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Emergency Planning Experiences in Hungary

One of the tasks of Hungarian industrial safety's regulation is to prepare for the elimination of the consequences of industrial disasters (major accidents). Firstly, the author of this article in her analysis is dealing with the systematization of major accident's consequences and lines of defence for the response of these critical events. Secondly, the aim of this article will be the analysis of the major accident's emergency response planning and implementation system for dangerous establishments and the settlements affected.

Keywords: industrial accidents; emergency planning; disaster management, population protection measures, emergency plan exercises

Introduction

As a result of globalization and internationalization, industrial hazards of Hungary follow an increasing trend. The disaster management system unified in 2012, and a system of industrial safety laws, institutes, procedures and assets has been established in order to improve the safety of life and properties of the population. Successful performance of the authority licenses, local government and operational tasks applied in frames of the industrial safety regulations make it necessary to develop further the system for prevention of consequences of industrial and environmental disasters.

In the first part of this article, I intend to review, evaluate and systematize the root causes of model accident scenarios involving dangerous substances, and to systematize the technical and management (control) measures for the elimination of the consequences of industrial and environmental disasters (including an international review).

Additionally, my task is the evaluation of the system of major accident hazard prevention planning and execution in relation to operational and settlement dangerous substances applied for dangerous activities. I handle the following main issues in the evaluation:

- standardization of the operation practice of emergency planning;
- measurability of the technical requirements against emergency plans;
- definition of authority compliance requirements concerning training and practice.

The method I use to achieve my purpose is the evaluation of the national and international publications, legislations, system of operational documents and authority legislative documents, and compilation of national and international comparative analyses.

Overview of the authoritative national and international literature

The government discusses fair and efficient operation of the Good State Administration in Chapter 3.8 of the Public Administration and Civil Service Development Strategy between 2014–2020. The document states that "[I]t is a national interest for the state to continually deserve credit of the citizens: serve them by protection and safety." [1] A stressed government task of the state is enhancing security and the feeling of safety of citizens. My research is in harmony with the fundamental rights stipulated in the Constitution of Hungary, [2] in Articles II. and XXI. and with the emergency tasks of the state to be performed in case of a special legal situation as defined in article 53.

We have to clarify the concept of industrial safety in order to define the subject. The concept of industrial safety was defined by Lajos Kátai-Urbán as follows: "All the dangerous activity (dangerous establishment) specific legal institutes and systems of tasks, procedures and tools, or methodologies that are used through compliance of the operator, authority, and Mayor's Office's tasks in relation to the management of major accidents involving dangerous substances, to transportation of dangerous goods, emergency responses to nuclear accidents, and safety of vital systems and installations for sake of high level protection of the life and health of the population, the environment and the assets and services that are necessary for survival." [3]

My researches are related to one of the most important elements of the definition: application of the legal emergency institutes to mitigate the consequences of major accidents involving dangerous substances that serve as preparation in order to manage the consequences of industrial and environment disasters.

The most important national rules of the subject are in *Act CXXVIII. of 2011 on Disaster management (hereinafter: DMA)* [4] *and in 219/2011. (X. 20.) Government Decree (hereinafter: Implementation Decree or ID.) on management of major accidents involving dangerous substances* [5]. These two public acts are the so called regulation of dangerous establishments (hereinafter: dangerous establishment regulations) that serve national compliance of the 2012/18/EU on control of major accident risks concerning dangerous substances (SEVESO III.) directive of the committee. [6]

In the foreword of this article, I mentioned the most important industrial safety regulation of the European Union and Hungary, whose application for industrial safety and technical purposes is supported by the "authority code" of disaster management: *the No. 17/2015. BM OKF provision of the director general on execution of authority and*

professional authority activities that involve the central, regional and local organizations of disaster management. [7] The provision handles the order of execution of the industrial safety authority and special disaster management tasks for defence against major accidents in its attachment.

The rules of operation of dangerous establishments are also contained by No. 208/2011. (X. 12.) *Government Decree on detailed rules of disaster management fines, and on payment and refunding of disaster management contribution [8] and Act CXL. of 2004 on general rules of administrative authority procedures.* [9] In frames of the Commission of the United Nations for Europe, March 17, 1992, the Convention on the Transboundary Effects of Industrial Accidents concluded in Helsinki has established international and two-way cooperation concerning industrial accidents, which was announced by the 128/2001. (VII. 13.) Government Decree. [10]

We can see in the international literature that the application of the so called "colour books" [11], [12], [13] published by the Holland External Defence Research Institute is inevitable for the analysis of the endangering situation. Further procedure and methodological research results and databases are in foreign language books that are respected as standard works of industrial safety such as the directives of the Chemical Safety Centre on quantitative risk analysis [14], the Environment Risk Analysis book published in London [15], and the Analysis of Losses of Processing Industry Technologies. [16]

The Major Accident Hazards Bureau of the Joint Research Centre of the European Union in Ispra, Italy has published several methodological guides, that were integrated in the national publications and guides. Such guides are the ones containing the requirements concerning safety reports [17], [18] and the guide detailing the rules of authority inspections [19]. Unfortunately, a Union methodological aid was not compiled to support the application of laws for the execution of establishment and settlement defence planning.

The industrial safety textbook of NKE gives procedural and methodological guide for the execution of the operator and authority tasks concerning major industrial accidents in relation to dangerous substances. [20] The *Methodological aid for execution of regional and local tasks of managing major industrial accidents in relation to dangerous substances* [21] writes about the execution of regional and local tasks of managing major industrial accidents; it is still applicable and it explains the rules of emergency planning. Altogether 15 theses and 3 habilitation thesis booklets were written on the subject of industrial safety, organized by the NKE and its predecessor, the Zrinyi Miklos National Defence University Military Technology PhD School, that were also used as a guide in my research work.

Review and evaluation of the root causes and consequences of accidents in relation to dangerous substances

Conceptual evaluation of industrial and environmental disasters

The most authentic conceptual definition of industrial and environmental disasters is in the regulation of dangerous establishments. The DMA contains conceptual definitions of disasters, major accidents, and major incidents.

The so called not qualified event is not qualified as an incident or as an accident in relation to dangerous substances. Such incidents may be so called not reportable events. Other operational incidents are also qualified like this, such as work accidents or an incident that occurred without the presence of a dangerous substance. A detailed description of this latter accident category is in Attachment 6 of the "Authority Code" [7] regulating the procedure of industrial safety incident site inspections.

It is necessary for the qualification of an "incident" as a major accident that the incident is a result of an uncontrollable process and the accident seriously endangers or damages health, environment or properties.

It is important to stress the definition of *serious danger* from the conceptual elements of a "major accident", which can be described by the following effects:

- possible consequences inside or outside of the dangerous establishment endangering human life and health;
- possible consequences endangering human life and health and causing public disorder involving a group of people;
- possible consequences significantly endangering environmental elements (air, surface and underground waters, soil);
- major damage of properties (constructed environment) within and outside of the establishment.

I will perform the evaluation of the root causes and consequences of accidents in the following parts.

Overall evaluation and systematization of the root causes, accident sequences and consequences of major accidents

The industrial safety authority examines the truth content of the safety documents submitted by the operator, within frames of an authority procedure for construction and commencement of operation, based on the regulation of dangerous establishments. The operator prepares and applies the emergency plan of the dangerous establishment

based on the major accident risk assessment, which plan also contains the necessary information for the external settlement emergency planning.

The *risk analysis* of the dangerous establishment must cover the following important elements:

- a detailed description of the internal and external prerequisites (causes) and probability of occurrence of possible major accident scenarios;
- evaluation of the seriousness and possible consequences of the identified major accident hazards;
- description of the technical prerequisites and the applied equipment that are necessary for the safe operation of the dangerous establishments;
- the emergency responses for the mitigation of consequences of major accidents.

The *internal emergency* plan of a dangerous establishment shall conform to the following content requirements:

- description of availability of the means and equipment for the mitigation of consequences of major accidents;
- information concerning determination of alarms and intervention measures;
- description of internal and external forces and equipment.

Identification of major accident scenarios creates connection between hazard identification and risk analysis in form of model accident scenarios. We can use these model major accident scenarios to assess compliance of emergency measures (barriers), and to create emergency plans and land-use plans.

The scenarios are usually based on supposition of incidents resulting in the emission of dangerous substances. The major accident sequence in the safety report usually describes the way (technical nature) how dangerous substances are released; it can be a fracture of a tank, a pipeline, or leakage of a vessel containing dangerous substances.

It also specifies the effect of the caused incident such as fire, explosion and release of dangerous substances (emission to the environment).

The so called *bow-tie diagram* is a generally used method to demonstrate the major accident sequences and their root causes. Based on the comparison of acknowledged references of the literature [11], [15], [20], the types of *sequences resulting in the release of dangerous substances* are the following: pool fire; flash fire; tank fire; jet flame; VCE (explosion of evaporating steam gas cloud); propagation of a toxic cloud; BLEVE (expanding vapour explosion of a boiling liquid); pollution of soil, air and water.

The above incidents usually occur at process equipment, storing equipment, pipelines, loading and unloading installations, or during transportation of dangerous substances within the establishment.

Modelling the consequences of a major accident requires input data such as physical and chemical properties of dangerous substances (inflammability, toxicity etc.), emission potential (heat radiation, overpressure) releasing properties (quantity, state of aggregation etc.) and weather conditions. The results of this model calculation is specified in terms of seriousness of the (potential) effect. Potential effect is usually expressed in terms of risk to health in the safety reports, although relative damages to property or environment can also be specified.

Systematization of emergency measures for the prevention of consequences of industrial and environment disasters

We can categorize the *measures for the mitigation of the consequences* of incidents resulting in the release of dangerous substances in three categories:

- reduction of the quantity of dangerous substances released in the environment, which depends on the type of the dangerous material and the type of releasing (such as emergency trip systems, water curtains, pool size reduction and foam covering);
- prevention of the extension of the incident that we mainly apply in case of incidents involving inflammable and explosive materials;
- closing up or evacuation measures can be used to protect people and infrastructure around the incident, which depends on the available time.

The following table shows the detailed categories of the risk reduction (defence) measures.

Table 1: Emergency measures (lines of defence); compiled by the author; (source: [18])

Type of the measure		Description of the measures
Technical measures	Passive technical measures	A mechanic solution is not necessary to operate the safety function. For example, a retaining wall around the tank designed to contain the full material quantity They can be operated with relatively high reliability.
	Active technical measures	They require external power source to perform their safety function but they operate without human intervention (such as automatic shutdown, emergency cooling systems).

Behaviour rules in the establishment	Passive behaviour rules	Regime rules are enforced in case of certain operational areas. The rule consists of the measure in itself, without applying any technical measure (such as protective distances, closed plant areas, areas to prevent naked flame).
	Active behaviour rules	They determine the obligatory behaviour rules to follow in the dangerous area of the establishment. (Such as evacuation measures in case of risk of intoxication or fire alarm, or the labour safety or fire safety regulations in case of handling chemicals).
Further measures		It is a combination of technical measures and behaviour rules. The combination of active measures is the most important because they are in interaction (such as plant shutdown procedures in case of an alarm).

The PhD thesis of István Grafjódi [23] discussed this issue where the author categorized the risk mitigation measures in three categories after studying expert analyses (results) and international literature references [11], [14]:

- elimination or mitigation of risk, hazard (by inherent safety);
- mitigation of the consequences;
- and mitigation of the frequency (probability of occurrence).

Based on an analysis of the international literature, we can label those measures as consequence mitigating measures that can be used if a source of risk cannot be eliminated fully due to financial, process management or other reasons. Such measures are for example: application of remote controlled valves, reduction of pipe diameter, reduction of process parameters, safety discharge systems, flooding systems and foam jets to extinguish or limit fire, steam or water curtains to flush toxic gases, fireproof structures, explosion-proof walls, application of rules against storing together, construction of closed buildings in the establishment. [23]

Study of regulations on emergency plans

An important part of the regulations of dangerous establishments is the industrial safety authority license concerning dangerous activities. The principle of performing industrial safety authority procedure is the safety documentation, which can be a safety report, analysis or major accident emergency plan, depending on the state of the dangerous plant.

The primary purpose of the operator documents is to prove adequately that the operator has done every expectable thing in order to prevent the consequences of a possible major accident in relation to dangerous substances.

The industrial safety authority continually inspects, among other things, whether the operator has adequate forces, equipment and infrastructure for the elimination or mitigation of the consequences of major accidents, whether the information contained in the safety report reflects the condition of the management system established in the plant, the emergency organizations and the systems that are necessary for the defence against major accidents.

The preparation measures by the operator are the following: writing a proposal to assign the endangered area; preparation of the internal emergency plan, its review, training and practicing. The industrial authority performs the following tasks: assigning the danger zone; checking of the developments planned in the danger zone; qualification of the internal emergency plan and its practicing; external emergency planning, inspection, practicing, supplying public information and adequate publicity, and related other disaster management tasks. [23]

Standardization of the operation practice of emergency planning

The operator must ensure the conditions of execution of the tasks specified by the internal safety plan. The internal safety plan in an attachment of the safety report of analysis; it is written at the same time as these. Review of the internal emergency plan shall be performed at least every three years, and also in case of a priority review of the safety report or the safety analysis, and a protocol is required about this fact. The operator must regularly inspect the feasibility of the stipulations specified by the plan. He performs a practice every year when they practice in a part of the organization covered by the plan (a plant practice), and every three years when they practice in all of the organizations covered by the plan. [5, 9. § (6)]

The operator details the emergency tasks in the plan by a thorough analysis, and then he determines the prerequisites of execution, the persons, forces and means.

The internal emergency plans that I assessed include the following in the order specified by Béla Szakál and his co-authors.

- The forces (manpower) participating in the defence: the management forces, the responsible manager and management of the damage control measures, the emergency organizations (plant fire brigade, technical rescue, chemical survey, relief, first aid team, etc.) and the workers performing their emergency tasks.

- Means of defence: personal protective equipment, fire extinguisher and technical rescue means, the special devices such as chemical detector, relief material, explosion limit detector, communication devices, alarm and announcement sets, first-aid kit etc.
- Defence infrastructure: fire alarm and monitoring systems, automatic and semi-automatic extinguisher systems, foam extinguisher system, fire water system, alarm system etc. [24]

The plan always consists of the basic plan, and the attachments that contain the requirements about the execution of the emergency tasks and other necessary activities.

A part of the plan is the description of the activities of controlling major accidents and the mitigation of their effects, which consists of the following elements:

- the tasks of defence against the situations, impacts as a result of a major accident, the organizations, forces and means used for the defence;
- the infrastructure, equipment and materials that can be used in the defence of major accidents involving dangerous substances;
- the measures taken for protection of the employees of the establishment, including their alarming, and the behaviour rules after receiving such alarms.

The plan contains a list of those major accident events when we intend to apply the forces, means and infrastructure of the establishment.

The following important element is understanding the emergency management whose main parts are:

- emergency management organization; the names, positions and contact data of people initiating emergency activities, controlling defence, having tasks and responsibilities;
- the names, positions and contact data of people who maintain connection with external organizations, and who work in the operation with the external emergency plan, the emergency response alarm and data supply;
- the necessary technical infrastructure for the management and evaluation of the situation and to prepare decisions.

The plan must specify the alarm tasks in work time and after that, the way of the alarm, their required tasks until the arrival, and the means and infrastructure that can be used for the alarms and management tasks.

The description of the tasks in relation to the external emergency plan consists of the following parts:

- the way of alarming the organization who is responsible for the initiation of the external emergency plan; the required information in case of an alarm;

- contents of the detailed information after the occurrence of the situation, and the way of its communication;
- possibilities of assistance to eliminate the emergency in the vicinity of the dangerous establishment, and its conditions.

In the following I summarize the requirements of training of the persons involved in the defence activities (practicing of the plan). The tasks mentioned in the plan were determined based on each major accident sequence and their possible consequences (effects) that were revealed during the risk analysis. The operator has every prerequisite for the execution of the assigned tasks, that is

- enough, and adequately trained and skilled emergency organization,
- emergency equipment in adequate quantity, quality and technical condition,
- emergency infrastructure in adequate quantity and technical condition.

The organization is qualified as adequate for the management of emergency tasks if it has a correctly selected management point and the technical infrastructure for management (communication, preparation of decisions, documentation, etc.)

The executing organization is applicable to perform its tasks if:

- forces are available in adequate volume based on the force-equipment calculations, and they are capable of performing their assigned tasks according to the plan,
- they have individual protective equipment, special devices, communication means, materials, and these are accessible for operative application,
- the assigned emergency management tasks can be performed in acceptable time,
- their training and practices have been performed according to the regulations.

The internal emergency plan practice is evaluated as successful if:

- they took in account that performing a pant level or complex establishment level practice is due in the actual year,
- they have an adequate plan to conduct the practice that declares the purpose of the practice correctly, and execution of the tasks are practiced according to the purposes,
- their specialist tasks are performed on an adequately professional level during the execution of the practices.

I suggest applying the following procedure as the sequence of compilation of the plan, based on the practices that I inspected according to the internal emergency plans:

- evaluation of the possible major accidents determined in the safety documents;

- definition of the emergency responses and operational tasks of the consequences of major accidents (emergency management);
- description of the required forces, means and infrastructure of the establishment for emergency management;
- description of the external forces and means to be utilized in frames of cooperation;
- evaluation of the capabilities of the available forces and means;
- definition of the management and cooperation tasks, regulation of the order of alarming and informing, and initiation of the plan;
- definition of the tasks for the protection of the employees in the establishment;
- recording the tasks of training, practicing and communication in the establishment.

The initial data of compilation of the internal emergency plan is the evaluation of the consequences of the major accident sequences caused by the establishment, revealed as a part of the risk evaluation in the safety report (analysis).

I found the following important observations concerning the adequacy of the plans based on the evaluation of the plans and experiences of their practices:

- The description of major accident sequences shall be done qualitatively and quantitatively as well in the plan; the summary shall also be expressed in table form about each accident sequence.
- The list of names of organizations, forces and means is usually incomplete in the plans; their performance data, the time of their availability and their location is not specified, above other things;
- Detailed description of the emergency management tasks is missing in several cases, or the included description is very general, and is not applicable to the actual effect of that major accident.
- Emergency management tasks of major accidents may be the following:
- extinction of the occurred fires; covering the released dangerous substance by foam; its chemical neutralization;
- definition of weather observation, the quality and quantity indexes involving the release and propagation of dangerous substances;
- ensuring individual protection of the manpower participating in the defence tasks (endangered the personnel of the establishment), their rescue, close-up, alarm, and informing tasks. [20]

Quantitative evaluation of the above detailed tasks is a serious challenge for the designers.

Survey of measurability of the requirements against emergency plans

The regulations of major accidents contain the legal (quality) requirements against emergency plans in general form.

A part of the system of authority aspects is assessment of the interconnection of the safety report (analysis) and the internal emergency plan; the evaluation of the evaluation procedure of the adverse effects and the adequacy of the obtained results; investigation of the competence of the managing organization; determination of adequacy of the forces and means; qualification of the special equipment, protective equipment and their technical condition, and evaluation of the training and practicing of the organizations. [25]

After the comparison of an analysis of the requirements of laws and my practical experiences I found that the area of the zone endangered by the supposed accident sequences shall be determined based on the list of dangerous substances present at the major accident, the forecast, and the measurability of the concluded primary population protection measures.

In order to have adequate quantity information in the emergency plan about the major accident, we have to determine the quantity properties of the major accident sequence, the rules of their uniform documentation and the quantity properties of its adverse effects. The legal regulations of dangerous establishments do not contain overall information about these data, therefore, we have to examine the technical recommendations of the available international and national literature (system of criteria). First I will evaluate the available information concerning adverse consequences of major accidents.

The decree does not determine the quality and quantity limits of the toxic effect, heat radiation, eco-toxic or overpressure effects influencing human health and the environment, in relation to the internal emergency plan. It is the same in case of the external emergency plan. Attachment 7 of the ID contains the quality rating aspects of the internal emergency plan because the system of tasks of the two correlated plans are considered to be identical [Attachments 5, 7, Point 4].

In case of dangerous establishments under the tier, we can find the criteria of the quantity calculations of adverse effects for qualification of the caused risk, which was included in law when the regulations on dangerous establishments were reviewed in 2016. Point 5.3 of Attachment 7 of the ID determines the quantity aspects of the qualification of the risk caused by an establishment under the tier, and it is based on the described possible consequences of the identified major accident. The risk caused by the dangerous establishment operating under the tier is acceptable if a fatal effect (fire or toxic effect, or overpressure) is not expectable in the residual area due to a major accident and if such

effects do not involve public facilities or buildings where crowds may be present [Attachments 5, 7, Point 5.3].

The law determines the magnitude of fatal effect which is

- a heat flux reaching or exceeding 8 kW/m2 value in case of fire, or a dangerous material concentration reaching or exceeding the half of the lower explosion limit in case of a vapour fire, a probit-based fatality probability reaching or exceeding 1%;
- the ERPG 3 value in case of a toxic effect, or a dangerous material concentration reaching or exceeding the value specified about irreversible health disease in the international literature, a probit-based fatality probability reaching or exceeding 1%;
- an air-blast wave reaching or exceeding 10 kPa (100 mbar) value in case of overpressure [Attachments 5, 7, Point 5.3].

The base of determination of the legal values was the scientific thesis of Zsolt Cimer [26] who made recommendations about the acceptance criteria of establishments under the threshold value.

We can apply the acceptance criteria (as specified by the law) concerning the magnitude of a fatal effect by an analogy to the internal and external emergency plans.

The manual titled "Industrial safety I." published by the National University of Public Service in 2013 gives adequate data for preparation of external emergency plans about definition of the zones (ranges) of adverse effects with the design limits specified in the following table, which book was applied by BM OKF in the compilation of the external emergency plan.

Table 2: Zones of external emergency plan; compiled by the author (source: [20])

Name of effect	Rescue zone	Informed zone
Heat effect	8 kW/m^2	4 kW/m^2
Overpressure	100 mbar	20 mbar
Intoxication	1% fatality in case of staying indoor (people staying inside the building)	1% fatality in case of staying outdoor (people staying outside of the building)

Therefore, we can see that the national legal regulations built on international (mainly European Union) practices determine the acceptance requirements for internal and external emergency plans basically in quality terms for establishments handling upper and lower tier dangerous substances. It quantifies the quantity limits among the acceptance requirements of the lower tier establishments. The effects were determined about accident sequences that risk human life and health. However, the quantity evaluation of environment damages caused by major accidents is missing.

So the Hungarian legal regulations do not specify the system of quantity aspects that evaluate the adverse effects of major accident sequences to be applied in internal emergency planning. I summarize the limits applied for the qualification of a major accident in three EU member states.

Table 3: Zones of adverse effects; compiled by the author (source: [27])

Values of effects	France	Italy	Spain
Heat radiation (kW/m^2)	Permanent effect: 3 Fatal effect: 5 Danger of domino effect: 8 at not protected locations; 12 at protected locations Exposure time over 60'	Not permanent: 3 Permanent effect: 5 Beginning of fatalities: 7 High fatality: 12.5 Domino effect: 12.5	Alarm zone: 3 Intervention zone: 5 Zone of domino effect: at protected locations: 12 at not protected locations: 37
Overpressure (mbar)	Permanent effect: 50 Fatal effect: 140 Danger of domino effect: 200 significant effect 350 serious effect 500 very serious effect	Not permanent effect: 30 Permanent effect: 70 Beginning of fatalities: 140 High fatality: 300 Domino effect: 300 *Vapour detonation (fireball):* Not permanent effect: 125 kJ/ m^2 Permanent effect: 200 kJ/ m^2 Beginning of fatalities: 350 kJ/ m^2 *Vapour fire (flashfire)* Beginning of fatalities: ½ x ARH High fatality: ARH	Alarm zone: 50 Intervention zone: 125 Zone of domino effect: buildings: 100 atmospheric tanks: 160 pressurized tanks: 350
Toxic effect:	Permanent effect SES Fatal effect CL1% fatal concentration	Permanent effect: 5 High fatality: LC50 30 s	Alarm zone: ¼ x IPVS Intervention zone: IDLH

Most of the risk and consequence analyzing programs that are used to determine the risk caused by dangerous establishments apply 4 kW/m^2, 12,5 kW/m^2 or 37,5 kW/m^2 value for heat radiation depending on the distance. A 4 kW/m^2 heat radiation poses risk of burns of second degree to people in case of longer than 20 seconds exposition. A 12,5 kW/m^2 heat

radiation means the limit where food ignites and plastics begin to melt, while 37,5 kW/m^2 heat radiation means that limit when damage of steel structures is imminent. The lower and upper explosion limits of the actual material are applied in case of examining vapour fires. In case of sequences of fireballs, overpressure is examined in proportion to distance. [28]

The situation is harder in case of evaluation of toxic effects because they apply the ERPG (Emergency Response Planning Guide) value and the IDLH value. According to generally accepted expert opinions, the ERPH 3 value can be used for emergency planning. The ERPG-3 value is a maximum concentration that does not have consequences endangering life after one hour exposure. [29]

Conclusions

In the first part of this article, I reviewed and systematized the root causes and consequences of model accident scenarios involving dangerous substances. Then, based on this, I systematized the technical and management (control) measures for the elimination of the consequences of industrial and environmental disasters (major accidents).

After performing the first element of the research, I drew the following general conclusions in addition to the part results described in each chapter.

- We can state that authorities have detailed quantitative and qualitative evaluation aspects based on the conceptual definitions of industrial and environmental disasters and major accidents for categorization of major accident events.
- The initiating causes of major accidents are connected to consequences of major accidents and their adverse effects to people and the environment by model accident sequences.
- The quantitative and qualitative characterization is necessary for the application of the major accident model sequences to internal emergency planning, which requires further researches.
- The major accident safety measures can be demonstrated by the application of fault and event tree models based on the so called bow-tie diagram.
- The major accident safety measures include establishment and equipment-specific properties, therefore general categorization methods can be used.

I made recommendation in the second half of my article about the measurability of the requirements against the establishment and settlement emergency plans, determination of requirements of training and practices, and integration of the document system of emergency planning in the establishment.

After performing the research according to the purposes of this study, I drew the following main conclusions in addition to the part results described in each chapter:

- The emergency plans shall be elaborated according to the system of content aspect based on the risk posed by the dangerous industrial establishment. The defence requirements shall be determined supported by (force and means) calculations.
- The major accident aspects and the safety management system procedures shall be integrated to the existing management systems according to the major industrial accident regulations. A management system shall be elaborated that also applies major accident aspects in the establishments where a certified management system is not established, but its elements are available.
- It is necessary to review and integrate the applicable legal practice, procedures and methodology in order to standardize the execution habits of the internal and external emergency planning and special tasks concerning practicing of the plans.
- I established based on the evaluation of the internal emergency plans and experiences of their practicing that the description of major accident sequences shall be done qualitatively and quantitatively as well in the plan; the summary shall also be expressed in table form about each accident sequence.
- During examination of the efficiency of the consequence mitigating emergency measures for the prevention of development of the major accident and its sequence, I concluded that the prerequisite for the protection of the workers of the establishment is quick detection of the dangerous substances, I discuss specification of their quality and quantity, forecasting of the propagation of the adverse effects, and measurability of the primary population measures (alarm, closing up and rescue) based on them.
- The size of the endangered area that belongs to the supposed accident sequence in order to ensure measurability of the dangerous substances present at the major accident, for the forecast and for the primary population protection measures, that is the quantity properties of the major accident, we have to determine the quantity properties of the major accident sequence, the rules of its uniform documentation and the quantity properties of its adverse effects.
- The national legal regulations determine the acceptance requirements for internal and external emergency plans basically in quality terms for establishments handling upper and lower tier dangerous substances. It quantifies the quantity limits among the acceptance requirements of the lower tier establishments.
- The effects were determined about accident sequences that risk human life and health. However, the quantity evaluation of environment damages caused by major accidents is missing.

The results of the research can be used for the development of textbooks of training for NKE KVI disaster management basic and master courses about the management of industrial and environment disasters (handling emergency management planning and accident prevention special tasks) in the industrial safety subject.

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Védelmi tervezési tapasztalatok Magyarországon

KÁTAI-URBÁN IRINA

A veszélyes tevékenységekben jelen lévő veszélyes anyagok tárolása, gyártása és használata magában hordozza a súlyos balesetek bekövetkezésének kockázatát. Jelen cikkben a szerző elsőként értékeli és rendszerbe foglalja a veszélyes anyagokkal kapcsolatos baleseti eseménysorok kiváltó okait és következményeit, majd ezt követően rendszerezi az ipari és környezeti katasztrófák következményeinek elhárítására szolgáló műszaki és vezetési (irányítási) intézkedéseket. Másodsorban a szerző ismerteti és értelmezi a veszélyes üzemek üzemeltetőivel szemben támasztott belső védelmi tervezési jogszabályi és műszaki követelményeket.

Kulcsszavak: ipari balesetek, védelmi tervezés, katasztrófavédelem, lakosságvédelmi intézkedések, védelmiterv-gyakorlatok