Kiss Béla

The National Nuclear Emergency Response System

With the appearance of nuclear weapons and peaceful utilization of nuclear energy, mankind faces a threat to its survival and to its living space. The author in this study presents the risk factors of pacific nuclear energy use in the light of nuclear accidents occurred up today. He describes the national and international nuclear emergency response systems and their legal background while also proposing measures and implementation strategies to enhance the efficiency of the Hungarian system.
Keywords: nuclear catastrophe, mobile laboratory, signalling system, NBC NRMS, disaster management exercise

Preface

The history of humanity has been marked by catastrophes often with significant amount of human casualties. Until the age of industrialization natural disasters such as earthquakes, floods, volcanic eruptions and wildfires wreaked the most havoc. But today owing to the advancement of society and the development of civilization (the presence of nuclear energy, the spread of dangerous industrial facilities and road transport of hazardous materials) civilization related disasters considering their magnitude and the number of causalities can be mentioned as major threats. “The often formulated criticism against fossil energy sources is the depletion of the resources. Of course this problem stands for the nuclear power plants too. In case of nuclear power plants the price of the uranium forms only a small part in the price of the electricity, but the availability, or rather the predictable long-term provision of raw materials is essential regarding to the future of the nuclear industry” [1]

However, these novel energy sources are potentially dangerous. Of all the man-made and technological types of disasters the greatest risk is posed by nuclear catastrophes owing to the exploitation of nuclear energy in modern history. The most serious disasters so far are the catastrophe of the Chernobyl nuclear power plant on the 26th April 1986 and the catastrophe of the Fukushima nuclear power plant on the 11th March 2011. In the light of this threat it is important to be prepared to prevent potential disasters and defend ourselves against them by having appropriate plans, task systems, resources and organizations in case a disaster occurs. Departments participating in disaster management tasks must be able to cooperate effectively, quickly and professionally, and have the required professional capability and technical background to execute their mission.

It is also necessary to provide decision-makers with information, analytic and evaluating systems, which are capable of providing the required data in the required time in the appropriate quality and quantity. In my study I would like to present the theoretical and practical background of nuclear emergency response systems with its national and international implementation.

Timeliness and reason for topic selection

Today approximately 430 nuclear power stations are in operation worldwide, which produce 2447 terawatts of electricity all together with an output of 351327 megawatts. From a Hungarian perspective it is important to keep in mind that there are nuclear power stations in Ukraine, the Czech Republic, Slovakia, Slovenia and Romania. Of these the greatest danger is posed by plants situated within 50 kilometres from the Hungarian border. However, the degree of the danger indicated in Chart 1 below depends significantly on the meteorological circumstances at the time of a possible catastrophe.

Nuclear Power Station	Length of the contaminated areas (kms)			
	A	B	C	D
NPS in Bohumice	< 5	20	110	300
NPS in Mohovce	–	31	74	150
NPS in Krsko	–	31	74	150

Chart 1: Radius of Projection zones [2]

However, nuclear and radiological threats are not only posed by nuclear power station accidents, space accidents (currently there are 30 satellites equipped with nuclear reactors, each with 300 years of life expectancy) and nuclear material transportation are also real risk factors, since nuclear pollution might also get into the air or the ground. Energy sector predictions forecast a rise in the number of nuclear power plants. "The deduced gross electricity need in our country, due to the economic advancement and to the requirement of international competitiveness will rise with a percentage of 1.9 annually until the year of 2020, which estimates 53–54 TWh to the end of the period. Due to the efficiency improvement which is related to the alteration in the engineering-technical part of the production and to the fuel combination, the net annual electricity need might rise more, with a percentage of 2–2.1. We expect that in the forthcoming decade electricity consumption in the summer period will rise more sharply than the average, so the growth of the peak time consumption can be around the percentage of 1.8." [3] Considering this prediction we can say that in the future we must focus on the prevention of man-made and technological disasters, especially on the nuclear emergency response system.

Nuclear accidents

The threat of nuclear disasters is an inherent part of nuclear energy use. The first catastrophe situation occurred in 1957 in the Windscale power station, where the graphite had been not warmed up by the regulations, as a consequence, the Wiggner effect evolved, i.e. the reactor overheated and the graphite ignited. The first attempt to extinguish the fire, in which they used carbon dioxide, proved to be unsuccessful, therefore experts decided to use water as an extinguisher. The filters within the reactor's 125 meters tall chimney filtered out the bulk of the radioactivity and the accident did not cause any serious natural disaster, and did not claim human casualties.

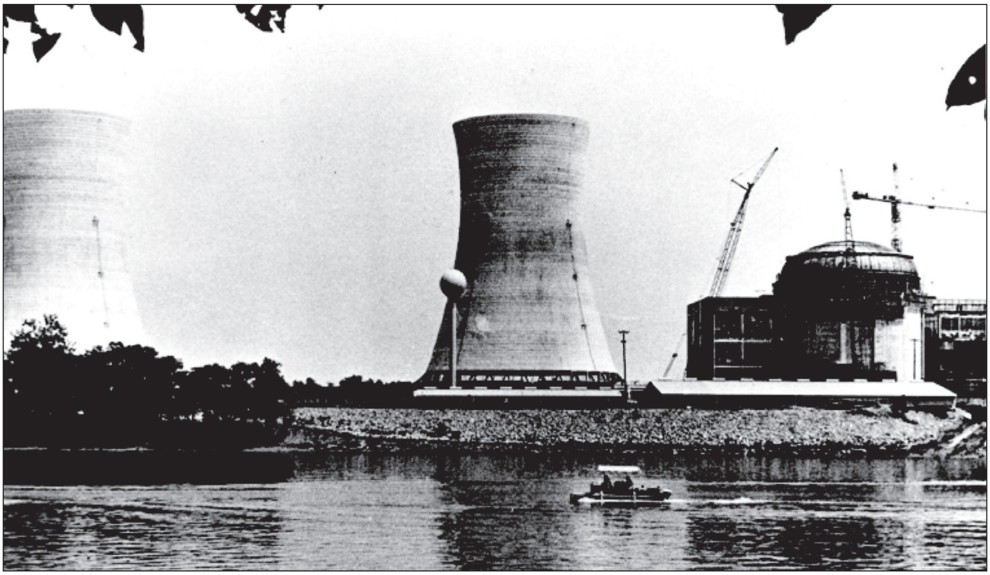

Image 1: Three Miles Island, 1970 [4]

Up to now the accident of the Three Mile Island Nuclear Power Station, shown in Image 1, (without any natural damages and human casualties, but several human failures) is known as the worst nuclear catastrophe in the USA. The line of occurrences came about on the 28th March 1979 and can be traced back to numerous construction and human errors. "Because of the misunderstanding of an irrelevant technical malfunction the operator reduced the water cooling system of the stagnant reactor, therefore it melted. Since a smaller Oxyhydrogen detonation occurred and it was feared that a larger Oxyhydrogen detonation might happen, the governor ordered the pregnant to be relocated. To examine the reasons President Carter sent a committee and he appointed János Kemény as chairman." [5] It is important to note that during the accident no significant amount of radioactive material got out to the environment.

The greatest nuclear catastrophe so far that will affect even the coming generations is the accident of the Chernobyl Nuclear Power Station. The accident occurred on the 26th April 1986 due to a poorly executed test run, in which the operators of the power station violated several safety regulations. Because of this and because of failures related to construction errors and the poor physical condition of the station, reactor four suffered a catastrophic power increase at 01:23 at dawn on the 26th April, i.e. the chain reaction became uncontrollable and unverifiable. Due to this process the heat output produced in the reactor bumped in a few seconds from the 7 percent of the nominal to the 10000 percent of the nominal (hundredfold).

The steam-explosion caused by the great output leap ripped open the tube-sheet of the cooling drains, and the hot water could flow onto the graphite moderators. It led to the increase of explosive gases and 2 seconds after the steam explosion another explosion occurred. The power of the 2 detonations can be described by the fact that the nearly 3000 tonnes pounder reactor cover above the cooling pipes elevated approximately 50 meters, it hit the reactor bay tearing up the roofing and turning it fell back into the reactor. [6]

As a direct consequence of the accident 3 men got killed, and in the next 3 months 28 persons died of acute radiation syndrome. In the years after the disaster the number of liquidators helping the clean-up was well under 800,000 (contrary to other claims). From the contaminated area 120,000 persons had to be relocated and rehoused to other settlements. Figure 1 below shows radiation exposure to the population of Europe in the first year after the accident in Chernobyl.

As part of damage control a concrete sarcophagus was built around the damaged 4th block of the nuclear power station and all the blocks were closed down. The serious medical, economic and social consequences of the catastrophe helped the progress of emission related pilot models.

Computer analysed data can show the spread and the transformation of toxic materials emitted into the atmosphere through the accident. Numerous such illustrations were prepared worldwide. [8]

On the 11th March 2011 in Fukushima Daiichi nuclear power station in Japan a serious line of malfunctions happened due to an earthquake in Tóhoku and the following tsunami. The basic reasons for the Fukushima accident can be traced back to constructional

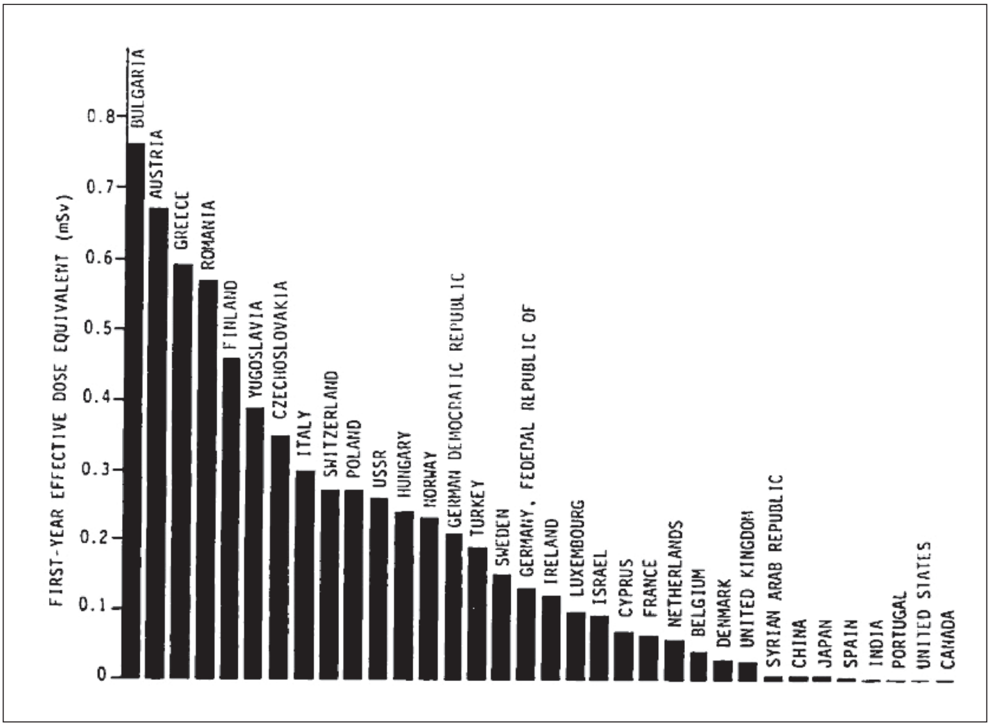

Figure 1: Country-wide average first-year committed effective dose equivalents from the Chernobyl accident [7]

inaccuracies. The tsunami dams were too low and the backup diesel generators were located on a lower floor, which was the main reason for the ablation; the abstraction of the residual heat was successfully done in the remaining reactors. Due to the earthquake the electric system collapsed in the northern part of Japan, thereby the electric supply to the power station ceased.

At this time the reactors were undamaged, because at the time of their design and construction the main goal was to construct statically earthquake secure buildings. After the black-out the diesel generators responsible for cooling the zones in case of a malfunction started to operate. But when the 15 meters high waves of the tsunami reached the power station's rampart (which was designed to withstand 6.5 meter waves) seawater inundated the diesel generators and the buildings ensuring their cooling. Through the accident complete zone ablation came up in 3 reactors, and 4 reactor cells damaged structurally. The incident was categorised as class 7 in the International Nuclear Event Scale.

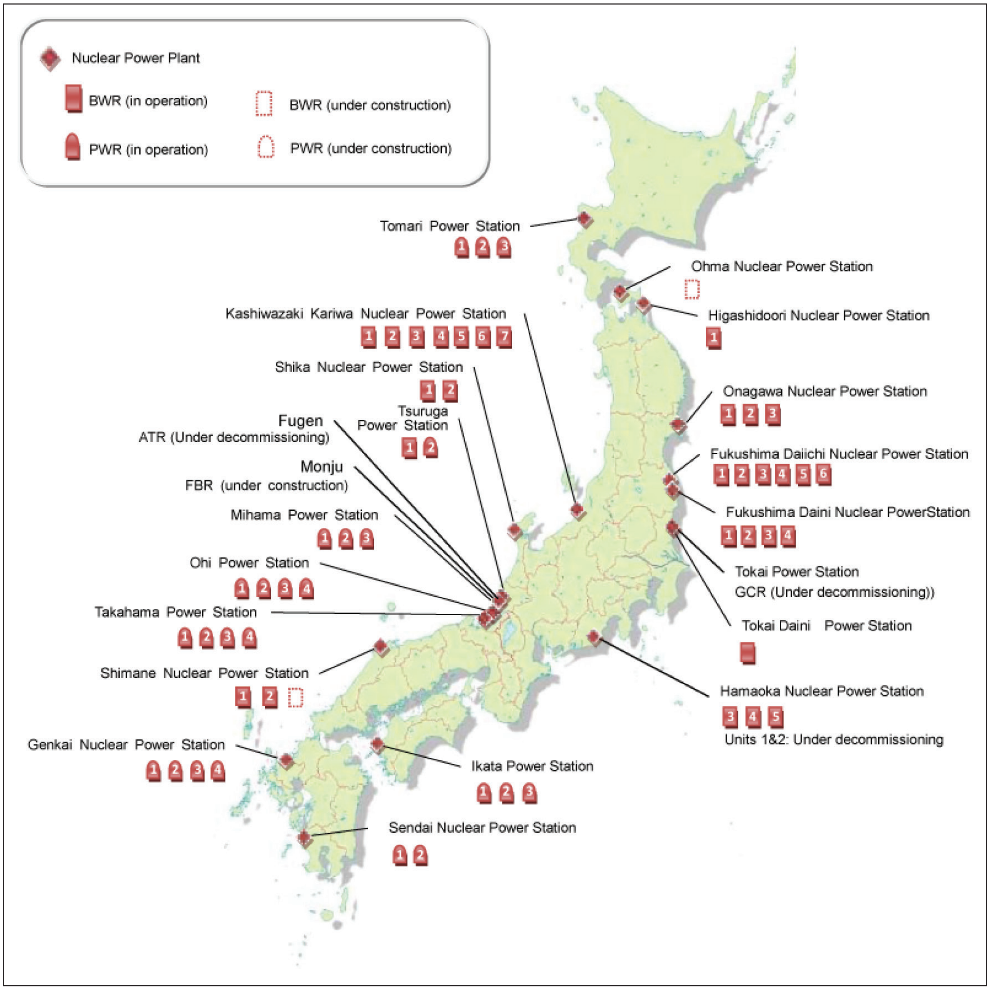

Figure 2: Nuclear Power Plants in Japan [9]

The impact of the Fukushima accident on human population and natural environment:

- rehousing in the 20 kms district of the accident;
- the I-13l content of the Tokyo tap water exceeded the limit suitable for children;
- radiation contaminated vegetables in Fukushima and in Ibaraki province;
- according to our current knowledge no health related problems is expected among the population.

However, the accident had political consequences: after the Fukushima emergency situation 92 percent of the population voted against nuclear energy at a referendum held in Italy. [10]

Hungarian National Nuclear Emergency Response System

Humans encounter radiation every day: visible radiation (ray), sensible radiation (thermal-radiation), and there are some types that cannot even be noticed. The natural background radiation in Hungary is between 50–180 nSv/hour, but its strength is greatly influenced by the meteorological (atmospheric pressure, precipitation) and geological (altitude) circumstances. The above mentioned accidents and the possible effects on human life and nature make it necessary to establish and operate a system to prevent nuclear accidents and in case of their occurrence to reduce the damages. In Hungary the National Nuclear Emergency Response System is responsible for fulfilling these tasks (henceforward NNERC). The primary operation of the system is on government level.

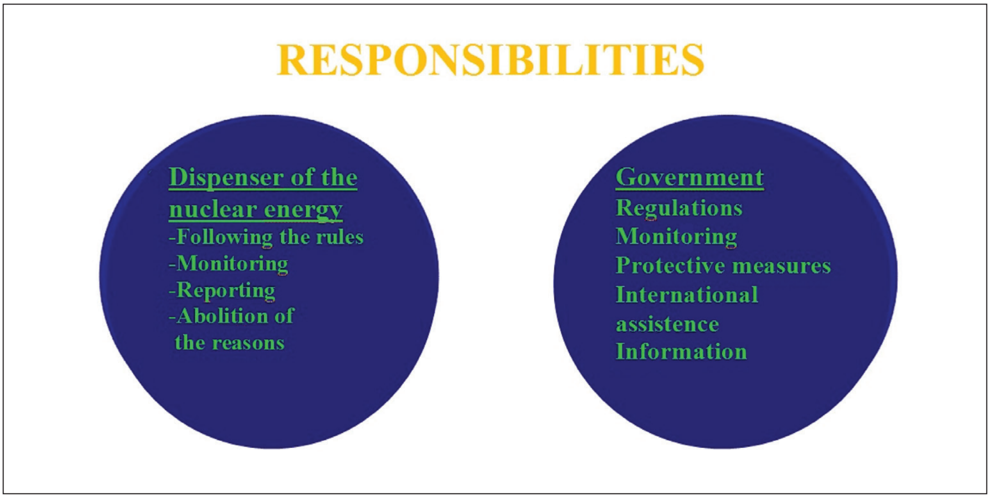

Figure 3: Distribution of responsibilities in the national nuclear emergency response system [11]

The structure of the national disaster management system, the ministers involved in the defence against catastrophes and the duties of state organisations involved in prevention, preparation and defence just as the tasks of the governmental disaster recovery coordination institute is regulated by the law CXXVIII.-2011. The structure and the tasks of the NNERC are controlled by Government Decree 167/2010 (V.11.). [12] The distribution of their responsibilities in Nuclear Emergency Prevention is shown in Figure 3.

On part of the government the Governmental Coordination Committee is handling the tasks, its objectives are as follows:

- controlling the accident reporting system;
- operating the National Radiation Monitoring, Signalling and Inspection System;
- actions apart from nuclear institutions;
- the regulation of an emergency prevention system.

National Radiation Monitoring, Signalling and Inspecting System

The National Radiation Monitoring System (henceforward: NRMS) monitors the spreading of radiant materials in the atmosphere of Hungary with 132 deployed measuring stations connected to a telemeter network as shown in Figure 4. The instruments of the stations make measurements every hour so it is possible to follow the dose output of radiant materials in the current atmosphere. The measured data gets processed in a central system, and when a particular limit (250nSv/hour) is exceeded a cautionary alarm is triggered. The NRMS measuring stations are connected to the measuring stations of the Hungarian Meteorological Service, Paks Nuclear Power Plant PLC, the Ministry of Agriculture (former Ministry of Environment and Water). The distribution of the measuring stations is as follows:

- 29 radiological telemetric measuring stations of the Hungarian Meteorological Service;
- 26 pcs National Disaster Management radiological telemetric net measuring station;
- 40 pcs Hungarian Defence Forces radiological telemetric net measuring station
- 20 pcs Paks Nuclear Power Plant PLC radiological telemetric net measuring station;
- 13 pcs Ministry of National Resources radiological telemetric net measuring station
- 4 pcs Public Limited Company for Radioactive Waste Management radiological telemetric net measuring station

In the territory of Hungary potential hazards are posed mainly by the Paks Nuclear Power Plant, and the nuclear power stations near the Slovakian border (Mohi /Mohovce/ and Apátszentmihály /Bohunyice/) and the Slovenian border (Kriskói /Krsko), as well as the research and educational reactors in Budapest. [13]

The control institution of the NRMS is the Nuclear Emergency Informational and Evaluating Centre in the Nuclear Prevention Department (henceforward NEIEC), which functions under the authority of the Ministry of Interior Hungarian National Organisation For Rescue Services (henceforward HUNOR), Department of Industrial Safety, Industrial Establishments Department from the 1st April 2012.

Mobile laboratories

Mobile laboratories control and collect the measurement data. Their primary objective is to detect contaminated areas and to define their border, while they verify the data obtained from the measuring stations of the NRMS and forward them to the decision making organisations. Various devices can be found in the mobile laboratory such as TVS-

Figure 4: Measuring stations of the NRMS [14]

3 ML VFCS, which is perfectly convenient to detect various industrial gases, toxic and dangerous materials, meteorological parameters and to measure radiation. Located on a stainless steel stand it is able to provide data continuously with high sensibility.

Image 2: TVS-3 ML VFCS [15]

The following organisations and institutions operate mobile laboratories in Hungary: Ministry of Interior, National Directorate for Disaster Management, Ministry of Defence – Hungarian Defence Forces, Hungarian Academy of Sciences Centre for Energy Research, Ministry of Human Resources – National Research Institute for Radiobiology and Radiohygine, MVM Paks Nuclear Power Plant, Ministry of Agriculture – National Food Chain Safety Office [16]. The design of the disaster management mobile laboratories in Hungary varies: in the centrally located areas up-to-date Mercedes Sprinters have been put to work, whilst in several counties Ford Transit vehicles, widespread in the 1990s, are still in use. The old vehicles are being replaced and on-board instruments updated. One of the main reasons for purchasing new vehicles was to deploy adequate Disaster Management Mobile Laboratories (henceforward DMML) in every county according to their relief and terrain features, i.e. they have to be capable of performing the required tasks, and therefore the vehicles need to be equipped with a smaller workstation. The above requirements greatly limited the choice of chassis. 2 types of DMML vehicles were constructed by the implementation of Gamma PLC; one was constructed using a Land Rover chassis, the other one using a Mercedes Vario chassis. [17]

Mobile laboratories are equipped with personal protective equipment against dangerous materials and decontamination kits.

Nuclear disaster prevention drills

National Nuclear Disaster Prevention Drills (shown on Image 3) are organized with the cooperation of various parties: Disaster Management, nuclear energy inspectorate, food chain safety inspectorate, public health, police and defence forces. During the practical drills the professionals simulate a nuclear accident occurring in Hungary. During the first phase of the drills the operational institutions and the decision-making procedures take the lead. At this level national and international communication is highly important. Afterwards active measures are taken, such as disaster management, radiological survey and decontamination. The Nuclear Disaster Prevention Drills are organized with attendance of the Hungarian professionals, the experts of the International Atomic Energy Agency and the experts from East-Central Europe. However, the low number of drills and incompatibility of the instruments used by the collaborators make the successful execution of the tasks impossible. The communication system with partner organizations is especially important.

At the time of international drills the knowledge of foreign languages is indispensable for a successful and effective international cooperation.

Image 3: International Nuclear Disaster Prevention Drill [18]

Nuclear Disaster Prevention System in international relation

The nuclear disaster prevention system in the United Kingdom is realized through plainly variable plans and on the integrated policy of disaster management. The legislation is the main task of the Civil Defence Corps' National Emergency Planning Department, which aims to increase the effectiveness of the national civil defence, the safety of the population against catastrophes and to enforce the principles of the government, related to civil defence. The tasks of the disaster management system are realized on 3 levels: on the operational, on the tactical and on the strategic. The police, the fire department, the departments of the National Health Service, the defence forces, volunteers and environment organizations all work towards achieving these tasks. The control procedures in case of foreign nuclear accidents belong to the Department for Environment, in case of a national nuclear accident it belongs to the Department of Trade and Industry. The National Radiation Protection Board is an advising organization established in 1970 by the Radiation Protection Act, and its primary task is to provide professional advice to the decision making and controlling boards.

Germany's nuclear disaster prevention system measures the radioactivity in the territory of the entire country; it was established by the Federal Environment Ministry, and is operated by the Federal Office for Radiation Protection. Since the nuclear power stations of the country are operated by private companies, the operating licences are granted by the federal state, and a special authority is responsible for preparing and enforcing rules and regulations for hazard prevention. Disaster management is within state jurisdiction, as laid down in the German Constitution. Its duties include disaster management, as well as the provision of nuclear supervision and radiation protection.

As a federal administrative task they monitor the execution and the fulfilment of the compulsory objectives laid down in the nuclear act and in other ordinances. In case of an accident the supervisory authority informs the state ministries and the Federal Environment Ministry about the condition of the facility and about the possible management of the accident. They cooperate with the interior organizations of the state, and they give advice to the regional disaster management authorities. [19]

NBC Warning and Reporting System

The early nuclear warning system is called Nuclear Biological and Chemical Warning and Reporting System (henceforward NBC WRS) and it is operated by the Hungarian Defence Forces and it is capable of achieving its tasks in normal and in emergency. The order of operations has three phases: normal, emergency and the phase of full preparedness. NBC WRS is controlled by the Hungarian Defence Forces Artúr Görgei NBC Information Center (henceforward HDF GA NBCIC). The role of NBC ANALYSIS programme in the military NBC evaluation is analogue to the role of RODOS (Real time Online Decision Support System) in disaster relief.

The aim of the programme is to execute predictions based on the information provided by automatic and conventional survey systems, related to NBC events, and to publish them, to introduce them into databases, or rather to alert and inform the related organizations. The evaluation publication recognized by the NATO is the ATP-45. It is fully orientated to the NATO NBC alerting and informing system, it makes it's danger calculations by the reference book called "Warning And Reporting And Hazard Prediction Of Chemical, Biological, Radiological And Nuclear Incidents" [20]

The capabilities of the HDF NBC WRS:

- Capable of defining the parameters of mass destruction weapon (henceforward MDW) and incendiary weapon attacks, as well as surveying and reporting on the evolved chemical, biological, radiological and fire situation, and capable of processing and evaluating data;
- capable of providing measured data about the change in the natural background radiation, and informing military, state and NATO leaders, and capable of making professional decisions;

- capable of executing the prescribed reports and alarms referred to NATO standardized agreements (henceforward STANAG) just as the ATP-45 and AEP-45 from 2013;
- capable of reporting and surveying chemical, biological, radiant emissions coming from strikes of conventional weapons, and other incidents too, and noticing, informing and alerting the compromised units.

The structure of the HDF NBC WRS:

- Base level:
  - NBC aerial and ground reconnaissance subunits,
  - automatic measuring stations,
  - mobile laboratories,
  - trained observers on company level.
- Professional evaluating organizations:
  - National NBC centre – HDF GA NBCIC,
  - Operational command posts - Centres
  - units (brigade, regiment) – NBC Sub-centre
  - subunits (battalion) – team, section

Base level organizations in the HDF NBC WRS:

- Sentinel posts and platoons on predetermined installations continuously measure the radiation level, the meteorology data on ground level, detecting the dangerous agents and the dangerous industrial materials.
- They transmit the measured data to the NBC sections.
- The parameters of the nuclear explosion are determinated by the operators of the sentinel posts.
- The task of the Automatic Measuring and Data Collecting System is to continuously measure the gamma loading dose, the meteorology data on ground level, the concentration of dangerous industrial materials in the air, furthermore to issue local and central alert in case of chemical or nuclear emergency.

The AMAR functions in normal period, Havaria laboratory, in an emergency situation, and the HDF GA NBCIC revolves with organizations assigned for disaster management, in the period of crisis management or in full preparedness. [21]

Summary

Terrorism and terrorist attacks have become permanent threats, therefore we have to take into account the spread of weapons of mass destruction and their deployment against the civil population. We cannot rule out the occurrence of a nuclear accident which might destroy buildings and disrupt public services while also exposing the population to radiation. Therefore every state, including Hungary needs to have a prevention and response system. [22]

The Hungarian nuclear emergency prevention system intends to avoid nuclear accidents and notice disturbances. The new Hungarian nuclear emergency prevention regulation treats the expectations of the nuclear institutions referred to their accident prevention readiness up-to-date and expansively, and at the same time it meets international standards. Partner organizations involved in disaster management are equipped with the relevant experience and necessary equipment to handle an incidental nuclear catastrophe. The 132 measuring stations operated within the framework of the National Nuclear Emergency Response System are able to alert the professionals at the right time in case the measured data differs from the background radiation. Thanks to the mobile laboratories data coming from a possibly contaminated area can be examined on the spot, and transmitted to the decision making organizations. The system's efficiency can be improved by increasing the number of drills in the National Nuclear Emergency Response System and by increasing the personnel's professional experience. Permanent task of the organizations referred is to unfold and survey the incidental defectiveness's of the system.

The efficiency of international exercises greatly depends on the personnel's foreign language knowledge. The benefit of international military exercises and the effective cooperation with professionals from other nations can be considerably increased by expanding the Hungarian staff's working knowledge of foreign languages. It is also essential to keep the Hungarian population informed and prepared about how to act in a possible foreign nuclear catastrophe situation. By doing so our homeland would acquire routine and would also set good example to neighbouring countries. First and foremost it is inevitable for all organizations taking part in the work of the National Nuclear Emergency Response System to use compatible instruments and equipment in order to cooperate successfully in disaster management. These are the most important tasks lying ahead. It seems that the defence organizations are ready for the challenges and significant developments are already underway.

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A hazai nukleárisbaleset-elhárítási rendszer

Kiss Béla

A nukleáris fegyverek és a nukleáris energia békés célú felhasználásának megjelenésével olyan kockázati tényezővel kell szembenéznie az emberiségnek, amely a teljes életterét és fennmaradásának jövőjét veszélyeztetheti. A szerző a cikkben bemutatja a békés célú nukleáris energia felhasználásának kockázati tényezőit az eddig bekövetkezett nukleáris balesetek tükrében. Ismerteti a hazai és külföldi nukleárisbaleset-elhárítási rendszereket, azok jogi szabályozását, működését. Javaslatot tesz a hazai rendszer hatékonyságának növelését célzó eljárásokra és azok megvalósítására.

Kulcsszavak: nukleáris katasztrófa, mobillaboratórium, jelző rendszer, ABV RIÉR, katasztrófavédelmi gyakorlat