire accidents in the United Nations Economic Commission for Europe region[1]

1. The table below presents an overview of fire accidents in the ECE region and their key parameters.[2] Following the table are more detailed descriptions of the accidents.

Overview of some fire accidents from the ECE region and their key characteristics

No.	*Year, company, place, country (transboundary or national)*	*Fire-compartment area*	*Volume of firefighting water used*	*Total costs of the accident*
1.	1986, Sandoz, Schweizerhalle, Switzerland (transboundary effects)	4,500 m² (burning)	20,000 m³	SwF 141 million (of which 60 million for soil remediation, 42 million for compensation payments, 15 million for building loss and 24 million other costs).[a]
2.	2005, Schweizer AG, Schramberg, Germany (potential, but no eventual transboundary effects)	2,775 m² (burning)	3,500 m³	€1 million (costs for the disposal of firefighting water only)
3.	2006, Brenntag Química, Caldas de Reis, Spain (no transboundary effects)	14,734 m² (burning)	3,000–3,500 m³ (estimate)	Inside the establishment: €3.4 million in damages in the establishment; €1.6 million for response, clean up and remediation inside the establishment; total cost for the operator: €5 million. Outside the establishment (social costs, including response, clean up and remediation outside the establishment): €8 million.
4.	2009, Abloy Company, Joensuu, Finland (no transboundary effects)	180 m²	2,200 m³	The damage was roughly estimated to cost "millions of euros"
5.	2011, Chemie-Pack storage facility, Moerdijk area, the Netherlands	6,500 m²	38,000 m³	€13 million

[1] This list is not exhaustive. Further case studies and lessons learned can be found in various sources.

[2] These examples are catastrophic accidents representing worst case incidents. The amount of firefighting water retention volumes needed are far beyond the ones resulting from the calculation models presented in the annex to the technical and organizational recommendations of these safety guidelines.

No.	*Year, company, place, country (transboundary or national)*	*Fire-compartment area*	*Volume of firefighting water used*	*Total costs of the accident*
6.	2011, Remiva ltd., Chropyně, Czechia	150 m^2 (later expanded up to 5,000 m^2)	6,350 m^3 of firefighting water; 38 m^3 of heavy fire foam (26 tons)	€10 million

[a] See Schweizer Radio und Fernsehen (SRF) (Swiss Radio and Television), “Schweizerhalle-Brand vor 30 Jahren – eine Nacht des Schreckens”, 30 October 2016 (in German). Available at. www.srf.ch/news/schweiz/schweizerhalle-brand-vor-30-jahren-eine-nacht-des-schreckens.

1. Switzerland – Fire at the Sandoz warehouse in Schweizerhalle in 1986

2. Shortly after midnight on 1 November 1986, a major fire broke out in a chemical warehouse near Basel at the Schweizerhalle site of the Swiss chemical company Sandoz. In the building was a mixed storage of 1,350 tons of chemicals, among them several pesticides, herbicides and mercury compounds, as well as highly flammable solvents. It took 160 firefighters almost seven hours to manage the large fire, even with the deployment of a special firefighting boat on the nearby Rhine River.

3. Approximately 20,000 m^3 of water was used for extinguishing and cooling the fire. Since the site had, at that time, no facilities for the retention of firefighting water, all of this firefighting water, together with 40–50 tons of highly environmentally toxic substances, was discharged into the Rhine through the rainwater drainage.

4. As a result, the entire population of eel, along with other fish species, was killed up to a distance of 400 kilometres downstream. Damage to other aquatic organisms could be seen as far as the Netherlands. Finally, the extraction of drinking water was suspended on the entire river from Schweizerhalle to Rotterdam until contamination levels had returned to normal values.

2. Germany – Fire at Schweizer AG factory in Schramberg in 2005

5. A fire at Schweizer AG, a producer of printed circuit boards, occurred in Schramberg on 5 June 2005, with a fire area of approximately 6,500 m^2. The whole factory area was about 34,000 m^2. The fire broke out in the wastewater treatment area and spread into the electroplating production and parts of the chemical storage. All the chemicals in production were released into the firefighting water — a total of approximately 400 tons of chemicals. About 1,000 m^3 of highly contaminated firefighting water, containing heavy metals, acids, solvents and traces of cyanide, could be retained in basins and improvised barriers on site. The firefighting water contained such aggressive substances that it etched through steel tanks within 72 hours. Another 1,000 m^3 of firefighting water was retained in an overflow basin for rainwater in Schramberg. Because of heavy rain forecasted, the firefighting water had to be transported quickly by means of special trucks to several chemical waste disposal facilities all over Germany. Parts of the firefighting water were released into the sewage treatment facility of Schramberg. Although it was provisionally chemically treated, the whole biology of the treatment facility was destroyed. The costs associated with the disposal of the firefighting water were €1 million.

3. Spain – Fire at the Brenntag company in Caldas de Reis in 2006

6. On 1 September 2006 a fire destroyed most of the storage facility of the company Brenntag Química, S.A., in Caldas de Reis, Pontevedra. The fire was reported to the emergency services at 2.04 p.m and was extinguished early the next day 12.14 a.m. on 2 September 2006.

7. During the unloading operation from the tank truck of 24,000 litres to containers with a capacity of 1,000 litres, a fire broke out. A deflagration of flammable gases followed. No one was injured in the accident, but the fire destroyed large parts of the storage facility. Owing to the high temperatures produced by the blaze, the chemicals stored at the site were largely incinerated. However, residue from the chemicals, mainly toluene and styrene, reached the nearby Umia River with the firefighting water. The river was partly contaminated with chemicals, primarily toluene. The extraction of drinking water was temporarily suspended. The suspension affected a population of 110,000 people.

8. The company's activity at the site was the storage and distribution of chemicals. The storage facility was a Seveso establishment to which articles 9, 11 and 13 of Council Directive 96/82/EC of 9 December 1996 on the control of major-accident hazards involving dangerous substances[3] (Seveso II Directive) were not applied. If the facility was active today, it would be classified as a lower-tier establishment, according to Directive 2012/18/EU of the European Parliament and of the Council of 4 July 2012 on the control of major-accident hazards involving dangerous substances, amending and subsequently repealing Council Directive 96/82/EC[4] (Seveso III Directive).

9. A combination of a static electricity discharge originating in the tank truck and existing high temperature conditions were considered the most probable cause of the accident. The fire area, which was contained within the boundaries of the facility, reached 14,734 m^2.

10. The estimated amount of water used was 3,000–3,500 m^3, based on the number of crews of different fire brigades included among the respondents, the equipment used and the duration of the emergency. Part of the firefighting water was contained and later recovered for treatment but most of it reached the nearby Umia River through the surface water drains of the facility, causing contamination owing to its content of chemicals, mainly toluene and styrene. Immediate measures were taken by the regional and local authorities to prevent the chemicals from spreading further. To contain and remediate the contamination, 5 kilometres downstream from the site of the accident a dam was built with sandbags. Next to the dam a series of retention dikes were built to channel the contaminated water to eight ponds for a decontamination process in three phases using active carbon (40 tons), oxygen and sand filters. Following treatment and subsequent inspection to verify acceptable water quality, the water was fed back into the river, starting two weeks after the accident. By one month after the accident the river had mostly recovered.

11. Environmental degradation included damage to protected and non-protected wildlife, including mortality, damage to freshwater habitats and water resources for residential and recreational uses, and damage to a protected area, a Natura 2000 site, located downstream of the site where the accident happened.

12. The list of chemicals involved is a long one, including toxic or highly toxic substances such as hydrogen fluoride, benzene, formaldehyde, flammable or highly flammable substances such as xylene, toluene and styrene and other substances. As mentioned above, toluene and styrene were the main drivers of the contamination when they were washed into the river by the firefighting water.

4. Finland – Fire at the Abloy company in Joensuu in 2009

13. A fire at a company called Abloy took place in 2009. Abloy is an upper-tier Seveso facility,[5] mainly because of its electroplating department, which is also where the fire occurred. The fire most probably started when the bus bars of the process power supply

[3] 1997 O.J. (L 10), pp. 13–33
[4] 2012 O.J. (L 197), pp. 1–37.
[5] An upper tier facility, in accordance with annex I to the Seveso III Directive.

system overheated. The overheating was probably due to loose coupling in the bus-bar system.

14. The part of the establishment where electroplating was located was completely destroyed in the fire. The surface area of the electroplating department was 180 m^2 with a height of 6 meters. This was all one fire compartment but it was a separate compartment from other departments. In total, the factory area was around 21,000 m^2. Most pipes, basins, etc., were polypropylene, and some were PVC. All the plastic basins melted. Those that were of steel had plastic plugs, so their content was also released.

15. The amount of water used was around 2,200 m^3. Not all of this was used to fight the fire, some was also needed to keep the hoses from freezing (in winter). Approximately 600 m^3 of a mixture of water and liquid chemicals was recovered from inside the factory and 65 m^3 from a nearby ditch. Some contaminated water also ended up at the municipal wastewater treatment facility (via the company's own wastewater treatment facility).

16. At the time of the fire, the electroplating department contained around 108 m^3 of various hazardous chemicals (e.g., chromium and nickel compounds, various acids and alkali as well as cyanides) and around 86 m^3 of rinsing water. The chemicals mixed with the firefighting water. The environmental damages were measured after the fire from the snow, soil, groundwater, rainwater sewerage system, nearby watercourses and the municipal wastewater treatment plant's outbound water and slurry. The most significant environmental damage was caused by the process chemicals, especially heavy metals and cyanide, and occurred within or near the factory site. The pH value measured from the firefighting water (outside the building) was 1–2.

5. Netherlands – Fire at the Chemie-Pack storage facility in Moerdijk in 2011

17. The fire at a company called Chemie-Pack, located in Moerdijk, the Netherlands, took place on 5 January 2011. The company's business activities consisted of mixing, distributing and packaging chemical powders and liquids. They did not actually produce any chemicals.

18. The fire started outside in the yard, while resin was being pumped from one immediate bulk container tank into another. Owing to the cold weather conditions, the pump's exhaust silencer began to freeze up. However, when the resin stopped flowing, it was decided to heat the middle of the pump with the gas burner. The use of open fire was against the provisions of the permit. This was a big risk because of the direct proximity of xylene, used to clean the pump and collected in a tray under the pump, which resulted in xylene catching fire. The attempt to extinguish the fire manually failed owing to the continuous flow of the burning resin. The company's emergency response team could not extinguish the fire when it began. Chemie-Pack's technical and organizational risk management processes did not live up to the levels of the risk of the company. The necessary organization and means allowing for an effective intervention were simply not present.

19. The fire at the Chemie-Pack storage facility occupied an area of approximately 6,500 m^2. The company had five large sheds in each of which hundreds of tons of hazardous materials were stored. In the outdoor area, there were another several hundred plastic containers, each filled with 1,000 litres of flammable liquid. In addition, a container with 16,000 litres of acetone (80 barrels of 200 litres each) and a tanker filled with 33,000 litres of a very flammable substance were located on-site.

20. The amount of firefighting water amounted to approximately 14 million litres. For the foam blanket 18,850 litres of foam shaping means were necessary. The large amount of firefighting water was stored in the sewers and embedded ditches. The contaminated firefighting water (38,000 m^3) was later transported by trucks to a waste disposal plant.

21. The effects of the fire were limited to the substantial material and environmental damage at the port and industrial area of Moerdijk. The materials list of Chemie-Pack included 52 pages, mentioning hundreds of flammable, corrosive, toxic and environmentally harmful substances. The soil on which the company Chemie-Pack and two adjacent companies were built had to be cleaned up. There were no threats to food safety or (drinking) water quality.

22. The total cost of this fire disaster is estimated at €71 million Euros.[6]

6. Czechia – Fire at the Remiva facility in Chropyně in 2011

23. A fire at the Remiva company took place in Chropyně, Czechia (Moravia), in 2011. The Remiva facility is used to store and recycle many kinds of plastic waste (polyethylene, polystyrene, polypropylene, polyurethane, polyamide, polytetrafluoroethylene, polycarbonate; and acrylate) on its grounds. As such, the facility was not treated as a Seveso plant. Nevertheless, the entire facility was divided into several fire compartments, equipped with electric fire signalization. The storing height was limited to 1.5–2.5 meters, and construction fire safety plans had been drawn up. Approximately 1,500 tons of plastic waste were stored right before the fire started on 8 April 2011 at 1.03 a.m.

24. The exact cause of the fire, generating losses initially estimated up to €10 million, was not specified. The company had violated most of the safety and fire recommendations for material storage. For example, the width of walkways between the bags for waste storage and the recommended height and location of material storage were not in accordance with the fire code. These and other violations facilitated the rapid spreading of the fire.

25. The fire hit an area of 12,250 m^2, divided into the two large fire compartments. The amount of water used was around 6,350 m^3, in addition to a limited amount of 38 m^3 of heavy foams. It seems that no specific firefighting water retention measures were in place, and the on-site sewerage system was outdated. The whole area was watched and controlled by units of the professional fire brigade, which fought this difficult fire until 19 April 2017. In total, 73 fire brigade units and 567 firefighters participated in extinguishing the fire. Fortunately for the population of Chropyně, the wind, carrying toxic fumes from the fire, blew towards an area of Chropyně with a low population density. A huge cloud of black smoke and soot were visible from the surrounding towns and villages. Potential air pollution (mostly aromatic hydrocarbons) was monitored by the fire brigade in the close neighbourhood of the facility.

26. Initially, a second-level alert of the chemical accident was declared by the county fire brigade operation centre, which was later upgraded to a third-level alert due to strong winds (15 metres per second). At 2 a.m., the chemical alert for the whole town of Chropyně was declared, because the emergence of toxic gaseous fumes was expected from the fire, containing phosgene, carbon monoxide, aromatic hydrocarbons and solid particles. Several streets of the town in the close neighbourhood of the facility were evacuated during the first day of the fire.

27. Firefighting water and heavy foams used during the fire leaked into the local sewerage system and flowed — under the supervision of fire brigade and the management of the local water cleaning station — towards the water cleaning station and further to the River Moravia. The operation commander (i.e., the chief of the fire brigade), after communication with the management of the local water cleaning station, banned the further use of heavy foams within this fire intervention. This early decision mitigated the potential

[6] For more information about the accident, see Dutch Safety Board report, “Fire at Chemie-Pack Moerdijk”, The Hague, February 2012. Available (in English)at www.onderzoeksraad.nl/en/onderzoek/1805/fire-in-chemical-firm-moerdijk-5-january-2011.

occurrence of more significant environmental damages. There is no specific data available about how much of the firefighting water in this case was recovered and/or cleaned. The production in the rest of the facility, saved from the fire, was renewed within a few weeks of the fire.