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Safety of Dangerous Goods Logistics Warehouses

Veszélyes áruk logisztikai raktárának biztonsága

In case of industrial accidents at logistics facilities of dangerous goods, contaminated firewater can cause major environmental consequences to the soil, surface and ground waters. The author of this article is dealing with the evaluation of related international technical regulation concerning the environmental risks caused by dangerous substances stored at logistical storage facilities; with an analysis of the industrial safety's features of those facilities and with the introduction of the applied practice of environmental risk management.

Keywords: logistics of dangerous goods, industrial accidents, environmental damages, firewater pollution

A veszélyes anyagok logisztikai létesítményeiben esetlegesen bekövetkező ipari balesetek során keletkezett szennyezett oltóvíz által a felszíni és felszín alatti vizekbe, vagy a talajba kerülve jelentős környezeti károkat okozhatnak. Jelen cikkben a szerző foglalkozik az oltóvízszennyezés megelőzéshez kapcsolódó nemzetközi műszaki szabályozás értékelésével, a veszélyesáru-raktárak iparbiztonsági jellemzőinek elemzésével, valamint a környezeti kockázatok kezelésének és gyakorlatának bemutatásával.

Kulcsszavak: veszélyesáru-logisztika, ipari balesetek, környezeti károk, oltóvízszennyezés

Introduction

Major accidents and fire events accompanied with emission of dangerous substances may eventually occur in the area of logistic bases storing dangerous goods when the polluted fire water may enter into the surface and sub-surface waters or soil causing major damage to the

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environment. These processes and scientific studies related to preventative and recovery actions in most cases still need to be analysed focusing on their correlation with major accidents.

Water pollution caused by accidents involving fire water might even have catastrophic cross-border effects, so international organisations have embraced the responsibility for preventing similar accidents through fire water retention.

The most significant organisation for preparing the regulatory framework is the UN Economic Commission for Europe (hereinafter referred to as: UN ECE).

The Guideline entitled *Safety Guidelines and Good Practice for Fire-water Treatment and Retention* is the result of the joint regulatory efforts of the UN ECE Industrial Accidents Convention² and Convention on the Protection and Use of Transboundary Watercourses³ (hereinafter referred to as: UN ECE Guideline).⁴

There are several technical guidelines on national level in the area of fire water retention recommended for the implementation of international regulation, and among them the German guideline regulating the technical solution and organisational action system for polluted fire water retention is of outstanding importance (hereinafter referred to as: German Guideline).⁵

The study of hazards arising from the storage of dangerous substances and goods storage is my primary target in the present thesis, and within this framework I focus onto the evaluation of international technical regulation related to the prevention of fire water pollution, the analysis of the characteristics of the dangerous goods storage sector, and presentation of practices in environmental risk management.

I will primarily use the publicly available international and domestic professional literature, laws, and internal regulatory tools that describe the relevant disaster management procedures as the research method for my study. During the preparation of the study, through personal consultations, I also contacted the experts; these experts are operators both in water quality remediation and in industrial safety.

In light of the ideas described in the introduction, we will now have a look at the technical requirements specified in the topic of the study in the international regulatory documents.

Analysis and Evaluation of Requirements for International Technical Regulations

The above mentioned UN ECE industrial accident regulation also appears in the internal environmental protection law of the European Union. Appendix II of the so-called Seveso III Directive⁶ (regulating the protection against major accidents related to dangerous substances) specifies the requirements in content for safety reports, where in Point 5 it prescribes that emergency retention vessels and fire water retention should also be presented.

² UN ECE 1992a.

³ UN ECE 1992b.

⁴ UN ECE 2017.

⁵ VdS 2013.

⁶ Seveso III 2012.

During my analysis, I have carried out a detailed study of the recommendations of the UN ECE Guideline – regarding the possibilities for its adaptation. In my work, I have studied the antecedents of fire water retention in international regulations, and also the results of the relevant regulatory activities of UN ECE. I have evaluated in details the content of the UN ECE guideline, and as part of this effort I have analysed the possibilities for its adaptation. During this work I have also evaluated the responsibilities of the authorities and operators in the field of fire water treatment and retention, and the technical and organisational (control) measures.

My research work has resulted in the following conclusions:

First of all, I have found that the guideline prepared by the UN ECE member states under the auspices of the UN ECE Industrial Accidents Convention and Convention on the Protection and Use of Transboundary Watercourses eliminates a major gap in the regulatory system through the legal and technical recommendations offered for the member states, competent authorities and operators.

The UN ECE Guideline covers dangerous operations under the scope of the UN ECE Industrial Accidents Convention – engaged in operations with dangerous substances and equipped with installed water-based firefighting equipment. Nevertheless, accidents occurring in the presence of substances that do not qualify as dangerous compounds may also be sources of major fire water pollution.

We can also add that recommendations of the Guideline build on the main preventative and preparatory legal instruments of the UN ECE Industrial Accidents Convention. The so-called Fire Protection Concept of the given facility provides the basis for introducing the fire water retention measures and this is the fundamental document for defining the primary scope and content of the control, organisational and technical actions for the operators in the area of water quality remediation, re-cultivation and restoration. The fire protection concept and its general and facility-specific elements will also determine the criteria for designing and implementing the operator's safety system.

Figure 1 presents the role of the fire protection concept played in the local protection system in a plant.

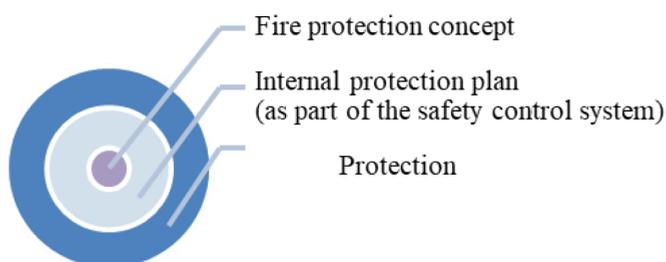


Figure 1. The role of the fire protection concept in the protection system

Source: Prepared by the author.

Main recommendations of the UN ECE Guideline as I have identified them:

- Polluted fire water might endanger the water environment and through that the soil irrespective of the dangerous substance that is present and burning during the incident. Products of combustion from packaging materials, foaming agents and structural materials of the warehouse building may cause pollution to the fire water. Consequently, we have to prevent the emergence of fire water in a major volume. The total volume of fire water should be captured, retained and stored in a proper manner so that we can avoid pollution to the soil and water.
- The UN ECE member states should prepare a legal regulation with statutory rules for the retention and treatment of fire water within the framework of the regulation for major accidents related to dangerous operations (e.g. logistic storage depots).
- Facilities supporting retention and storage of fire water should be established at logistic storage depots working with dangerous substances, and these should be broken down to as small as possible fire compartments.
- The German Guideline can be used as the primary sample for calculating the volume of fire water to be stored in the retention facilities.
- No difference must be made between new and already operating facilities regarding safety requirements.
- The volume of fire water can be significantly (even with one order of magnitude) reduced applying modern and sophisticated automatic installed firefighting equipment (sprinkler system, drip systems, high-pressure system using water fog, and gas fire extinguisher equipment).
- Regarding the retention of polluted fire water, the guideline recommends a method for calculating the volume of fire water that can be applied through a simple and precisely defined process. Application of this process primarily depends on the level of existence of active and passive installed fire protection systems.

I have separately studied the applicability of provisions specified in the German guideline covering danger analysis and risk assessment, estimation of the quantity of fire water, pollution prevention and retention facilities regarding the design and implementation of facilities applied for fire water retention.

Based on my studies we can arrive at the following main conclusions:

- In my opinion, the German Guideline published in 2013 by the Federation of German Insurance Companies complies with the requirements specified in the draft UN ECE Guideline and provides an excellent example for defining the relevant organisational and technical measures.
- We can identify the need, type and degree of measures aiming at the prevention and avoidance of damages caused by fire water based on the detailed danger analysis and risk assessment described in the guideline. The guideline provides samples and examples for applying the calculations, and there is an internet-based application supporting the designer experts. Nevertheless, in my opinion design and planning works can be relatively difficult without the required engineering and technical expertise and qualification.

- The guideline also contains the following regulatory elements: calculation of the quantity of fire water produced during the firefighting process; organisational measures to be applied so that damages caused by the polluted fire water can be prevented, avoided and treated; technical measures required for fire water retention; requirements related to the construction, installation, inspection, supervision, maintenance and operation of facilities used for fire water retention; actions required in case of a damage event; requirements applicable onto neutralisation and remediation of polluted fire water.
- It should be also considered that intervention of the firefighting squads may produce a significant volume of polluted fire water, as the used foam contains foaming agent components PFOS (perfluor-octane sulfonate) and PFA (perfluor-alkoxy) which are dangerous to the environment.
- The structure of the building, production and packaging materials, as well as products of combustion emerging from the fire can also generate polluted compounds that are dangerous to the environment.
- The damage caused by fire water can occur only after the occurrence of a fire incident accompanied with the emission of a major volume of polluted fire water. Consequently, there is no need for fire water retention, if the chance for fire can be absolutely excluded or the eventually arising fire is not killed with water. Furthermore, there is also no need for retention if the risk potential of the results of the risk analysis of the dangerous substance performed in accordance with the guideline mostly shows a "low" or only in some cases a "medium" level.
- We can state that there is no reason to differentiate dangerous substance warehouses and production plants as damages caused by fire water might emerge in both cases.

Based on my studies, it can be stated that all over Europe the number of those modern warehouses where guidelines for preventing pollution to surface and underground waters with polluted fire water is quite high. However, there are major shortcomings and deficiencies in the existing warehouses and plants in respect of the special issues I studied.

Analysis of Industrial Safety Parameters of Warehouses of Dangerous Goods

The most typical locations for dangerous goods are the plants that produce, store and process dangerous substances and transportation operations with dangerous goods. Facilities working with dangerous substances under the regulation on the protection against major accidents with dangerous substances and facilities working below the limit values are categorised as dangerous facilities. Facilities working with dangerous substance are called "Seveso plants" that work with dangerous substances between the lower and upper limit values.

As the rule of thumb, logistic facilities working with dangerous goods do not belong to the scope of the Seveso III Guideline. Already in 2012, lawmakers have covered the scope of the regulation on the facilities that transport dangerous substances through pipelines. However,

railway shunting yards and ports are most unfortunately still not considered facilities working with dangerous substance presenting major accident risks.

In the present study, I am addressing industrial, agricultural and commercial facilities where dangerous substances and dangerous goods are stored. These may include the following:

- logistic warehouse bases engaged in independent dangerous substance storage
- or base material, semi-finished product or finished product warehouses of plants where dangerous substances are processes, stored or produced

In the classical concept, logistic warehouses storing dangerous substances are depots where such substances are stored in packaging in compliance with the ADR,⁷ and no operation is performed that would require a specific packaging process of the opening of the internal packaging.

Logistic warehouse bases implemented in Hungary during the past 10–15 years were built in compliance with technical safety, environmental protection and disaster management requirements prescribed for modern dangerous goods warehouses. Some of the dangerous substance warehouses operating in the area of the chemical sector and agriculture (for instance pesticide warehouses) are, however, in residential areas and have outdated configuration and equipment pool, moreover as a consequence of their transformation, they are often used for purposes other than their original destination.⁸

Logistic bases implemented with traditional plans are, in my opinion, only partly acceptable for the storage and treatment of dangerous goods from fire protection and industrial safety aspects.

It can be concluded that logistic warehouse bases implemented in Hungary with state contribution – as they, at the same time, form a combined transport nod – are also able to play production and distribution functions.

Based on interviews, I prepared with experts of dangerous goods transportation, the following are the typical characteristics of the activities of logistic warehouse bases of dangerous goods:

- The purpose of logistic warehouse bases storing dangerous goods is to perform the logistic warehousing operations in these facilities in leasing structure and in a passive form.
- In these depots, only finished products are stored, commissioned and distributed.
- The arriving ADR packaged products are forwarded without further procession and in most cases in their original package.
- The goods received in these warehouses are stored in a pallet system, on scaffolding or shelves, and forklifts etc. are used for moving the goods.
- In case of logistic warehouse bases, we cannot speak about a "classical" equipment of chemical technology.
- In these logistic warehouse bases storing dangerous goods, the "technology" basically covers the movement and storage of materials and substances in qualified packaging solutions.

⁷ ADR is the acronym for the French "Accord européen relatif au transport international des marchandises dangereuses par route", i.e. "The European Agreement Concerning the International Carriage of Dangerous Goods by Road", which was prepared by the UN Economic Commission for Europe.

⁸ SÁROSI 2006.

The Management of Environmental Risks in Dangerous Goods Warehouses

Incidentally emerging fire incidents in logistic facilities of logistic warehouse bases working with dangerous substances and the emission of dangerous substances into the environment from such facilities can directly endanger the environment of the facilities, and through this the surface and underground waters of the environment. On Picture 1, I have presented the consequences of the fire incident that occurred in the Sandos pharmaceutical plant in Switzerland.



Picture 1. Accident at Sandos in 1986 in Basel, Switzerland

Source: IKSR 2016.

Substances polluting the environment may be emitted into the environment of the depot in various ways:

- directly through the rainwater and leachate drainage system of the depot
- through the drainage of surface waters existing in the vicinity of the facility working with polluted substances, or leakage of such water into the ground directly polluting the underground water layer
- through the wastewater system or the wastewater treatment plant
- migrating through the air, for example by evaporation

Based on the analysis of a series of major accidents that occur in logistic warehouses, we can conclude that such series of incidents can be the following:

- toxic effect arising from emission of toxic dangerous substances,
- fire incident following the emission of inflammable compounds or substances, and
- pollution of water and air by toxic combustion products evolving in fire.

The fire water pollution can in most cases produce its harmful effects in the form of pollution to the environment in medium and long-term, and remediation requires major efforts both

from the operator and the authority, particularly if the emitted polluted fire water could leak into surface waters or the soil layers.

The international documents clearly determine the remediation actions for the operator.

Compliance with the technical requirements of polluted fire water is only one of the elements in the regulation on the establishment and operation of modern warehouses that store dangerous substances (logistic warehouse bases). The so-called VCI⁹ warehouse guideline (hereinafter referred to as: VCI guideline) is the basis for the requirements of dangerous goods warehousing activities. The European Federation of Chemical Industry¹⁰ proposed to apply this guideline as early as at the beginning of the nineties.

Among the technical guidelines for legal applications related to polluted fire water retention, the guidelines applied in the United Kingdom are considered the most up-to-date documents.

Among the methodology guidelines for preventing industrial pollution, PPG 18¹¹ (prepared in 1992) was the first that addressed the topic of equipment, tools and processes used for the prevention and remediation of pollution of surface and underground waters due to incidents that occur during spillage of fire water and dangerous substance.¹²

The guideline presents information related to the introduction of technical, management and control measures forming parts of the so-called accident prevention action plan. It divides the dangerous substance storage systems into two categories: primary (technology) and secondary (emergency) storage systems. The guideline also specifies the rules for implementing secondary storage capacities, where polluted fire water or leaked dangerous substance can be collected. Secondary storage can be a local or remote unit. Picture 2 presents a remote storage.



Picture 2. Fire water retention facility

Source: JMM s. a.

⁹ German Federation of Chemical Industry, in German: *Verband der Chemischen Industrie*.

¹⁰ CEFIC, acronym in French: *Conseil Européen des Federations de l'Industrie Chimique*.

¹¹ In English: *Managing Fire Water and Major Spillages PPG 18*.

¹² EPA, SEPA 1992.

We call the local storage facility salvage basin or pool which – if the consequence analysis so requires – should be able to receive the fire water that is produced in case of a fire incident. Remote salvage pools may include storage pits or basins or underground and surface storage tanks. These facilities should be equipped with a shutdown device or gate, and in case of hydrocarbon storage, an oil separator or recovery unit. Primary storage facilities include the emergency storage systems which are used as mobile or portable units in incidents that occur far from the salvage basin. These units may include a stormwater basin, parking lots with solid surface cover, ditches or trenches, basins or pools, mobile storage tanks and tanker trucks. Other solutions may be also used, such as absorbing materials, applicable absorbents, sealing tools/plugs and materials for damaged storage vessels and pipelines, as well as valves or gates for canals, channels and shafts/pits.

The English Environmental Protection Agency issued its draft guideline on the requirements on the establishment of polluted fire water retention facilities in 2018.¹³ This guideline contains – inter alia – the presentation of the risk assessment and management process, rules for establishing a polluted fire water retention facility, description of types of retention facilities, and the rules of waste management, neutralisation and disposal.

When the volume of the polluted fire water is calculated, first the quantity of fire water available at the depot is determined, and then the volume of fire water required for killing the fire in the production plant, tank farm or the warehouse. In addition to the data of the sprinkler system, firefighting capacities shall be determined both in the depot and also in external sources when determining the volume of fire water. It must also be mentioned that the guideline prescribes to apply the maximum fire water volume as the minimum polluted fire water retention capacity, and the quantity of precipitation during the incident is added to this figure.

Technical description of the sprinkler systems and their storages, data of sources of water supply, fire water storage capacity, volume delivered by external intervention parties, or data of local surface waters provide input data as information for determining the volume of fire water available in the depot.

Conclusions

The present article provides a short outlook on international trends in legal regulations published in the field of management of environmental risks arising in dangerous substance logistic warehouses.

I came to the conclusion that the UN Economic Commission for Europe, the European Union and its member states typically demand for compliance with the same legal and technical regulation from operators of dangerous substance logistic warehouse bases.

Dangers caused by dangerous substances and dangerous goods storage units appear in Hungary (just like abroad) in facilities that store dangerous substances, and base materials,

¹³ EPA 2018.

semi-finished and finished products with sub-limit qualification. Such units include plants producing and processing and storing – mainly for commercial purposes – dangerous substances (dangerous goods logistic warehouse bases).

We may experience damage to the environment as a consequence of emission of dangerous substances and irregular leakage of fire water into the environment.

Events or incidents that occur in the presence of dangerous substances typically begin with the emission or leakage of dangerous substances, and it might lead to fire or explosion as a consequence. Fires emerging from dangerous activities may exert harmful effects onto the elements of the environment in the form of extensive toxic combustion cloud and fire water polluted with dangerous substances (combustion products). Harmful effects of fire water pollution can be observed on medium and long term in the form of pollution to the environment, and its remediation or recultivation requires a similarly major operation both from the operator and the competent authorities.

Designing and installation of fire water retention and storage facilities are the most important technical tools for prevention.

I came to the conclusion that there are significant differences in the application of international practices in Hungary both in the area of modern fire prevention systems and pollution mitigation in respect of the equipment park of the warehouses.

Technical requirements should be preferably standardised in the European region in the relevant countries. The same standardised system is also required for the existing and new developments, where fire prevention regulation, the operator's water damage control system and automatic fire alarm and fire extinguishers and firefighting equipment have a pre-eminent role. The fire water pollution prevention guideline (German Guideline) perfectly working in Germany can provide the basis for all these, and the Fire Protection Technical Guideline can prescribe its statutory application in Hungary.

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