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# Preparation for Transport Accidents of Dangerous Goods by Inland Waterways at the Establishments Involving Dangerous Substances

*An important condition for the elimination of accidents during the transport of dangerous goods by inland waterway is the existence of appropriate legal rules. The unloading and loading of hazardous goods in ports as a hazardous plant involves a high risk. Internal safety planning enables operators of dangerous establishments with a port to be prepared for the prevention, elimination and mitigation of major accidents involving dangerous substances during the transport of dangerous goods at the premises. In the present study, the author will address this scientific problem in detail.*

**Keywords:** disaster management, industrial safety, inland waterway transport of dangerous goods, internal safety planning

## 1. Introduction

Substances with dangerous properties pose a risk to human life, health and the environment, as well as to material property, during production, transport, storage and use. The immediate environment of many dangerous establishments – such as ports – has become densely populated as a result of urbanisation. This makes it significantly difficult to ensure the minimum safety distance and provide an efficient emergency planning process.<sup>2</sup>

The production and storage of dangerous substances usually takes place on sites where the quantity of dangerous substances present at the same time is high, and therefore, according

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<sup>2</sup> Zsolt Cimer, Gyula Vass, Attila Zsitnyányi and Lajos Kátai-Urbán, 'Application of Chemical Monitoring and Public Alarm Systems to Reduce Public Vulnerability to Major Accidents Involving Dangerous Substances', *Symmetry* 13, no 8 (2021).

to Act CXXVIII of 2011 on disaster management and the amendment of certain related acts<sup>3</sup> (hereinafter: Disaster Management Act), these sites are classified as establishments involving dangerous substances.

International literature and experience from both international and Hungarian low enforcement practice show that the unloading and loading of dangerous substances among others in ports is associated with a high risk of major accidents involving dangerous substances. However, Directive 2012/18/EU of the European Parliament and of the Council<sup>4</sup> of 4 July 2012 on the control of major-accident hazards involving dangerous substances and amending and subsequently repealing Council Directive 96/82/EC (hereinafter: Seveso III Directive) and Chapter IV of the Disaster Management Act do not cover the dangerous activities linked with the transport of dangerous goods by road, rail, air or inland waterways outside dangerous plants. Nevertheless, internal emergency planning of dangerous establishment creates both the opportunity and the obligation for the operator to draw up a plan to prevent major industrial accidents and mitigate their consequences, and to initiate primary intervention and mitigation activities with its own employees until the arrival of the professional emergency services. The aim of this study is to analyse the possibilities provided by the legislation for the elimination of major industrial accidents and damages in the territory of ports of dangerous industrial establishments.

## **2. Evaluation of the regulation of dangerous establishments and inland waterway transport of dangerous goods in Hungary**

The elimination of accidents during the transport of dangerous goods requires more than just the provision of adequate forces and equipment. The legal framework must also define the tasks of the organisations involved in the response and the possibilities for cooperation in order to ensure a coordinated, efficient and professional response activity.

### **2.1. Assessment of the legislation on dangerous establishments**

The Seveso III Directive was published on 4 July 2012, transposed into Hungarian law and entered into force on 1 June 2015 with the amendment of the Disaster Management Act and its implementing decree, Government Decree 219/2011 (X.20.) on the protection against major accidents involving dangerous substances<sup>5</sup> (hereinafter: Government Decree 219/2011).

Depending on the quantity and type of dangerous substances present on the operator's site, the Seveso III Directive distinguishes between an upper-tier establishment and lower-tier establishments involving dangerous substances. The operator is required to prepare a safety

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<sup>3</sup> Act CXXVIII of 2011 on disaster management and amending certain related acts.

<sup>4</sup> 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.

<sup>5</sup> Government Decree 219/2011 (X.20.) on the protection against major accidents involving dangerous substances.

report for an upper-tier establishment and a safety analysis for a lower-tier establishment. The competent disaster management authority assesses these safety documentations. The safety report or analysis shall include information on the establishment, the dangerous substances present at the site, the installations and storage premises, the potential major-accident scenarios and risk analysis, the prevention and response measures and the management system in place.

The Seveso III Directive requires the operator of a dangerous establishment to take all necessary measures to prevent major accidents, mitigate their consequences and implement remedial measures, and therefore the internal emergency plan must be annexed to the safety report or safety analysis.

The internal emergency plan shall describe the tasks and measures to prevent and reduce the risk of major accidents involving dangerous substances. In the event of a major accident, all the measures necessary for the implementation of the first response activities, the equipment required and the number of staff and their duties involved shall be specified.

In order to prepare for emergency situations, an external emergency plan must be drawn up for the municipality, in view of the dangerous effects of dangerous establishments on the population. The testing of the internal and the external emergency plans must be ensured. In the event of major accidents involving dangerous substances, the tasks set out in the plans must be carried out immediately.

## 2.2. Analyses of the legal regulation on inland waterway transport of dangerous goods

The "Recommendations on the Transport of Dangerous Goods", developed by the United Nations Economic and Social Council, is the basis for the transport of dangerous goods and the model for the regulation of the different transport sectors. The collection, also known as the Orange Book because of its orange colour, contains detailed descriptions, requirements and instructions for the transport of materials and objects that may pose a hazard during transport because of their physical, chemical or biological properties or their condition during transport.<sup>6</sup>

Directive 2008/68/EC of the European Parliament and of the Council<sup>7</sup> (24 September 2008) lays down the rules for the inland transport of dangerous goods, which includes the rules for the transport of goods on natural and artificial surface waters in the Member States of the European Union.

In Hungary, persons and undertakings involved in the transport of dangerous goods by inland waterways must comply with the ADN, (the European Agreement Concerning the International Carriage of Dangerous Goods by Inland Waterways),<sup>8</sup> the European Agreement

<sup>6</sup> Ivett Viktória Kiss, Lajos Kátai-Urbán and Gyula Vass, 'A légi szállítás hatósági ellenőrzési tevékenységének aktuális jogalkalmazási kérdéseinek vizsgálata', *Védelem Tudomány* 5, no 4 (2020), 95–116.

<sup>7</sup> Directive 2008/68/EC of the European Parliament and of the Council of 24 September 2008 on the inland transport of dangerous goods (Text with EEA relevance).

<sup>8</sup> UNECE, European Agreement Concerning the International Carriage of Dangerous Goods by Inland Waterways.

concerning the International Carriage of Dangerous Goods by Inland Waterways, concluded in Geneva on 26 May 2000, as amended.

The rules of the ADN are changed in every two years. In the domestic legal regulation they are currently promulgated by Government Decree 386/2021 (VI.30.) on the promulgation of the Regulations annexed to the European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN) and on certain issues of its domestic application.<sup>9</sup>

NFM Decree 26/2017 (VII.5.) on the domestic application of the Regulations annexed to the European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN)<sup>10</sup> contains supplements to the domestic application of the ADN Regulations.

In Hungary, from 1 January 2012, the Disaster Management Authority will have the autonomous authority to control the transport of dangerous goods by inland waterways, alongside the shipping authority and the waterway police organisation. The legal background for the official supervision is provided by the Disaster Management Act and Act XLII of 2000 on Water Transport.<sup>11</sup>

The ADN also sets out in detail the safety requirements for ships carrying dangerous goods, the type of technical equipment and personal protective equipment required on board and the rules for loading, unloading. The minimum number of personnel on board is laid down in the ship class certificate. According to the ADN rules, the process of transporting dangerous goods ends when the operator of the receiving facility has allowed the dangerous goods to be unloaded or discharged and the discharge is completed and the consignee has taken delivery of the dangerous goods. In most cases, these processes take place in the ports of dangerous establishments involving dangerous substances.

### 3. Assessment of rules for the internal emergency planning for ships carrying dangerous goods

In the European Union, there are around 15 to 35 industrial accidents classified as major accidents involving dangerous substances.<sup>12</sup> In their article entitled 'Veszélyhelyzeti tervezés, belső védelmi tervezés' [Emergency Planning, Internal Protection Planning], Béla Szakál and Imre Hoffman draw attention to the economic and social consequences of major accidents in dangerous establishments involving dangerous substances. They conclude that the off-site

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<sup>9</sup> Government Decree 386/2021 (VI.30.) on the promulgation of the Regulations annexed to the European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN) and on certain aspects of their domestic application.

<sup>10</sup> NFM Decree 26/2017 (VII.5.) on the domestic application of the Regulations annexed to the European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN).

<sup>11</sup> Act XLII of 2000 on Water Transport.

<sup>12</sup> EU Joint Research Centre, *Major Accident Reporting System*, 2020.

effects of accidents, and the extent of their damage, depend mostly on the quality of the preparedness measures.<sup>13</sup>

De Leijer et al. also write about the importance of emergency planning in the study *Inland Waterways Transport: A Good Practice Manual and Reference Guide*. The need for rapid intervention is justified by the severity of the effects of accidents involving the transport of dangerous goods by inland waterways. They draw attention to the need to train the ship's crew and to the usage of risk and consequence analysis procedures and methodologies.<sup>14</sup>

In emergency planning, operators should consider the port in the area of operation as a dangerous installation. The operator should identify potential major-accident events involving dangerous substances and their frequency of occurrence.

The methodology for the risk and consequence analysis of dangerous operations that can be used in the development of safety documentation for establishments is contained in the so-called Dutch colouring books. The publications are published by the Dutch Research Institute for Applied Sciences on behalf of the Dutch Disaster Prevention Committee. The Dutch colouring books are acknowledged as internationally recognised literature. The CPR 18E Purple Book (hereafter: Purple Book)<sup>15</sup> contains the risk-based quantitative risk analysis procedure and the methodology and databases for the vulnerability analysis.

The Purple Book describes possible accidents related to the transport units on the site in section 3.2.9.2. In Table 3.20, two main categories were identified. The first category includes incidents occurring during the unloading, discharging or loading of ships (L.1, L.2 incidents). The second group includes events related to the ship during external impact (E.1, E.2) events.

Table 1: Loss of containment events for ships in an establishment

L.1	Full bore rupture of the loading/unloading arm – outflow from both sides of the full bore rupture
L.2	Leak of the loading/unloading arm – outflow from a leak with an effective diameter equal to 10% of the nominal diameter, with a maximum of 50 mm
E.1	External impact, large spill – gas tanker continuous release of 180 m <sup>3</sup> in 1800 s semi-gas tanker (refrigerated) continuous release of 126 m <sup>3</sup> in 1800 s single-walled liquid tanker continuous release of 75 m <sup>3</sup> in 1800 s double-walled liquid tanker continuous release of 75 m <sup>3</sup> in 1800 s
E.2	External impact, small spill gas tanker continuous release of 90 m <sup>3</sup> in 1800 s semi-gas tanker (refrigerated) continuous release of 32 m <sup>3</sup> in 1800 s single-walled liquid tanker continuous release of 30 m <sup>3</sup> in 1800 s double-walled liquid tanker continuous release of 20 m <sup>3</sup> in 1800 s

Source: Compiled by the author based on the Purple Book.

<sup>13</sup> Béla Szakál and Imre Hoffman, 'Veszélyhelyzeti tervezés, belső védelmi tervezés' [Emergency Planning, Internal Protection Planning], in *Iparbiztonsági és Hatósági Szakmai Nap. Tudományos Konferencia* [Industrial Safety and Official Professional Day, Scientific Conference], ed. by Tamás Hábermayer (Paks: Tolna Megyei Katasztrófavédelmi Igazgatóság, 2020), 70–76.

<sup>14</sup> Harrie De Leijer, Martin Quispel, Sandra Van Putten and Richard Van Liere, *Inland Waterways Transport. Good Practice Manual and Reference Guide* (Rotterdam: The World Bank, 2015).

<sup>15</sup> Ministry for Housing, Spatial Planning and the Environment (VROM), *Guidelines for quantitative risk assessment – CPR 18E*. Publication Series on Dangerous Substances (PGS 3) (The Hague, October 1997).

The frequency of occurrence of accidental incidents involving tankers within the area of the establishment is summarised in Table 3.21 on page 54 of the Purple Book.

Table 2: Frequency of occurrence of accidental events involving tankers within the area of the establishment

Ship	L.1 Full bore arm	L.2 Leak arm	E.1 External large spill	E.2 External small spill
Single-walled liquid tanker	$6 \times 10^{-5}$ /per transhipment	$6 \times 10^{-4}$ /per transhipment	$0.1 \times f_0$	$0.2 \times f_0$
Double-walled liquid tanker	$6 \times 10^{-5}$ /per transhipment	$6 \times 10^{-4}$ /per transhipment	$0.006 \times f_0$	$0.0015 \times f_0$
Gas tanker, semi-gas tanker	$6 \times 10^{-5}$ /per transhipment	$6 \times 10^{-4}$ /per transhipment	$0.025 \times f_0$	$0.00012 \times f_0$

Source: Compiled by the author based on the Purple Book.

In accordance with Section 3.2.9.2. of the Purple Book, the base accident failure rate,  $f_0$ , is equal to  $6.7 \times 10^{-11} \times T \times t \times N$ , where T is the total number of ships per year on the transport route or in the harbour, t the average duration of loading/unloading per ship (in hours) and N, the number of transhipments per year.

Michalis D Christou in his study entitled 'Analysis and control of major accidents from the intermediate temporary storage of dangerous substances in marshalling yards and port areas' analyses a number of major accidents involving dangerous substances, which have in common the fact that they occurred in ports or in the immediate vicinity of ports.<sup>16</sup>

The major accident scenarios and the safety measures contained in the internal emergency plans relating to tankers residing within the premises of the establishment do not cover the management and clean-up operations of accidents occurring in the immediate vicinity of ports. Internal emergency plans should therefore be supplemented with emergency planning information related to the immediate vicinity of ports.

The successful elimination of accidents primarily requires close cooperation between the dangerous establishments and those involved in the transport of dangerous goods, as well as between the emergency services, the water management authority, the shipping authority, the water police, the national tax and customs authorities. The importance of inter-agency cooperation in the investigation of accidents related to the transport of dangerous goods by rail has already been stated by Hermina Horváth in her work entitled 'A vasúti veszélyesáru szállítási balesetek felszámolásának tapasztalatai, különös tekintettel a vasúti vegyi elhárító szolgálat működésére' [Experiences in dealing with accidents involving the transport of dangerous goods by rail, with particular reference to the operation of the rail chemical

<sup>16</sup> Michalis D Christou, 'Analysis and control of major accidents from the intermediate temporary storage of dangerous substances in marshalling yards and port areas', *Journal of Loss Prevention in the Process Industries* 12, no 1 (1999), 109–119.

emergency service].<sup>17</sup> However, in case of inland waterway transport of dangerous goods, the operators of dangerous goods establishments and the carriers must also take responsibility for mitigating damage and eliminating accidents.

In the course of internal emergency planning, the operator must develop appropriate measures for initial intervention to counter the consequences of the hazard sources. The operator must create the necessary conditions for the implementation of the tasks specified in the emergency plans. The operator must provide the appropriate means for the enforcement bodies involved in the response operations. The plant response infrastructure necessary for protection must be set up and operated. The organisations identified in the plans must be equipped with specialised equipment and personal protective equipment appropriate to their specific tasks and their technical condition must ensure their proper and effective use. The operator must regularly exercise the feasibility of the internal emergency plan.

Picture 1 below shows, as an example of an internal emergency plan exercise, where the workers at the plant are using a floating immersion wall and a floatation loop to contain the gas oil leaking into the Danube.



Picture 1: Internal emergency plan exercise in a dangerous establishment  
Source: Made by the author.

## 4. Summary

The production and storage of dangerous substances usually takes place on sites where the quantity of dangerous substances present at any time is high and therefore they are classified as dangerous substances facilities. International and domestic literature and practice show that the operations involving dangerous substances in dangerous establishments are associated with a high risk of major accidents.

<sup>17</sup> Hermina Horváth, 'A vasúti veszélyesáru szállítási balesetek felszámolásának tapasztalatai, különös tekintettel a vasúti vegyi elhárító szolgálat működésére' [Experiences in dealing with accidents involving the transport of dangerous goods by rail, with particular reference to the operation of the rail chemical emergency service], *Hadmérnök* 11, no 1 (2016), 107–114.

The purpose of the internal emergency plans is to ensure that, pending the arrival of the professional emergency services, the establishment is able to carry out primary intervention and mitigation activities with its own forces.

The internal emergency plan is limited to the area of the dangerous establishment. Hungarian emergency management experience has shown that accidents during the transport of dangerous goods by inland waterways have occurred in the ports of dangerous goods establishments or in the immediate vicinity of these ports, usually just before the unloading or loading operations. I suggest that internal emergency plans prepared for the ports of dangerous establishments be supplemented with information on the prevention of major accidents outside the plant. The range of personal protective equipment and specialised technical equipment specified in the internal emergency plan should be reviewed at the same time.

Reporting obligations to the disaster management authority of the operator in the event of major accidents involving dangerous substances should be regulated in the internal emergency plans. This reporting obligation, in my opinion should be extended to the transport authority and the waterway police organisations.

In the course of training of internal emergency plans, due emphasis should be given to the sequence of events related to inland waterway transport accidents involving dangerous goods.

In my opinion, the above proposals on internal protection plans can be effective tools in reducing the consequences, environmental, economic and social impact of accidents involving the transport of dangerous goods on the Danube river.

## References

- Christou, Michalis D, 'Analysis and control of major accidents from the intermediate temporary storage of dangerous substances in marshalling yards and port areas'. *Journal of Loss Prevention in the Process Industries* 12, no 1 (1999), 109–119. Online: [https://doi.org/10.1016/S0950-4230\(98\)00043-6](https://doi.org/10.1016/S0950-4230(98)00043-6)
- Cimer, Zsolt, Gyula Vass, Attila Zsitnyányi and Lajos Kátai-Urbán, 'Application of Chemical Monitoring and Public Alarm Systems to Reduce Public Vulnerability to Major Accidents Involving Dangerous Substances'. *Symmetry* 13, no 8 (2021). Online: <https://doi.org/10.3390/sym13081528>
- De Leijer, Harrie, Martin Quispel, Sandra Van Putten and Richard Van Liere, *Inland Waterways Transport. Good Practice Manual and Reference Guide*. Rotterdam: The World Bank, 2015. Online: <https://documents1.worldbank.org/curated/en/332181538034793651/pdf/Inland-Waterway-Transport-Good-Practice-Manual-Reference-Guide-2015.pdf>
- EU Joint Research Centre, *Major Accident Reporting System*, 2020. Online: <https://emars.jrc.ec.europa.eu/en/emars/statistics/statistics>
- Horváth, Hermína, 'A vasúti veszélyesáru szállítási balesetek felszámolásának tapasztalatai, különös tekintettel a vasúti vegyi elhárító szolgálat működésére' [Experiences in dealing with accidents involving the transport of dangerous goods by rail, with particular reference to the operation of the rail chemical emergency service]. *Hadmérnök* 11, no 1 (2016), 107–114. Online: <https://doi.org/10.32567/hm.2016.1.11>
- Kiss, Viktória Ivett, Lajos Kátai-Urbán and Gyula Vass, 'A légi szállítás hatósági ellenőrzési tevékenységének aktuális jogalkalmazási kérdéseinek vizsgálata'. *Védelem Tudomány* 5, no 4 (2020), 95–116.

Ministry for Housing, Spatial Planning and the Environment (VROM), *Guidelines for quantitative risk assessment – CPR 18E*. Publication Series on Dangerous Substances (PGS 3). The Hague, October 1997. Online: <https://content.publicatiereeksgevaarlijkestoffen.nl/documents/PGS3/PGS3-1999-v0.1-quantitative-risk-assessment.pdf>

Szakál, Béla and Imre Hoffman, 'Veszélyhelyzeti tervezés, belső védelmi tervezés' [Emergency Planning, Internal Protection Planning], in *Iparbiztonsági és Hatósági Szakmai Nap. Tudományos Konferencia* [Industrial Safety and Official Professional Day. Scientific Conference], ed. by Tamás Hábermayer. *Paks: Tolna Megyei Katasztrófavédelmi Igazgatóság, 2020, 70–76*. Online: <https://tolna.katasztrofavedelem.hu/application/uploads/documents/2020-04/70644.pdf>

## Legal sources

Act CXXVIII of 2011 on disaster management and amending certain related acts.

Act XLII of 2000 on Water Transport.

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.

Directive 2008/68/EC of the European Parliament and of the Council of 24 September 2008 on the inland transport of dangerous goods.

Government Decree 219/2011 (X.20.) on the protection against major accidents involving dangerous substances.

Government Decree 386/2021 (VI.30.) on the promulgation of the Regulations annexed to the European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN) and on certain aspects of their domestic application.

NFM Decree 26/2017 (VII.5.) on the domestic application of the Regulations annexed to the European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN).

UNECE, European Agreement Concerning the International Carriage of Dangerous Goods by Inland Waterways.