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The Place and Role of HAZMAT Units with Respect to Increasing Public Safety in Hungary

The basis of public safety is dependent on the assessment of risk of potential disasters. Furthermore, the term involves protecting and safeguarding people from disasters and other potential dangers or threats. The increasing importance of a nation's preparedness is becoming more obvious in case of disasters, in order to protect the health and safety of citizens, properties, material assets, industrial facilities and the environment. This paper offers an outline review of hazardous materials related emergency response units' (HAZMAT Units) role in the fields of prevention, control, communication, identification of hazard impacts, decontamination and recovery activities.

Keywords: **public safety, disaster, crisis management, dangerous substances, equipment, training of intervention units**

1. A brief overview of the Hungarian and international systems of hazardous material safety

Major accidents are becoming more frequent with the development of industry, consequently affecting our environment or, more broadly, the earth's biosphere, which includes humanity.

Nowadays, it is an observable and growing phenomenon that natural disasters and further circumstances in the same manner with global climate change are causing more and more industrial disasters and vice versa. Recognising these problems for decades, developed industrial countries have created a system of special devices, mobile laboratories, which are able to detect, indicate, evaluate these phenomena and designate the danger zone.

In Hungary, disaster management authorities have been involved in the official control of the transport of dangerous goods by road (ADR) since 2001, according to the amendment of Government Decree No. 122/1989 (XII.5.). Accidents occurring

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during the transport of dangerous goods (be it ADR, ADN, RID, and so on) are investigated by the HAZMAT Units.[2]

The purpose of this short article is to present the possibilities that characterise the world of HAZMAT Units in order to determine how well they cope in today's world. Therefore, I primarily present the tools and forces currently operating in the world, then I present the Hungarian possibilities by highlighting one or two features, for instance training technique, instrumentation and field practice.

However, it is important to note that the factual, accurate description is also justified by the fact that this document is intended to represent the current state in 2021. In several years, decades, there will be a basis of comparison in which we will be able to determine how far we have reached and where we have come from.

Therefore, I dedicate the research method to describe, compare and evaluate the existing foreign literature, manuals, descriptions, as well as the experience gained during the domestic operation in order to suggest directions for possible further developments.

1.1. Main sources of disasters in Hungary

Similarly to most European countries, there are two main sources of disasters in Hungary. One of these is flood, which has been proved to be predictable due to monitoring the indicative factors. Another outstandingly significant cause of harm happens to be related to the transport of dangerous goods, which definitely seems to be less foreseen. The development of science and industry has created the opportunity of new sources of danger. Producing of hazardous chemicals has never faced similar heights before. This actively demonstrates the simultaneously increasing result in the volume of road transport of hazardous substances, contributing to the boost in the chances of accidents. Besides, a notable indicator of contemporary society is that industrial and natural disasters can occur simultaneously with social dissatisfaction, mass riots, arson and violent activities. Therefore, the importance of CBRN preparedness is undeniable and the participation of HAZMAT Units is essential.

1.2. International overview – Europe

In the event of an accident, not only the population, the environment, but also the interveners are at particular risk (poisoning, acid corrosion, and so on). As normal protective gear does not protect against all hazardous materials, special protective clothing is required. Primarily, larger fire departments can afford acquiring and maintaining these special equipment.

[2] Act No. CXXVIII of 2011 concerning disaster management and amending certain related acts.

1.2.1. Germany

In Germany, transport of dangerous goods is regulated by act. In case of hazardous material related accidents, the Gemeinsames Melde- und Lagezentrum coordinates nationwide as an intervention centre. The interveners use the ERI-Cards[3] and the TUIS system for collecting information. Fire brigades,[4] TUIS firefighters, environmental authorities, the Technische Hilfswerk and the Disaster Management units are capable of providing intervention, varying from province to province. The CBRN reconnaissance car used by the Fire Department's Analytische Task Force may seem to be similar to Hungary's HAZMAT Units. The tasks of the CBRN reconnaissance car involve detection of radiological and chemical radiation, the identification of hazardous and tactical materials, the measurement of radioactive contamination, the demarcation of the contaminated area, support of disaster management and sampling (air, soil, vegetation, water). The devices can also measure while driving at a maximum speed of 20 km/hour, furthermore, they can be removed from the vehicle and installed at a particular location. Devices are constantly updated, equipped with the latest software, they are adapted to the latest trends in radiation measurement, and the sampling procedure is also renewed regularly. Civil Defence provides tools for fire departments, as well as manages the training of personnel. The crew does not hold field practice, they prepare by simulation.[5]

1.2.2. Cyprus

The Cyprus Fire Service does not have a special vehicle used only for hazardous detection purposes. Each District area has its own fully equipped hazardous substances vehicle, capable of managing any incident involving leakage of hazardous materials. The storage, inspection and control of any hazardous materials are in the duties of the competent and relevant departments of the state such as the Labour and Inspection Department, local authorities and the appropriate department of the Ministry of Energy Commerce and Industry, and the Environmental Department. The personnel working in the field and all the relevant departments corporate and coordinate jointly in such cases within the framework of their duties.

1.2.3. The Netherlands

In the Netherlands, the responsibilities regarding hazardous materials are divided between different organisations. Safety regions are responsible for the mitigation of CBRN incidents. For nuclear incidents there is a special law, and one of the safety regions is in charge of procedures, regulations, inspection and organisation of expertise. Fire service is not in

[3] *Eri-Cards – Ausgabe 2008: Emergency Response Intervention Cards* (1st German Edition, Kohlhammer, 2008).
[4] Ulrich Kortt, Rolf Schmid, Hermann Schröder and Walter Hamilton, *Hamilton. Handbuch für den Feuerwehrmann* (Boorberg, 2003).
[5] Oliver Meisenberg and Stefan Sellmeier, *ABC-Einsatz: Realistische Übungen mit der "Erkunder-Simulation"* (BRANDSchutz, 2013), 957–959.

charge when a nuclear incident should occur. Apart from that, the military has special experts and equipment. In case of a CBRN related terrorist attack, forces take over with the assistance of the fire service. Each station (950) is equipped with explosion sensors, sensors for radioactivity and CO_2. The regional expert has the same gear as we have in Hungary, but also all kinds of indicator tubes and sensor cells, and more sophisticated sensors like IR detection equipment, and also more sophisticated sensors for radioactivity. There are also reconnaissance teams all over the country, composed of firefighters, who have a box of indicator tubes and they are commanded to the field to make measurements. The regional expert receives special education with a chemical background. The coordinator has a special education to calculate and predict the spread of hazardous materials and to coordinate measurements. Reconnaissance and HAZMAT teams are educated at regional educational offices by instructors who are educated by IFV.

1.2.4. Ireland

Fire services in Ireland carry detection equipment on emergency vehicles, as well as a range of rescue equipment.[6] Response to hazardous materials incidents is led by fire services, with support from ambulance, police and other local authority services, such as environmental protection. For large-scale incidents at industrial installations which attract the requirements of the Seveso Directive, the response includes activation of on-site emergency plans by the operator of the installation, along with off-site emergency plans of the principal response agencies (police, health service and local authority including fire service). This response provides for mobilisation of the necessary resources, and co-ordination between the principal response agencies and the operator of the installation. There are 27 fire services providing training for their firefighters.[7] Training for officers is provided centrally by the National Directorate for Fire and Emergency Management.[8]

1.2.5. Turkey

The institution affiliated to the Ministry of Internal Affairs, namely AFAD, is responsible for coordinating the events from the chemical, biological, radiological and nuclear materials that occur within the country. The first diagnosis and detection is made by AFAD teams. They have a vehicle equipped with various measuring devices to detect CBRN agents scattered around as a result of any industrial accident. In addition, people affected by the CBRN agent in the incident area are also referred to hospitals being decontaminated by AFAD teams. Theoretical training related to CBRN issues are given to the personnel on a regular basis and applied field exercises are carried out.[9]

6 'CBRNe World Convergence – All Hazards Response 2013', Dublin, Department of Defence, 16 April 2013.
7 'Training and development in the Reserve Defence Forces', Defence Forces Ireland, 2016; 'Annual Report of An Garda Síochána 2009', An Garda Síochána.
8 Darren Boyle, 'Gardai get 'dirty bomb' protection', *The Mirror,* 29 March 2007.
9 L Malerova, K Chmelikova and M Zajic, 'The Safety Situation within the Context of Simulations of Crisis Management Processes', *Wit Transactions on the Built Environment* 150 (2015), 209–218.

1.3. International overview – USA

The official website of the Federal Emergency Management Agency provides guidance on hazardous materials for primary interveners, which contains a basic knowledge of HAZMAT events in the United States.[10] The HAZMAT Response Team, as defined in the Hazardous Materials Response Special Teams Capabilities and Contact Handbook is 'an organized group of individuals who are trained and equipped to perform work to control actual or potential leaks, spills, discharges or releases of hazardous materials, requiring possible close approach to the material. The team/equipment may include external or contracted resources'.[11] The teams are subdivided into three categories. HAZMAT teams must meet all of the minimum criteria to qualify for Type I, II, or III. In terms of differences, Type I equipment for field measurement to test for known chemicals, unknown chemicals, known or suspected weapons of mass destruction, chemical/biological agents, and to ensure their decontamination. Type I and II are equipped with measurement tools suitable for known and unknown chemicals, while Type III HAZMAT unit is only for testing known materials as well as ensuring the removal of contaminants. In case of radiation measurement, the first two types of units are suitable for Alpha, Beta, Gamma detection and the third type is suitable for Beta, Gamma detection; while Type I has 7 personnel, the others have 5 personnel. The primary goal of the Type I team is to respond to a large-scale, complex and long-lasting event that involves multiple hazards and/or contains unknown chemical/biological hazardous substances. Deployment time should be within four hours. Type II is a hazardous materials response team that requires sustained effort in the event of a known and unknown hazardous materials incident. Deployment time is two hours. Type III response teams can be deployed in case of specific/known hazardous substances within one hour. The list of standardised equipment prepared by FEMA (AEL 19) is available on the official website. The AEL illustrates the types of equipment approved in FEMA's preparedness programs, and consists of 21 equipment categories, which are divided into further subcategories and individual equipment items.

1.3.1. International overview – Russia

In Russia, the Ministry of the Russian Federation for Civil Defence, Emergencies and Elimination of the Consequences of Natural Disasters is responsible for coordinating disaster related activities and emergency management. Also known as EMERCOM of Russia, involving six regional territories, like the Volga–Ural Regional Center, the Siberian Regional Center, the Central Regional Center, the Northwestern Regional Center, the Southern Regional Center and the Far Eastern Regional Center. Furthermore, it includes the subdivision of several departments, such as the Department for Protection of the Population and Territories; the Department for Disaster Prevention; the Department

[10] United States Fire Administration, *Hazardous Materials Guide for First Responders* (Emmitsburg: USFA, 1999).
[11] *Hazardous Materials Response Special Teams Capabilities and Contact Handbook* (Washington, D.C.: U.S. Coast Guard, 2003).

of Forces; the Department for International Cooperation; the Department for the Elimination of Consequences of Radiological and other Disasters; the Department for Science and Technology; and the Management Department.[12] Although, there is not a large amount of data available in English language on the Russian critical infrastructure policy,[13] the fact is known that technological disasters are accountable for the death of more than 1,000 people on a yearly basis, and further affecting numerous others,[14] as the list providing data on emergencies used to be available on the official EMERCOM website until 2017.[15] Hazardous materials related transport accidents, emissions, explosions and fires, plant accidents pose the highest percentages of threats. Classification of HAZMAT differs from the method used in the EU, mainly regarding the current lack of environmental hazards regulation in Russia.[16]

This brief international overview underlines the fact that industrial development is accompanied by the occurrence of major accidents. The reduction and prevention of emergencies have become important factors regarding the population and environment in all European and other developed countries. The mobile laboratories of HAZMAT Units are becoming more and more differentiated, with chemical, atomic, biological and water quality units specialising in certain cases. In Hungary, all ranges of tools are adapted into one unit, consequently narrowing the measurement capacities, boundaries and possibilities of devices.

2. Skills and duties of HAZMAT Units

The systematisation is based on the need of having a primary deployable unit at territorial level, which is able to identify hazardous substances released into the environment in case of an accident or disaster. A unit which is able to monitor the changing situation by providing continuous measurements and their analysis; present data and proposals to protect the health and safety of individuals. Furthermore, is able to reduce the impact of incidents by means of active responses. If necessary, in case of complex events, the response team is able to cooperate with other emergency response organisations, as Police, Ambulance Service, Environmental Protection or Water Management Authority, to manage and support emergency response duties through mutual cooperation.[17] There are currently 22 equipped units operating in Hungary. One for each county, one for the capital and one for the Liszt Ferenc International Airport. In addition to these, the Disaster Management Training Centre also has one

[12] John Pike, *Military,* s. a.
[13] Roger Roffey, Russia's EMERCOM: Managing Emergencies and Political Credibility (Swedish Defence Research Agency [FOI], 2016).
[14] Christer Pursiainen, 'Russia's Critical Infrastructure Policy: What do we Know About it?', *European Journal for Security Research* 6 (2021), 21–38.
[15] Antonia Reihlen, Juhan Ruut, Philipp Engewald, Heidrun Fammler and Elvira Moukhametshina, *The Russian system of chemicals management* (Baltic Environmental Forum Group, June 2010).
[16] Elena Petrova, 'Natural Hazards and Technological Risk in Russia: The Relation Assessment', *Natural Hazards and Earth System Sciences* 5, no 4 (2005), 459–464.
[17] Katasztrófavédelmi Mobil labor (KML), s. a.

unit for their own special tasks in aspects of vocational training. In the capital and in Borsod County, the vehicles possess a full set of superstructure and supplies. There are two types of vehicles[18] adapted in Hungary, as depicted in the following pictures.

Picture 1
Fully equipped HAZMAT vehicle
Source: Molnár, Fully equipped HAZMAT vehicle.

2.1. Primary duties

Just as public safety is a complex, multi-layered activity, the duties of the team are diverse. Their basic priority is related to emergency response activities: the cleanup of hazardous substances released into the environment in the event of an incident; the protection of the operational personnel, the population and material assets in the case of natural and civilisational disasters. This includes detection, data collection and measurement-evaluation tasks, in addition to risk assessment with reference to the vulnerability of the intervention team, the population and material assets. Furthermore, making proposals to assist the commander in decision-making and in the field of public protection measures. The unit can also participate in warning the population, even in case of a necessary evacuation. It performs planning and organising activities, contributes to the implementation of discharge duties, cooperates with the interveners of the emergency, provides professional assistance to cooperating agencies, contributes to vulnerability assessment and provides data for the Defence Committee. In case of an incident, it maintains contact and co-operates with other organisations dealing with emergency detection, damage prevention and environmental protection.

[18] KEHOP-1.0.6-15-2016-00008 SEQ ID project, "Advanced industrial safety interventions and capacity development" HAZMAT Unit vehicle procurement.

Picture 2
Fully equipped HAZMAT vehicle
Source: Molnár, Fully equipped HAZMAT vehicle.

2.2. Secondary duties

From time to time, the unit plays a crucial role in ensuring the protection of delegations and major sport events in the aspects of public safety. When there is no alert, it also performs official duties according to a defined plan; participates in the control of hazardous material transportation including on-site checkups; as well as investigates accidents and incidents related to the transport of hazardous materials in order to stabilise public safety in a broader sense. Additionally, it also carries out periodic official supervision of hazardous plants, reviews and certifies the practices of internal protection plans; investigates the circumstances of accidents and breakdowns in factories.

The development of HAZMAT Units in Hungary was largely determined by what is called public safety in a broader sense. A significant part of this new task is provided by the compliance with the new expectations, which are intended for the security and the economy of the population.

3. HAZMAT equipment

The equipment of currently operating teams can be grouped in various categories, such as chemical detection devices; biological detection devices, radiation measuring

devices; water analysis devices; personal protective gear; meteorological detection devices; sampling devices; first aid kit; rescue gear, electrical and lighting tools; info-communication tools; ADR equipment for transporting hazardous goods and others. The abbreviation 'ADR' refers to the European Agreement concerning the International Carriage of Dangerous Goods by Road. The reason behind the necessity of biological detection tools can be attributed to the anthrax panic in Hungary, causing serious financial losses and the fact what terrorists are preparing for at present still remains unforeseen. Special tools of chemical detection: hand-held spectrometers, action detection tubes, MHA detection tubes and motor pump, universal indicator (pH) papers, digital pH meter.

3.1. Grouping

These tools and devices can be grouped according to the state of the hazardous substance or the perceived unknown substance.

3.1.1. Gas measuring equipment

Certainly, measurement monitoring with gas detectors is almost without exception one of the basic tasks, as the level of individual protection and safety depends on the oxygen and carbon dioxide content of the air, the presence of explosive gas vapours, possible dangerous gases and vapours. There are several options available for analysing gaseous samples. One possible option would be the determination with a set of detection tubes, mainly for qualitative determination, but under appropriate conditions for quantitative, as well. The gas sample to be analysed is passed through the detection tubes by means of a motorised gas pump. The detectable gases can be divided into several groups, these are separated according to test sets. Detectable gases include inorganic gases: acid gases (hydrochloric acid), hydrogen cyanide, carbon monoxide, alkaline gases (ammonia), nitrous gas (nitrogen dioxide), sulfur dioxide, chlorine, hydrogen sulfide, phosphine, phosgene, organic gases, ketones (acetone), aromatics (toluene), alcohols (methanol), aliphatics, chlorinated hydrocarbons (perchlorethylene) and toxic warfare agents: thioether/sulfur mustard, hydrogen cyanide, arsenic hydrogen and organic arsenic compounds, organic nitrogen compounds, chloro cyanide, thioether, phosphoric acid esters, and so on. Gas measuring equipment also includes a gas detector, containing various sensors for measuring explosive gas mixture, oxygen content, carbon monoxide, carbon dioxide, methane, hydrogen sulfide, ammonia, chlorine, hydrogen cyanide and phosphine.

3.1.2. Solid or liquid substances

Nearly 12 to 13,000 compounds can be identified with tools capable of detecting unknown substances in solid or liquid form. Each measurement can be performed in

a few minutes, making them suitable for fingerprint-like, non-destructive analysis of compounds or mixtures. In connection with chemical detection, a portable GC-MS has also been installed at two different locations to implement analysis of gaseous, liquid or solid samples after the appropriate sample preparation. This extremely sensitive tool has been developed specifically for field usage; however, it requires special professional qualities, for which the operator is specially trained. The device can be used for detection or analysis, although it would be suitable for quantitative analysis as well, but mostly applied for qualitative analysis, for the particular reason that quantitative analysis also demands special competence and in the case of most interventions this type of analysis is not required.

3.1.3. Biohazard detection

A biohazard detection device has been installed for biological detection on the mobile laboratory vehicles, providing the sampling for 8 infectious agents. With this rapid test, a liquid or solid sample can be detected in a relatively short time frame of 10–15 minutes. Agents that can be uncovered by the series of tests: anthrax, ricin, botulism, staphylococcus, plague, tularemia, filoviruses (ebola), smallpox, Q fever, salmonella, dysentery, coli, alphaviruses. Water analysis tools include items for sampling and sample preparation, as well as the digital pH meter and the spectrophotometer with a series of measurements tests (free chlorine, ozone, chloride ions, nitrite ions, nitrate, cyanide ions, sulfate ions, iron, manganese, ammonia, phenol, water hardness) and a measuring tool for determining the dissolved oxygen content and measuring conductivity.

3.2. Meteorological reconnaissance gear

Systematic meteorological reconnaissance devices and instruments are an integral part of the Environmental Monitoring Station. The mobilisable micrometeorological measuring system is suitable for scanning wind speed, wind direction, temperature at 2 points to determine the vertical stability of the air, relative humidity, air pressure, plus it is able to measure radioactive radiation along with a gas detection part for monitoring 12 different gases, and further applicable for modelling and propagation calculations. The data scanned by the measuring device installed on the on-board computer is managed and evaluated by a software developed for this particular purpose. Certainly, an alarm system also belongs to the unit, providing signs when the gas detector or the radiation measuring apparatus reaches a specified value. The surveying unit is suitable for field installation, either set on the vehicle or attached to a separate stand, besides being able to on-the-go monitoring and executing scanning procedures while the vehicle is on the move at reduced speed. The meteorological reconnaissance gear contains an additional item, a hand-held meteorological appliance to define wind speed, wind direction, relative humidity, air pressure values.

3.3. Additional tools

The fully equipped hazardous material response unit vehicle contains the following accessories: mobile and handheld radios, binoculars, night vision binoculars, safety rope and seat harness, cordless lamp, torch, handheld search lamp, LED reflector, several types of power generator extensions, damage marking devices (cordless cone and chemical protection signal kit), textbooks, databases, maps, on-board computer communication module, laptops, multifunction printers, disinfectants, toiletries, special first aid equipment, thermal imager, video recording system, folding ladder GPS, hand tools (axe, pick, shovel), blanket, seat belt-cutter, plastic bag, handheld powder fire extinguisher, handheld foam extinguisher and first aid kit. Besides, there are ADR gears including telescopic mirror/camera, number plate with arrows, laser range finding telemeter with a laser reflective plate, tape measure, plastic seals, 70–50–30 speed limit traffic signs, sign for vehicles transporting dangerous goods to proceed in the direction indicated by the arrow, additional road sign depicting 'ADR control', portable traffic sign stands and life jacket with lamp. Mandatory material requirements for the control of the transport of dangerous goods are defined by the measures of the National Directorate General for Disaster Management. The vast majority of the appliances includes compulsory standby appliances, but some can be optionally detached and only carried when needed.

3.3.1. Protective gear

The hazardous material response unit is also armed with personal protective equipment, as the type "A" heavy gas protective suit, supplied-air respirators and spare composite bottle, gas mask, filter inserts, filter type protective suit, light protective suit, protective gloves, protective hood, safety helmet, rubber boots and protective trousers with boots. With these personal protective equipment, type A and C protection can be provided.

3.3.2. Decontamination kit

For decontamination, there is a decontamination kit available on vehicles including water, CBRN decontamination substance, decontamination ring, decontamination tray, cold season decontamination solution. Besides, a portable shelter and shower system containing a hot water module with pumps, hoses and a flexible 1 m^3 waste tank to capture contaminated water generated during discharge. With the mentioned equipment, only a partial removal of dangerous substances can be executed, before the next deployment, some apparatus needs to be sent to a specialist for a complete neutralisation.

Listing the options has a purpose to show what these units are currently capable of. Their procedure and applicability are largely determined by the professionalism of the devices and their operators. This is the key to the future, for the reason that it provides a foundation and a vision to move towards new challenges.

4. Vocational training of HAZMAT Unit personnel

The training of personnel is extremely important, as the rapid response unit has to be prepared for unforeseen situations, and in addition to the special set of apparatus, they need to acquire in-depth theoretical competence and a wide range of practical preparation. In Hungary, the Civil Protection and Industrial Safety Section of the Disaster Management Training Centre is responsible for the training of the personnel.[19] The currently operating units have been gradually introduced into the system since 2012. The tools and responsibilities that had formerly belonged to the authority of the former Emergency Response Team, were subsequently further developed and modified, taking into account past years' experiences, the possible emergence of new risk factors and the technological development related to the equipment. The first interveners are able to identify various chemical compounds and their hazardous properties, also in case of gaseous, liquid and solid samples, as well as to detect certain infectious – biohazardous – agents and radioactive substances.

4.1. The development of the HAZMAT training

The training of Hungarian HAZMAT Units was carried out in a multi-step process from 2012–2013 by transforming the previous programs. The training is carried out by the Civil Protection and Industrial Safety Department of the Disaster Management Training Centre, under the supervision of the Education Department and Disaster Management Examination Centre of the National Directorate General for Disaster Management and the Nuclear Emergency Response Department. Considering the new deployment unit, the transformation of the training program began with the preparation of teachers. Then, after a smaller transition cycle, today's structure has been gradually developed, during which, the necessary theoretical and practical knowledge is acquired in almost five weeks. The extensive professional experience of our educators, their insight and approach to the field, helps our students to master the equipment of such a complex deployment unit, the specialties of their usage and the tactical features of subsequent reconnaissance at the highest possible level. During the development of the program, our teachers also took into account the previous field experiences and the feedback related to the training. Furthermore, the experience of professional competitions, the newly obtained equipment and additional needs were also taken into consideration.

4.2. The current form of the HAZMAT training program

The current form can also be divided into several parts, as the colleagues who previously intervened with the predecessor Emergency Response Team, had already

[19] 9/2015 (III/25) Decree of the Ministry of the Interior on the professional qualification requirements and vocational training of those employed in professional disaster protection bodies, municipal and facility fire brigades, voluntary fire brigade associations, and related fields.

acquired the necessary basic skills. Therefore, in the context of the transformation, they participated in supplementary training. However, professional firefighters who attended a course for the first time will receive education from the most fundamental.

4.2.1. The structure of the modules

The current training program[20] consists of 3 modules, as follows: Module I – Basics of Emergencies; made up of 30 theoretical and 12 practical lessons. During the lessons, the necessary theoretical basics can be acquired by the participants (mobile laboratory vehicle construction, equipment; basics of radiology; basics of chemistry; basics of navigation; basics of epidemiology; decontamination; water analysis).[21] Module II is based on Technical Asset Management (21 theoretical lessons, 45 practical lessons). Students get acquainted with the instruments, devices and superstructure of the vehicle, their usage, the relevant occupational safety and health rules and the maintenance of the devices. Module III aims to practice the use of technical equipment within the framework of 5 theoretical lessons and 33 practical sessions. During this module, students can practice the use of instruments, protective gears, and various accessories, as well as experienced colleagues provide presentations on deployments to have an impression of real life activities. In addition, two teachers of the Section also participate regularly as directors at the biennial professional HAZMAT competitions. As the best of the counties' units compete here, the gained special experience also greatly contributes to the shaping of the training material now and again, in order to be as complete as possible.

Picture 3
Professional HAZMAT competition
Source: Molnár, Professional HAZMAT competition.

Picture 4
Professional HAZMAT competition
Source: Molnár, Professional HAZMAT competition.

[20] Disaster Management HAZMAT Unit training program (approved by Dr. Zoltán Góra Ff. Major General, Director General of NDGDM, 16 April 2019, registration no. 35001/874/2019).
[21] DMTC Civil Protection and Industrial Safety Section, 'Megújult KML képzés a Katasztrófavédelmi Oktatási Központban', *KOK Híradó* 16, no 1 (2020), 22–23.

Table 1

Table of the program structure

Source: Compiled by the author.

	Course title	Number of Classes			
		Theoretical	Theoretical Practice	Field Experience	Total
	I. Basics of Emergencies				
1.	The Role and Operation of HAZMAT Unit	2			2
2.	Construction and Equipment of the Vehicle	1	1		2
3.	Occupational Safety	1			1
4.	Management Skills	2			2
5.	Introduction to Psychology	1			1
6.	First Aid Knowledge	2		4	6
7.	Basics of News System		2	2	4
8.	Basics of Fire Protection	3			3
9.	Radiological Knowledge	4			4
10.	Basics of Chemistry	8			8
11.	Epidemiological Knowledge and Biological Detection	3	1		4
12.	Navigational Knowledge	2	2		4
13.	Hazardous Material Databases	1			1
	Total:	**30**	**6**	**6**	**42**
	II. Technical Asset Management				
14.	Chemical Detection and Equipment	3	1	4	8
15.	Radiological Detection, Radiation Measuring Devices	3		5	8
16.	Water Analytical Knowledge and Instruments	3		5	8
17.	Sampling and Sampling Equipment	1	1		2
18.	Meteorological Knowledge and Equipment	2	1	5	8
19.	Decontamination, Disinfection and Equipment	2		2	4
20.	Personal Protection	2	1	5	8
21.	ADR and Accessories	1	1		2
22.	Power Generation Operator Training	2		2	4
23.	Practice in parts	1	1	6	8
24.	Complex Practice (control session)	1		4	5
25.	Evaluation of complex practice		1		1
	Total:	**21**	**7**	**38**	**66**
	III. Practice in Handling Technical Equipment				
26.	Vulnerability of the Capital/County and Local Characteristics	2	4		6
27.	Power Generation Operator Training			8	8
28.	Use of Electrical, ADR and other Devices			2	2
29.	Use of Personal Protective Equipment			4	4
30.	Use of HAZMAT Equipment in Practice			12	12
31.	Intervention Experiences and Documents	3	3		6
	Total:	5	7	26	38
	Sum Total:	**56**	**21**	**69**	**146**

4.3. Table of the program structure

Table 1 above also represents the current structure of HAZMAT Units' vocational training in Hungary. There is a great emphasis on the practice-oriented approach, as well as on the fact that new trainees may have the chance to get familiar with the intervention experiences of the professional staff. External lecturers are also involved in aspects of guaranteeing certain special education, for example Radiological Knowledge is taught by Nuclear Emergency Response specialists. The practice mobile laboratory vehicle, which had been designed for educational purposes containing reduced equipment, also plays a major role in the preparation of the personnel. In addition to this, for the practical lessons of the module, the County Disaster Management Directorates also provide additional mobile laboratory vehicles. Hence, a sufficient number of machinery and other tools are available for the students to acquire knowledge and to carry out various partial or complete reconnaissance exercises. Part of the training is composed of complex practice involving a situational exercise similar to real deployments. In doing so, students have to solve a complex task in teams of 3. While accomplishing the task, the activities of the team are constantly controlled – helping them if necessary, and afterwards the evaluation is performed together. The aim is to provide both teachers and students with feedback on whether they have successfully mastered the skills, and explore those parts where practice is still needed. The complex practicing process also helps to prepare for the theoretical and practical parts of the final exam.

4.4. The structure of the final exam

The final exam, in the renewed curriculum also, consists of 3 main parts (written, oral and practical), which are carried out on two following days. On the first day, trainees fulfil the requirements of the theoretical part in written and oral forms. Students who successfully complete the requirements may take a practical exam on the second day. The practical exam involves a complex exercise by solving a situational task in groups of 3. Although individuals find solutions in groups, the committee judges the performance individually. For instance, the driver is responsible for installing the micro meteorological station, keeping in touch with the on-scene commander and county news services. Meanwhile, the commander directs reconnaissance, partially evaluates measurement data and advises the on-scene commander on possible civil protection measures. Certain chemicals cannot be extinguished with water or toxic gases may be formed during the extinguishing. The optional number of students participating in the training is no more than 15. The following photos were taken during the training.

Picture 5
HAZMAT training
Source: Molnár, HAZMAT training.

Picture 6
HAZMAT training
Source: Molnár, HAZMAT training.

Picture 7
HAZMAT training
Source: Molnár, HAZMAT training.

Picture 8
HAZMAT training
Source: Molnár, HAZMAT training.

As it has been pointed out in the evaluation of the previous section, instrumentation and mobility are worthless, if there are no masterfully trained handlers. Clearly, the structure of training becomes more complicated in parallel with the increasing opportunities and expectations set for HAZMAT Units. In addition, the vast majority of these individuals can only respond to a task with a delayed alert. Consequently, this does not form part of their primary tasks, therefore, multiple repeats of training are required. Furthermore, participants need to get to know the best field practice method via different competitions, considering that even after all these years the same tasks are implemented differently across the country. It may be affirmed that a well-trained management personnel is the key to success.

5. Certain examples of HAZMAT Unit deployments

The mobile laboratory can be alerted in case there is a circumstance indicating the presence or threat of a hazardous substance or suspected to be hazardous substance at the scene of the disaster; identification of unknown substances or taking protective measures for the population become necessary. MO, in the case of requiring the unit's special apparatus on the site. Standby service operates with territorial jurisdiction and authority. Nationwide, HAZMAT Units are alerted in 1,200–1,500 cases per year. The following diagram represents the distribution of each deployment type during the last 3 years (2018, 2019 and 2020).

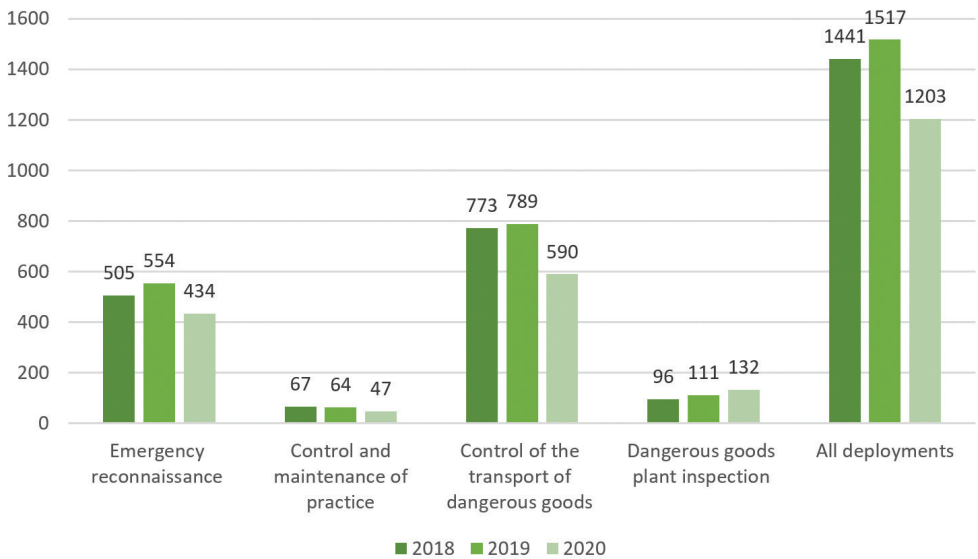

Figure 1

Deployment of HAZMAT Units in recent years

Source: Barbara Korbély Ff. Captain; data source: "Disaster Management Yearbook 2019" and data provision of the Department of Nuclear Accident Prevention NDGDM.

As the graph illustrates, emergency detections preferably account for only about a third of all interventions in a year. Every once in a while, there are a series of significant events or incidents in Hungary, at which the crucial importance of the professional work and assistance of HAZMAT Units is indispensable.

5.1. White Powder Packages

Following the terror attack in New York on 11 September 2001, suspicious packages containing white powder being sent in a package or envelope to famous people

happened to be frequently reported. This powder could have been the carrier of Bacillus anthracis, the bacteria that causes anthrax, as it happened before.[22] The number of 'white powder' cases in Hungary increased before the 2002 elections. Fortunately, there were no positive cases in Hungary, but the hundreds of cases per day significantly increased the number of ERT interventions (predecessor of today's HAZMAT Unit). For that reason all ERT colleagues were on duty (back then all counties, including the capital, were on standby), provided with engine and protective gear needed (gas mask, dust mask, disposable protective clothing, protective gloves, footwear protector, lockable smooth-locked bag, boxes). They were responsible for delivering the suspicious packages under safe conditions to the testing laboratories (Epidemiological Center). Due to the increased number of cases, rapid tests capable of identifying the pathogen of anthrax were procured, with which 'negative packages' could be filtered out in a short time. During the 2006 elections, 'white dust' cases also occurred, but fortunately in fewer numbers. Nowadays, in such 'white powder' or 'white dust' suspicious cases, the interveners work in cooperation with other defence bodies and organisations. Such cases must be handled according to special procedure order and professional briefings.[23]

5.2. The red sludge disaster

Hungary's most severe industrial ecological disaster occurred on 4 October 2010, when the western dyke of cassette X of the sludge reservoir on the site of the Hungarian Aluminium Production and Sales Plc (MAL) breached. Consequently, the mixture of approximately one million cubic meters of red sludge and alkaline water inundated, through the Torna Creek, the lower parts of the settlements Kolontár, Devecser and Somlóvásárhely. Ten people were killed during and after the sludge flow, 286 persons were hospitalised. The disaster in Devecser, Kolontár and Somlóvásárhely affected 358 residential properties, over a thousand hectares of arable land were contaminated. Even on 5 October, in the morning of the day following the disaster, red sludge was standing one meter high in Devecser. Schools, family care services and cultural centres were transformed into temporary shelters, so evacuees could be lodged. On 9 October complete evacuation was ordered in Kolontár, also the Government declared state of emergency in the areas of Veszprém, Győr-Moson-Sopron and Vas Counties. Following the disaster, a total of 106 firefighters and 24 fire engines and 6 Emergency Response Teams (ERT) from the immediately deployable disaster management and firefighter forces were alerted under the territorial Emergency and Rescue Plan. Later, measures were taken to merge 8 ERT into the area, their main task was the continuous sampling, monitoring and informing the population. The basic strategic goal of the water quality control efforts was to stop the pollution reaching the Danube River, since threatening the water source would have caused long-lasting damages. During the rescue duties, the removal of the contaminated sludge and its discharge at the landfill was continuously ensured by the response team.

[22] NDGDM National Industrial Safety Inspectorate press conference no. 1/2013 on the tasks of the HAZMAT Units related to the handling of 'white powder' packages, 12.09.2013.
[23] NDGDM supplementary guide no. 35000/2544/2018 to investigate 'white powder' events, 06.03.2018.

On 1 November, the serving ERT reported that the threads measuring the gap had broken. According to the surveyor assigned to the site in order to assess the situation, the dam rupture could have occurred at any time, so the monitoring of the dam movement with a measuring thread was discontinued and only visual observation was happening. The following day, the possibility of installing a 'building motion and vibration' monitoring system to permanently observe the possible movement was considered. Next week, the possibility of partial withdrawal of the emergency Response Team directed to Devecser was reviewed. The supervision of the damaged dam section was provided by the remaining 5 ERT until the installation of the prism monitoring system, which was put into operation on 1 December. Subsequently, the ERT was withdrawn. The following photographs were taken during the post-disaster work.

Picture 9
Monitoring of dam rupture
Source: Unknown author, 2010.

Picture 10
Red sludge disaster
Source: Unknown author, 2010.

Picture 11
Red sludge disaster
Source: Unknown author, 2010.

5.3. Hazardous waste disposal and storage facility fire in Királyszentistván

2019, in the afternoon of 10 August, a fire broke out at the regional waste management facility in Királyszentistván. The bale storage area behind the biological room, where a total of 9,966 bales (approximately 6,000 tons) were stored, was completely affected. The fire was accompanied by a strong smoke formation. The local response unit provided 52 hours of continuous service in two shifts. Complicating circumstances of firefighting and intervention were the prolonged usage and the long distances between the populated areas. The concentration of hazardous substances in the vicinity of the plant, as measured by the crew was above MAK value in several cases, which refers to the highest permitted rate. However, based on the values measured in populated areas, it was not justified to alert an additional HAZMAT unit to the site and the values measured outside the plant area also did not justify the introduction of population protection measures. The fire attracted considerable interest in the media and several public information requests were also received, therefore the measurement results were made available by the Veszprém County Disaster Management Directorate on its website. Duties and capabilities of the mobile laboratory vehicle were presented at the Veszprém County Disaster Management Directorate press conference. The following photographs were taken at the scene of the fire.

Picture 12
Monitoring of HAZMAT Unit
Source: Unknown author, 2019.

Picture 13
Fire in Királyszentistván
Source: Unknown author, 2019.

The field practice also shows the versatile requirements that have to be met by the operating personnel of the Hungarian HAZMAT Units. Generally, coping with the given challenge is due to the ingenuity of the engineers, which represents the importance of training.

6. Future directions

1. In the case of questions beyond the capabilities, measurement accuracy or technical capabilities of HAZMAT–ADR units, it may be necessary to develop a sampling capability that allows the group to collect environmental or chemical samples for analysis and identification under time-varying circumstances as a first intervention unit, or their contaminant content will be determined in a more sophisticated, specialised laboratory environment.

2. Several elements are already available to ensure the adequacy and closure of the entire sampling chain, for instance the built-in refrigerated sample storage system and certain manual sampling devices.

3. Providing the unit with sampling and storage devices capable of guaranteeing cross-contamination and closed, protected storability that allow the collection, safe storage, appropriate labelling and documentation of liquid or solid samples containing organic compounds, heavy metals or biological contaminants.

4. Implementation of this development program has already begun. The equipment is awaiting allocation. In addition, it is necessary to further train the personnel and develop sampling methodological recommendations for unplanned, risky or unknown sites.

After the study of operator training, it may be stated:

One of the key players in preventing major industrial accidents and mitigating potential damage is the fire department as the primary intervener, but at least as important would be another HAZMAT Unit capable of fast and efficient atomic, chemical, biological detection and reliable data provision.

The word 'would be' has a great significance because the current alarm system does not mean immediate alert in all places.

These organisations, with their current forces and tools, are able to carry out their related reconnaissance tasks in a fundamental way. Nevertheless, – based on my research, experience, consultations and practical training – in the near future, it will be necessary to develop them and prepare their personnel for industrial accidents in the interest of a more operative response.

The areas of development, from my standpoint, could be:

1. Coordination of means of communication with the cooperating and own forces, ensuring the adequacy of the information received in the event of an alert, both in terms of quantity and content.

2. It is recommended to assess the applicability of procedures and technical capabilities, the training and suitability of personnel, and to make practiced all segments of the human and technical sides for specific intervention.

3. As this has not been fully done so far, it is expedient to examine the impact of accident factors (heat and toxic effects, explosions, and so on) on the physical and mental coping capacity of the intervener personnel due to the risk of an accident.

4. It is necessary to analyse the efficiency of the application of HAZMAT Units in the event of an industrial accident, to adapt the adequacy of its existing equipment and its quantitative and qualitative addition to the outflow potential of the hazardous substance that can be predicted in the given plant, switch to the principle of local

and territorial protection, thus to provide them with fewer but more specialised instruments.

5. In parallel, it would be worthwhile to examine, as a possible model, the feasibility of micro-regional rescue stations based on municipal associations, which could provide the material, technical and human conditions for rapid intervention, just like the German, Austrian, Danish examples.

6. In any case, the personnel of existing civil protection organisations planned to contribute to the prevention of chemical accidents shall be reviewed in terms of their organisation, number, training and equipment. Furthermore, following the review, the designated personnel shall be made suitable for continuous work in the damaged area with appropriate training and personal protective equipment, as one of the lessons of the red mud disaster.

7. Conclusion

In conclusion, this research provides an overview of HAZMAT Units, in terms of applicability provided by technical tools. HAZMAT–ADR Units are able to perform detection and public protection functions in extremely hazardous environments. Their instrumentation supports the continuous monitoring of environmental conditions either in installed or mobile mode. Gas sensors in the vehicle can be used to monitor the extent and changes of environmental load by determining gas concentration in the vehicle's environment. They are able to set up a propagation model using their own measured weather and air movement data. Based on the data collected, the personnel makes a proposal to the rescue management team to take the necessary measures to protect the population, and to support the decisions made on possible containment or eviction with measurement data. They are able to determine unknown organic and inorganic gaseous, liquid or solid substances by manual or mobile measuring instruments. The units have acquired proficiency in the determination and identification of Raman active compounds, in the recognition and identification of up to three components of unknown liquids and solids, chemical products. Their water testing kit supports the recording of typical variable parameters of a given environment, the colorimetric and spectrophotometric determination of pH, conductivity, dissolved oxygen and various ions facilitating the rapid detection of water pollution phenomena. By reason of its manual and built-in elements and radiological equipment, the unit is capable of performing complex reconnaissance and is able to monitor continuously even on the move. An important part of the equipment is a rapid immunochromatographic test for the detection of the most characteristic biological agents in bio-terrorism, which is used for detecting the presence of microbes released into the environment in a short time frame. The range of personal protective equipment provides the suitability for secure detection, independent data collection and communication in locations exposed to biological hazards along with chemical risks. The three-person team are able to perform various types of hazardous material and danger detection tasks with appropriate cooperation in industrial and civilian environments, at the scene of an accident, or in unknown built-up and outdoor conditions. Following the interventions,

a HAZMAT Unit is able to provide decontamination for two reconnaissance personnel on site, to remove biological, chemical and radiological contamination, and to safely change protective clothing. The on-board devices allow digital, protected radio broadcasting, besides internet access, as an information base for the involvement of external experts providing on-site advice via video.

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Abbreviations

HAZMAT: hazardous materials and substances that may pose risk to health, property, or the environment
CBRN: Chemical, Biological, Radiological and Nuclear
IR detector: a sensing device that reacts to infrared radiation
IFV: the institute for disaster relief and public crisis management in the Netherlands (Instituut Fysieke Veiligheid)
AFAD: Ministry of the Interior, Disaster and Emergency Management Authority of Turkey (Afet ve Acil Durum Yönetimi Başkanlığı)
EMERCOM: Ministry of Russian Federation for Civil Defence, Emergencies and Elimination of Consequences of Natural Disasters
ADR: an international term referring to the European Agreement concerning the International Carriage of Dangerous Goods by Road
RID: an international term referring to the European Agreements Concerning the International Carriage of Dangerous Goods by Rail
ADN: an international term referring to the European Agreement concerning the international carriage of dangerous goods by inland waterway
MAK: maximum concentration of a chemical substance
ERT: Emergency Response Team