MODELING INTERNATIONAL NUCLEAR CHEMICAL BIOLOGICAL DEFENCE FORCES IN CASE OF CHEMICAL WEAPONS APPLICATION FOR TERRORIST PURPOSES

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Summary:

Accelerated technical and technological development of civilisation during the twentieth and the beginning of the twenty-first century has fundamentally contributed to an uneven distribution of total world resources. Such distribution of resources has led to frequent armed conflicts which resulted in the use of both conventional weapons and those of mass destruction. Unlike conventional weapons, this kind of weapons possesses specific characteristics that make it very attractive for terrorist purposes. The best example for this is the terrorist attack in March 1995, when the ,,Aum Sinrikjo“ cult used sarin (toxic chemical from a lethal chemical weapons group) in the Tokio subway which resulted in 12 deaths and over 5,000 exposed to intoxication. This paper aims to present a model of using international nuclear chemical biological defence forces in case of the application of chemical weapons for terrorist purposes. Oppinions of CBRN experts were used for determining the criteria for the selection of a nuclear chemical biological defence forces model. The analytic hierarchy process (AHP) method was used to obtain optimal results. The obtained results can be used as a starting point for modeling nuclear chemical biological defence forces at international exercises with similar content.

Key words: *international forces, terrorism, CBRN units, weapons, nuclear, chemical.*

Introduction

Increasing disparities between rich and poor regions have created conditions for the application of the "asymmetrical method", where the fight against the rich uses everything available to individuals, organizations or countries. Terrorist groups are trying to procure and use weapons of mass destruction (WMDs). Events worldwide have brought terrorist attacks with WMDs into focus. There is hardly any global scientific, technical, political and economic gathering where new risks and threats to global and national securities are not a topic.

The danger of the use of WMDs for terrorist purposes is reflected in uncontrolled events in the form of explosions, fires, radiation, leakage and spillage of materials. Emergencies caused by using WMDs for terrorist purposes are unpredictable and can result in a large number of casualties, contaminated and injured. Also, material damage that can occur in these situations is not small. Fear and panic among the population can cause immediate collapse in traffic. These facts contribute to actualizing the problem of protection from the use of WMDs for terrorist purposes as well as a problem of an adequate response.

Chemical, biological, radiological and nuclear (CBRN) defense units, in most armies of the world, are intended for nuclear, chemical and biological (NCB) observation, radiological, chemical and biological (RCB) survey, laboratory analyses and RCB decontamination of sites targeted with WMDs in combat. In peace, in the event of the application of WMDs for terrorist purposes, these units would also have an important role in eliminating the consequences of the application of this weapon. Because more than one country could be affected by a terrorist act, an integrated approach of international CBRN forces to eliminating the consequences of WMDs usage becomes increasingly important. However, there are not enough data on how to model international CBRN defence forces in such situations.

This paper will analyze the use of international CBRN defence forces in eliminating the consequences of the chemical weapons application for terrorist purposes.

Presentation of chemical weapons usage for terrorist purposes

In the current conditions of global social changes and tendencies of treating terrorism as a global security problem, there is an increasing possibility of chemical terrorism, especially if it is taken into account that certain forms of chemical terrorism have already appeared. The USA Federal Agency for Emergency lists several reasons for this: the first - chemical agents are easier to produce than nuclear weapons or radioactive material, the second - 26 nations managed to develop chemical weapons, and another

12 are trying to do it, and the third - chemical agents are easier to transport and purchase. For the possibility of being used for terrorist purposes, chemical agents must have the following characteristics: they must be highly toxic by its unit weight, relatively resistant to various atmospheric conditions and possible to be mass-produced (Petković, 2009, pp.248-275).

Chemical means and toxic chemical agents may be used for terrorist purposes when terrorists carry out chemical contamination[1] of particular areas, the air, water or food, causing fear on a large scale.

A large number of toxic chemicals (TCs) when entering the human body manifest adverse effects, but not all are suitable for use in terrorist activities, because, after entering the body, chemicals must remain outside the sensory perception of the victim until the appearance of poisoning symptoms. General conditions to be met by TCs are their toxicity and favorable physicochemical properties, poor ability for detection and identification, and difficulty to provide first aid. A comparative review of the toxicity of some agents is shown in Table 1 (Lazarević, Radovanović, 2015).

Toxic chemicals from chemical weapons are an effective tool for terrorist purposes. Their advantages are that they can be used en masse, can cause rapid contamination of a large number of people and are easy to synthesize. The most important classes of highly toxic chemicals – poison gases are: nerve (sarin, soman, tabun, VX and F-poisons), Vesicant/Blister (sulfur and nitrogen mustard, lewisite), choking/pulmonary (phosgene and diphosgene) and incapacitating (psilocybin, mescaline, BZ, LSD 25) agents.

Table 1 – Comparative review of the toxicity of some agents
Таблица 1 – Сравнительный обзор токсичности некоторых соединений
Tabela 1 – Uporedni pregled toksičnosti nekih jedinjenja

Class of agent	Agent name	Origin	Dose (μg/kg)
Toxins	Botulinum toxin	bacteria	0.00003
	Tetanus toxin	bacteria	0.01
	Ricin	bacteria	0.02
	Diphtheria toxin	bacteria	0.2
	Koko toxin	frog	2.7
	Bufotoksin	frog	390
	Curare	plant	400
	Strychnine	plant	3000
Toxic chemicals	VX	synthetic	7.5
	Soman	synthetic	50
	Sarin	synthetic	63
	Tabun	synthetic	150
Incapacitating	LSD–25	synthetic	2
	ALD–52	synthetic	2
	BZ	synthetic	2.4
	DMHP	synthetic	60

[1] The term "chemical contamination" implies the presence of chemical agents in the form of droplets, vapors, fumes or gases in dangerous concentrations in a particular area, the air, the population, food and water or indoors.

For terrorist organizations, it is particularly important that chemicals are easily available and that they can be produced by simple chemical processes, known to every student of chemistry. This kind of terrorism can be performed not only with chemical war agents, but also with "ordinary" chemical compounds that are normally used in the production of chemical, petrochemical, pharmaceutical, oil and other industries. Pesticides, phosgene and chlorine were the chemical warfare agents of the First World War, and today there is a huge amount of these substances used in the chemical industry. In the so-called concealed terrorism, i.e. "Silent doing", chemicals are used or facilities damaged, which is subsequently declared as a chemical accident caused by human factor. Even poor terrorist organizations can easily obtain and use chemical weapons (Lazarević et al, 2003, pp.13-36).

Besides having several times higher efficiency than conventional weapons, they are impossible to be detected effectively and easily. Only a small number of TCs can be detected during their usage. Two of their properties, extremely convenient for terrorists, are their low purchase price and relative ease of purchase. "Chemical weapons proved their lethality even in the First World War, when millions of people were exposed to chemical weapons, among which there were even 90,000 victims" (OPCW, 1998).

It is characteristic of terrorists who are planning a chemical attack that they neither have help from outside nor there are authorities who can retain and prevent the execution of their terrorist activities. Religiously motivated sects, for example, are cut off from the outside world, and their leaders are charismatic and indisputable authorities. In 1986, a white racist Christian group known as „The Covenant, the Sword and the Arm of the Lord" (CSA), wanted to destroy the American administration and accelerate the return of the Messiah. Its members bought 30 gallons of cyanide in order to, according to the leader of the group Jim Ellison, poison the water supply in several major US cities, believing that God would direct death from cyanide only to selected individuals: non-Christians, Jews and black people in the capital. Although the desire for causing mass loss is one of the specific factors that may motivate terrorists to use chemical weapons as opposed to usual guns, hand grenades and explosive devices, there are other reasons for terrorists to apply chemical weapons (Willkinson, 1986).

Today it is easy to obtain chlorine, phosgene, and organophosphate toxic compounds which are used in agriculture. The lethal dose of this class poison is 10-50 times higher than the doses of toxic chemicals suitable for terrorist purposes and it amounts to 1.05 to 7 mg/kg, which for a man of 100 kg is about 0.4 grams. The third drawback is the safe use of TCs for the execution of terrorist acts. However, the level of technical complexity for the TC usage may be lower than, for example, the production of more complex explosive devices.

Chemical accidents usually occur in chemical industry plants due to technical and technological shortcomings and human factor, but also due to possible diversion and sabotage of various terrorist organizations. Examples of previous accidents at chemical plants indicate potential catastrophic consequences for people and the environment, and a profile of today's terrorists who do not hesitate to recur to mass destruction indicates that the risk of terrorist attacks on chemical plants is real. Many incidents in the last years indicate the need to fight against terrorism. In the former World Trade Center, a bomb was placed in February 1993, and sarin was placed in the Tokyo subway in March 1995. The statistics presented by an American state representative based on the data of the Federal Bureau of Investigation (FBI) shows that the number of terrorist acts has decreased in recent years, but the number of victims has been growing dramatically. During 1994, 321 acts of international terrorism were reported, out of which 66 were committed against the United States. A year earlier there were 431 terrorist actions, out of which 88 were against the United States, with 109 deaths and about 1,500 injured, which was the highest number in the previous five years. This fact indicates that terrorists use modern weapons and tactics during their actions. Terrorists are increasingly giving up bombings and turning towards the use of more efficient means (Petković, 2009, pp.248-275).

The most difficult terrorist attack in which a chemical weapon was used took place on 20th March 1995 in the Tokyo subway. The attack was launched in a primitive manner, so that eight plastic bags out of eleven prepared were so damaged during drilling with sharpened umbrellas that sarin (purity of only about 30%) largely evaporated. This was the main reason why the outcome was "only 12 dead" and more than 5,500 seriously injured people. Many of these people still suffer from permanent nerve damage.

Presentation of the effects of a terrorist attack on a chemical facility

Let us assume that a chemical accident occurred in a chemical industry building due to a terrorist attack (at a chlorine-alkale complex), where 30 tons of chlorine were spilled from an above-ground tank, under the following conditions:

- pouring into a concrete receiving vessel - a protective pool, without chemical interactions and absorption of chlorine,
- wind speed at a height of 2 m above the ground is 2 m/s,
- wind direction 270 ° - Western,
- vertical stability of the atmosphere: isotherm,
- terrain: urban area, mainly low buildings,
- relief: flat terrain, open.

The "HESPRO"[2] software package for the evaluation and chemical situation prognosis gives the results shown in Table 2 (Luković, et al, 2004).

Table 2 – Data on a designed terrorist attack on a chemical facility
Таблица 2 – Данные о смоделированном теракте на объекте химической промышленности
Tabela 2 – Podaci o modelovanom terorističkom napadu na objekat hemijske industrije

ACCIDENT DATA	
Time and date of accident	19:00 21.07.2015.
Hazardous substances	chlorine
Quantity	30 t
The average thickness of the puddles	1.5 m
HOTSPOT	
Radius	9.9 m
Surface of evaporation	14.5 m^2
Speed of evaporation	2921.8 g/s
Converted into the fume phase	5.89 t
Time of natural decontamination	02:18 (hour:min)
PRIMARY CLOUD	
Depth propagation / surface area	3.5 km/5 km^2
SECONDARY CLOUD	
Depth propagation / surface area	7 km/40.3 km^2
OBSERVED POINT	
Distance from the hotspot / direction	2.00 km/90° (E)
The time and date of arrival of the primary cloud	19:15 / 21.07.2015.
Weather facts	9.9 s
The concentration of fumes	9.85 g/m^3
Inhalation doses	97.03 g s/m^3 (2.7 toxic dose)
HAZARDOUS SUBSTANCE DATA	
Hazardous substances	chlorine
Molecular weight	71 g/mol
Boiling temperature	-34°C
HAZARDOUS SUBSTANCE DATA	
Vapour pressure at 20 °C	680000 Pa
Median lethal concentration	360 mg/m^3
Maximum permitted concentration	3 mg/m^3
Limit values of emission	0.1 mg/m^3

[2] "HESPRO" - a software package for a quick evaluation and prognosis of chemical situations at chemical accidents (in the process industry facilities or in the transport of dangerous goods). It exists in the units of the Serbia Armed Forces and in other institutions of the Republic of Serbia.

Median threshold toxic dose	36000 mg/m^3
Density at the liquid phase	1380 kg/m^3
Specific volume	0.34 m^3/kg
Converts into the vapor phase at 30 °C	22.5 %
WEATHER DATA	**19:00 21.07.2015.**
Wind (speed / direction)	2 m/s - 270° (3)
Temperature (2 m)	20°C
Vertical stability	Isotherm (neutral)

The obtained results are analyzed and the situation is assessed – the chemical situation is analysed.

The terrorist attack point is located approximately 2km to the west from the observed point, in a settlement with prevailing low buildings. The transportation infrastructure affects the propagation of TC vapor clouds, carrying them towards the observed point. The relative height difference compared to the observed point is small so it does not affect the propagation of clouds.

Meteorological conditions favourably influence the fume propagation. It takes TC vapor clouds 15 minutes and 20 seconds to get to the observed point, so that the personnel in the military facilities have enough time to take adequate protection measures, depending on the warning speed.

The local population has no shelter and the buildings are old so the windows do not have a required level of air-tightness. Since collective shelters are inadequate due to the conditions of the buildings, the local population is completely exposed, which causes the need for evacuation.

As the cloud approaches the observed point, and the buildings are not air-tight, evacuation is necessary. The population must be evacuated as soon as possible either to the north or to the south. The distance zone for the evacuation should be 10 km minimum from the accident spot, bearing in mind that the depth of propagation of the primary cloud is 3.5 km and that of the secondary cloud is 7 km. The evacuation can be carried out with or without vehicles, depending on the assessment, because the cloud reaches the observed point in 15 minutes and 20 seconds. It is safest to walk, but it is necessary for the population to gather as soon as possible and go towards the specified regions before the expiration of this time. The evacuation by vehicles will be difficult due to the increased frequency of traffic.

From the obtained results – the summary report, it can be concluded that chlorine produces a primary and a secondary cloud and that it takes 9.9 seconds of the inhalation of these vapors to receive 2.7 toxic doses at the observed point. The evacuation is necessary because the buildings are not adequate for protection.

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Local residents have enough time to organize the protection through timely evacuation to safe regions. During the contamination event, all regular activities in the city would be cancelled, except providing building security. After 2 hours and 18 minutes, which is the time of natural decontamination of 30 tons of chlorine, residents can go back to their homes.

This situation happens when there is no decontamination of the place were an accident occurred. Its decontamination reduces the risk and the likelihood that people will inhale the subsequent fumes; they will be exposed only to those fumes that evaporated prior to decontamination.

The analysis of the assessed chemical event shows that these amounts of chlorine form zones of high contamination through the effects of primary and secondary clouds. After the formation of the primary cloud, a considerable amount of chlorine in the liquid form remains in the protective pool, so it is necessary to take measures for the elimination of accident consequences, by refilling into the spare tank, by blocking the evaporation surface, by neutralizing hazardous materials, etc.

CBRN service units

CBRN service units are organizational units, formed, equipped and trained individually or as part of other defense units to successfully carry out tasks and special NBC protective measures and protection from nuclear and chemical accidents (Rutić, 2009).

The implementation of WMDs, their huge power of destruction, speed of manifesting effects, the scale and diversity of effects and consequences on people and material resources requires the organization of NBC protection commands, units and institutions of the Serbian Armed Forces in order to reduce losses and preserve their operational and functional capabilities. This important protection of the Army of Serbia includes general and special measures for the protection of human power, material goods and resources from nuclear, chemical and biological events as well as the reduction of their consequences. The NBC protection content is shown in Figure 1 (Rutić, Milošević, 2015, pp.443-455).

General NBC protection measures are implemented by all members of the Army of Serbia in accordance with the tasks and responsibilities in assigned missions. General measures are realized by reconnaissance, use of equipment for personal and collective protection, force maneuvering dosimetry control, organization of control and protection services, and decontamination.

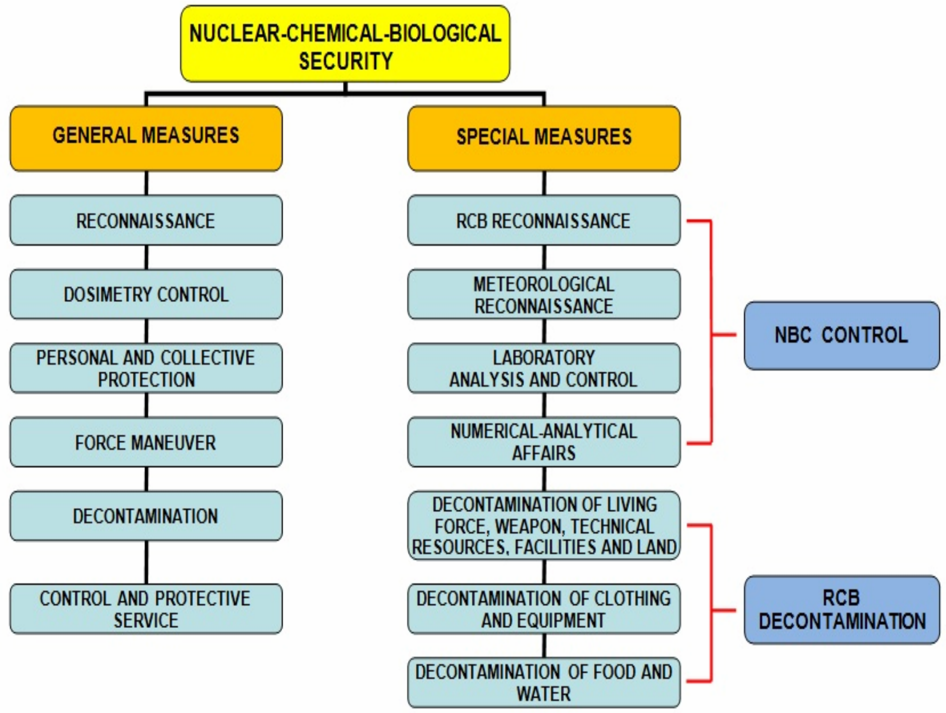


Figure 1 – Content of the CBRN protection measures
Рис. 1 – Список мероприятий по *РХБЗ*
Slika 1 – Sadržaji PNHB obezbeđenja

Special measures of NBC protection are carried out by specialized units and institutions of the Republic of Serbia. Special measures are carried out through nuclear-chemical-biological control and radiological-chemical-biological decontamination.

The CBRN service units of the armed forces of foreign countries are mainly designed for the realization of the same tasks as the SAF units. Units capabilities are directly related to the organizational structure and modern equipment for NBC protection, detection and identification of TCs and toxic industrial chemicals, detection and dosimetry of ionizing radiation, RCB decontamination and means and equipment for the purposes of carrying out laboratory testings and controls.

A comparative display of CBRN service units of foreign countries and the SAF, through the prism of means for RCB reconnaissance and protection, laboratory work and biological decontamination, is given in Table 3 (Indjić, 2014.).

In the analyzed countries, there are mostly CBRN service units at the rank of battalions with a similar organizational and formation structure.

Table 3 – Comparative display of the CBRN service units of the armed forces of foreign countries and those of the SAF
Таблица 3 – Сравнительный обзор отечественных и иностранных взводов *РХБЗ*
Tabela 3 – Uporedni prikaz jedinica ABH službe VS i stranih zemalja

RCB reconnaissance and protection means	Means for laboratory work	RCB decontamination means
1. Republic of Serbia		
Vehicle for RCB reccee: AR 55 RC without an NBC protection system. C detectors: CD M11B, ACD. Protection means: PO M-5, PM M-3, PG M-4.	Mobile laboratory LH M-3U, very modest capabilities.	Automobil tank for decontamination M-78: - Dc personnel – 192/h - Dc vehicle – 6 до 10/h - Dc route– 12000 m^2
2. Republic of Austria		
Vehicle for RCB reccee: „DINGO“ with complete NBC protection and IC sensors for reccee. C detectors: CAM, Drager, RAID. Protection means: similar as in the SAF.	The „DINGO“ vehicle contains: gas chromatograph, ionization and mass spectrometer, which determine DCM in a very short time. Information is instantly available.	Decontamination vehicle „ÖAF S-LKW“: - Dc personnel– 42/h - Dc vehicle – 4 до 8/h - Dc route– 2000 m^2
3. Republic of Slovenia		
Vehicle for RCB reccee: „SKOV HC 400“ with complete NBC protection. C detectors: CAM, RAID. Protection means: protective suits SARATOGA, other similar as in the SAF.	Mobile laboratory „PJRKBALAB“ with modern means for CBRN analyses, connected with the NRC alert system.	Decontamination system „Sanijet“ on m/v TAM: - Dc personnel– 60/h - Dc vehicle – 6-12/h - Dc route– 12000 m^2
4. Republic of Latvia		
Vehicle for RCB reccee: „PATRIA“ with complete NBC protection. C detectors: CAM, Drager, SVG2. Protection means: protective suits „Seintex“ and „Zodiac“.	Similar characteristics as in the SAF.	Device for group Dc – „PSDS-10“ and decontamination system „TS5/S“: - Dc personnel– 100/h - Dc vehicle – 10/h - Dc route– 1000 m^2
5. Republic of Italy		
Vehicle for RCB reccee: „VBR - NBC“ with complete NBC protection. C detectors: CAM, Drager, Toxi Rae. Protection means: „Drager“ for full protection from DCM.	Mobile system "GC-MS" for quick CBRN analyses, connected with the alert system. Automobile lab "Cyclone" for complete analyses of DCM in the field.	Decontamination system „Sanijet c.921“ on m/v IVECO: - Dc personnel– 50/h - Dc vehicle – 10/h - Dc route– 15000 m^2

The analysis of the CBRN service units in the Serbian Armed Forces and those from other countries leads to the conclusion that they have similar organizational structures (CBRN service battalions), but the considered foreign armies are better equipped with modern means for RCB reconnaissance and protection, RCB decontamination and laboratory analyses (except a small number of means for protection and decontamination).

Capabilities of CBRN service units

The SAF CBRN service units can remove consequences of chemical weapons usage for terrorist purposes through chemical reconnaissance, chemical decontamination and chemical analysis and control. The multinational exercise "Balkan response 2015" was carried out in 2015 at the CBRN centre (Krusevac) with a topic: "Rescue action in terms of contamination caused by terrorism action using weapons of mass destruction and accidents." The exercise aimed at presenting the training level and a model of joint reaction of civil and military structures in the prevention and elimination of radiological and chemical contamination due to effects of terrorism and WMDs accidents.

One of the aims was the improvement of interoperability, mutual understanding and training of NBC members from the countries in the region at the tactical level, governmental and non-governmental organizations and the Organization for the Prohibition of Chemical Weapons (OPCW) in a joint action for elimination of radiological and chemical contamination consequences, caused by the effects of terrorism and WMDs accidents.

At the exercise there were:

- members of CBRN service units of the armed forces of the Republic of Slovenia, Bosnia and Herzegovina, Montenegro, the Republic of Macedonia and the Republic of Austria,
- OPCW,
- representatives of the Republic of Serbia – members of Serbian Military Medical Academy, 246th CBRN Battalion, Training Command, CBRN Centre, Ministry of Internal Affairs Special Anti-Terrorist Unit, Police Department Krusevac, Ministry of Internal Affairs National Crime Technical Centre, Fire-rescue units, Department for Emergency Situations specialized units of Civil RCB Protection in Krusevac, Krusevac General hospital and the Red Cross of the Republic of Serbia. The exercise was attended by numerous observers from home and abroad.

The exercise was carried out as a representation of the reaction of civil-military structures through 31 suppositions, which was planed by the List of major events and suppositions. The realised activities focused on the removal of terrorist attacks effects on the chemical industry facilities (chemical contamination of workers and the population, extensive damage). Another practiced scenario concerned the removal of consenquences caused by a terrorist "dirty bomb" and toxic chemicals, after which the OPCW carried out an investigation in the case of the alleged use of weapons of mass destruction.

The exercise was based on practicing work and coordination of all relevant institutions in the Republic of Serbia, which are included in a response to the crisis caused by the use of WMDs, with a special emphasis on the combined risk (chemical and radiological accident due to a terrorist act), large potential consequences for the population, material resources and the environment.

A survey of the organizational structure and equipment of CBRN units of the armed forces of the countries participating in the exercise "Balkan response 2015" points to certain differences which have a decisive impact on their overall capabilities while removing the consequences of a terrorist attack on the chemical industry facilities. The comparative capabilities of the CBRN units of the armed forces of the countries participating in the exercise "Balkan response 2015" are shown in Table 4.

Table 4 – CBRN units capabilities – participants of the „Balkan response 2015“ exercise
Таблица 4 – Возможности взводов *РХБЗ* – участников учений «Балканский ответ 2015»
Tabela 4 – Mogućnosti jedinica ABHO oružanih snaga zemalja učesnica vežbe „Balkanski odgovor 2015”

Engaging possibility	**Type of engagement**	**SAF**	**Slovenian Army**	**Macedonian Army**	**Army of BiH**	**Military of Montenegro**
Chemical reconnaissance	Detection	+	+	+	+	+
	Identification	+	+	+	+	+
	Remote reconnaissance	-	+	-	-	-
Sampling	Operational	+	+	+	+	+
	Forensic	-	+	-	-	-
Chemical decontamination	People	+	+	+	+	+
	The wounded and the sick	-	+	+	-	-
	Aircraft	-	+	-	-	-
	Vehicles and equipment	+	+	+	+	+
	Electronic instruments	-	+	-	-	-
	Land and buildings	+	+	+	+	+
Chemical identification	Spectrometric methods	-	+	-	-	-
	Classical chemical methods	+	+	+	+	+

International CBRN units model for a removal of chemical weapons consequences

In case that chemical weapons used for terrorist purposes cause chemical contamination of several countries (mainly bordering areas) or in case one country cannot solve this problem alone, international CBRN units can be involved for consequences removal (on request and in compliance with international agreements).

In order to realize the tasks of removing consequences, various CBRN international forces (CBRN IF) may be engaged. A decision-maker responsible for accident relief must choose adequate CBRN units out of existing alternatives in order to use the best possible solution (Inđić, et al, 2014, pp.23-41).

The paper discusses the employment of various CBRN units (for RCB reconnaissance, RCB decontamination and laboratory work), as well as temporary units (forces formed to implement a specific task and then to return to their original units). The resulting consequences, time and other parameters when using CW for terrorist purposes also influence the way of organizing CBRN IF.

The problem of selecting CBRN IF for removing CW consequences is defined as follows:

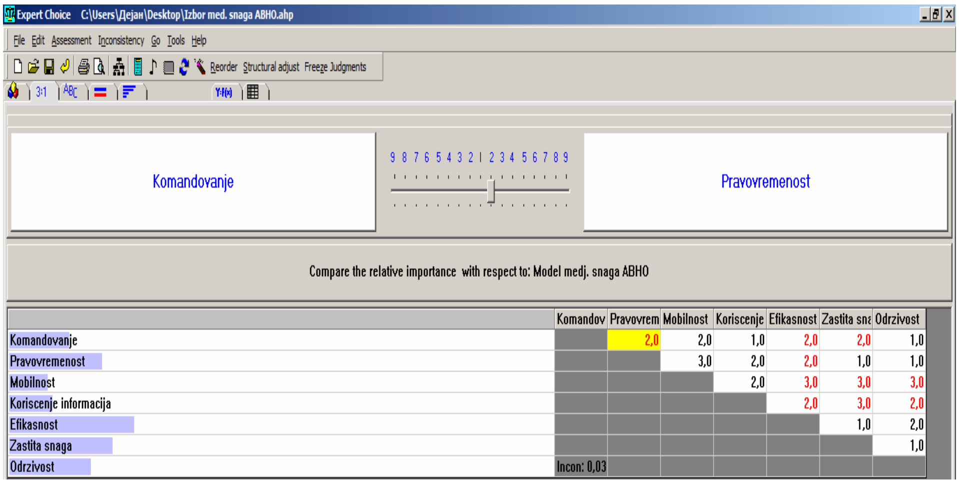
Level 1: choice of CBRN international forces (decision)

Level 2: attributes (decision criteria) are defined through the operational capabilities of forces:

- A1 - Leadership;
- A2 - Timeliness;
- A3 - Mobility;
- A4 - Use of information;
- A5 - Efficiency;
- A6 - Force protection, and
- A7 - Sustainability.

Then the attribute importance can be provided at the second level through the following matrix, Table 5:

Table 5 – Comparison of the attributes at the second level
Таблица 5 – Сравнение атрибутов на втором уровне
Tabela 5 – Upoređenje atributa na drugom nivou



	Komandov	Pravovrem	Mobilnost	Koriscenje	Efikasnost	Zastita sna	Odrzivost
Komandovanje		2,0	2,0	1,0	2,0	2,0	1,0
Pravovremenost			3,0	2,0	2,0	1,0	1,0
Mobilnost				2,0	3,0	3,0	3,0
Koriscenje informacija					2,0	3,0	2,0
Efikasnost						1,0	2,0
Zastita snaga							1,0
Odrzivost	Incon: 0,03						

where the index of inconsistencies is $CR = 0.03 \leq 0.10$.

Level 3: attributes (alternatives) are defined as:

- B_1 - CBRN IF 1 (one RCB reccee section; three RCB decontamination sections and one RCB laboratory section);
- B_2 - CBRN IF 2 (two RCB reccee sections; two RCB decontamination sections and one RCB laboratory section);
- B_3 - CBRN IF 3 (one RCB reccee section; two RCB decontamination sections decontamination and two RCB laboratory sections).

After entering the criteria for the selection of the CBRN IF into the programming package "Expert Choice", the results shown in Figure 2 are obtained. It can be seen that, in the selection of CBRN IF, a dominant criterion is power efficiency (0.228), which is understandable considering the type of WMDs applied (chemical weapons). It is followed by force protection (0.194), timeliness (0.168) and the force sustainability (0.153), which is also to be expected, taking into account the danger forces are exposed to during the removal of consequences incurred by CW. After that comes command (0.107), use of information (0.077) and mobility (0.073), which have a certain influence in solving this problem, but to a lesser extent compared to the previously mentioned criteria.

Of course, the extent of the consequences given in Table 2 must be considered and implemented when making a selection of alternatives in relation to the offered criteria.

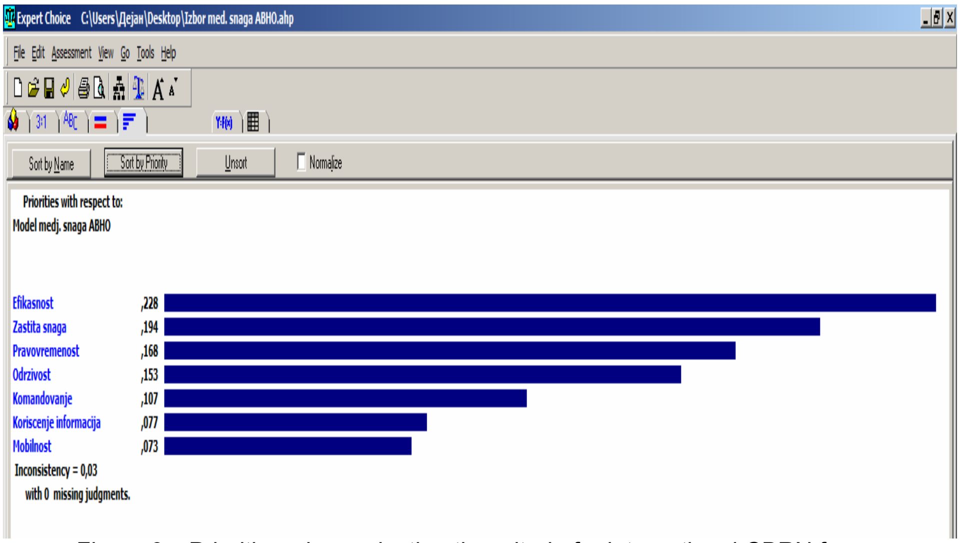


Figure 2 – Priorities when selecting the criteria for international CBRN forces
Рис. 2 – Приоритеты при выборе критериев международных войск РХБЗ
Slika 2 – Prioritet prilikom izbora kriterijuma međunarodnih snaga ABHO

The corresponding matrices of comparing the alternatives from the third level for each attribute and their priorities are presented from Table 6 to Table 12:

Table 6 – Matrix of the relevant importance of alternatives to attribute A_1 (Leadership)
Таблица 6 – Матрица релевантной значимости альтернатив по отношению к атрибуту A_1 (Командование)
Tabela 6 – Matrica relevantne važnosti alternative u odnosu na atribut A_1 (komandovanje)

	B_1	B_2	B_3	Weight
B_1	1	5	3	0.109
B_2	1/5	1	2	0.582
B_3	1/3	1/2	1	0.309

where is: $CR = 0.00352 \leq 0.10$.

Table 7 – Matrix of the relevant importance of alternatives in relation to attribute A_2 (Timeliness)
Таблица 7 – Матрица релевантной значимости альтернатив по отношению к атрибуту A_2 (Своевременность)
Tabela 7 – Matrica relevantne važnosti alternative u odnosu na atribut A_2 (Pravovremenost)

	B_1	B_2	B_3	Weight
B_1	1	3	2	0.169
B_2	1/3	1	1	0.443
B_3	1/2	1	1	0.387

where is: $CR = 0.02 \leq 0.10$.

Table 8 – Matrix of the relevant importance of alternatives in relation to attribute A_3 (Mobility)
Таблица 8 – Матрица релевантной значимости альтернатив по отношению к атрибуту A_3 (Мобильность)
Tabela 8 – Matrica relevantne važnosti alternative u odnosu na atribut A_3 (mobilnost)

	B_1	B_2	B_3	Weight
B_1	1	3	1/2	0.163
B_2	1/3	1	2	0.540
B_3	2	1/2	1	0.297

where is: $CR = 0.00877 \leq 0.10$.

Table 9 – Matrix of the relevant importance of alternatives in relation to attribute A_4 (Use of information)
Таблица 9 – Матрица релевантной значимости альтернатив по отношению к атрибуту A_4 (Использование данных)
Tabela 9 – Matrica relevantne važnosti alternative u odnosu na atribut A_4 (korišćenje informacija)

	B_1	B_2	B_3	Weight
B_1	1	4	3	0.122
B_2	1/4	1	2	0.558
B_3	1/3	1/2	1	0.320

where is: $CR = 0.02 \leq 0.10$

Table 10 – Matrix of the relevant importance of alternatives in relation to attribute A_5 (Effectiveness)
Таблица 10 – Матрица релевантной значимости альтернатив по отношению к атрибуту A_5 (Эффективность)
Tabela 10 – Matrica relevantne važnosti alternative u odnosu na atribut A_5 (efikasnost)

	B_1	B_2	B_3	Weight
B_1	1	4	3	0.126
B_2	1/4	1	1	0.458
B_3	1/3	1	1	0.416

where is: $CR = 0.00877 \leq 0.10$.

Table 11 – Matrix of the relevant importance of alternatives in relation to attribute A_6 (Force Protection)
Таблица 11 – Матрица релевантной значимости альтернатив по отношению к атрибуту A_6 (Защита войск)
Tabela 11 – Matrica relevantne važnosti alternative u odnosu na atribut A_6 (zaštita snaga)

	B_1	B_2	B_3	Weight
B_1	1	3	1	0.210
B_2	1/3	1	2	0.550
B_3	1	1/2	1	0.240

where is: $CR = 0.02 \leq 0.10$.

Table 12 – Matrix of the relevant importance of alternatives in relation to attribute A_7 (Sustainability)
Таблица 12 – Матрица релевантной значимости альтернатив по отношению к атрибуту A_7 (Устойчивость)
Tabela 12 – Matrica relevantne važnosti alternative u odnosu na atribut A_7 (održivost)

	B_1	B_2	B_3	Weight
B_1	1	5	4	0.100
B_2	1/5	1	1	0.466
B_3	1/4	1	1	0.433

where is: $CR = 0.00527 \leq 0.10$.

The process ends with the synthesis of the problem of choosing CBRN IF for the removal of consequences caused by the use of CWs for terrorist purposes. All given alternatives are multiplied by the weights of individual decision-making criteria, and the results are summarized thus giving the optimal alternative. In this case, it is the alternative B2 – CBRN IF 2 (0.496), followed by B3 (0.358) and B1 (0.145). The final procedure of applying the AHP method and the software package "Expert Choice" is shown in Table 13 and in Figure 3.

Table 13 – Synthesized table for the selection of the optimal alternative
Таблица 13 – Сводная таблица выбора оптимальных альтернатив
Tabela 13 – Sintezna tabela za izbor optimalne alternative

Criteria	Criteria weight	B_1	Weight x B_1	B_2	Weight x B_2	B_3	Weight x B_3
A_1	0.107	0.109	0.012	0.582	0.062	0.309	0.033
A_2	0.168	0.169	0.028	0.443	0.073	0.387	0.065
A_3	0.073	0.163	0.011	0.540	0.039	0.297	0.022
A_4	0.077	0.122	0.009	0.558	0.042	0.320	0.025
A_5	0.228	0.126	0.029	0.458	0.104	0.416	0.095
A_6	0.194	0.210	0.041	0.550	0.106	0.240	0.047
A_7	0.153	0.100	0.015	0.466	0.070	0.433	0.066
			0.145		**0.496**		**0.358**

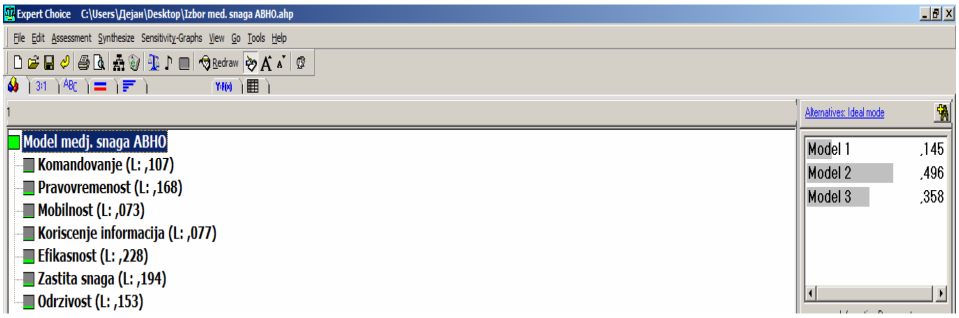


Figure 3 – Priority during the selection of a model of international CBRN forces
Рис. 3 – Приоритеты при выборе моделей международных войск РХБЗ
Slika 3 – Prioritet prilikom izbora modela međunarodnih snaga ABHO

On the basis of the selected model of CBRN IF (model 2) which would be engaged in solving the problem of the removal of consequences caused by the use of CWs for terrorist purposes, further activities would be implemented as follows:

– selected CBRN forces go to the place targeted by CWs as a part of the forces that carry out the removal of consequences,

– forces carry out chemical reconnaissance tasks on the place targeted by CWs (area of CW usage, access routes, chemical contamination marking, sampling, etc.),

– taken contaminated samples are analysed and based on that, the need for further engagement of the forces is determined, and

– if necessary, chemical decontamination of the place targeted by CWs is performed (primarily people, vehicles and structures, and then, if necessary, communication routes with the emphasis on the one for evacuation).

This paper does not specially consider time required to engage CBRN IF in the implementation of these tasks, because it is defined by the international standards of CBRN units (in this case, adequate equipment and force capabilities do not come into question).

Conclusion

As one of huge plagues of the twenty-first century, terrorism imposes a need for fast operation of the international community in its "eradication". Unfortunately, we are witnessing large-scale consequences terrorist acts may cause.

The paper presents a possible situation of chemical weapons application for terrorist purposes, its consequences and a way of creating international CBRN units for solving the problem. The engagement of international units is determined by the United Nations Charter, international agreements or other documents, but the time of their engagement can be a specific problem.

Of course, the paper starts from the fact that the engagement of CBRN IFs has all the necessary preconditions.

When solving the problem of the removal of consequences caused by CW usage for terrorist purposes, criteria for selecting international CBRN units (their operational capabilities) were determined first, and based on that alternatives (three unit models) were offered. After that, the analytic hierarchy process method was applied to find the optimal problem solution. The authors took the criteria values from CBRN experts engaged in the multinational exercise „Balkan response 2015“.

A precise implementation of the AHP method gave the following order of alternatives in the CBRN IF model:

- B_2 (second alternative) – 0.496 (first in rank),
- B_3 (third alternative) – 0.358 (second in rank),
- B_1 (first alternative) – 0.177 (third in rank).

From this, it can be concluded that the second alternative has the highest value (0.496), which is why it is the best (the most applicable). This option, model CBRN IF 2, presents a combination of two CBRN reccee sections, two CBRN decontamination sections and one CBRN laboratory section. It is the most applicable model for the created situation, since, due to short time of natural decontamination (approximately 2.5 hours), the foxus is on chemical reconnaissance and the laboratory analysis of samples. Decontamination is carried out to the necessary extent and in order of priority: personnel, equipment and materials, followed by evacuation routes.

The third alternative, model CBRN IF 3, which presents a combination of one RCB reconnaissance section, two RCB decontamination sections and two laboratory sections, has a value of 0.358 and is not far behind in comparison to the previous one. In it, the focus was on a quick analysis of the contaminated samples.

The first alternative, model CBRN IF 1, which presents a combination of one RCB reconnaissance section, three RCB decontamination sections and one laboratory section, has the lowest value 0.177 and is far behind compared to the previous two. This is understandable when taken into account that in this variant the focus was given to RCB decontamination which is not a dominant measure in the modeled situation.

It can be concluded that the engagement of international CBRN units for solving problems of chemical wepons use for terrorist purposes is possible and justified; there are, however, certain limitations that must be taken into consideration when deciding upon the engagement of these units.

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МОДЕЛИРОВАНИЕ МЕЖДУНАРОДНЫХ ВОЙСК РАДИАЦИОННОЙ, ХИМИЧЕСКОЙ И БИОЛОГИЧЕСКОЙ ЗАЩИТЫ ПРИ ПРИМЕНЕНИИ ХИМИЧЕСКОГО ОРУЖИЯ В ТЕРРОРИСТИЧЕСКИХ ЦЕЛЯХ

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Резюме:

Ускоренное технологическое развитие человеческой цивилизации двадцатого и начала двадцать первого века существенно повлияло на неравномерное ипользование мировых ресурсов. Такое распределение ресурсов способствовало разгоранию вооруженных конфликтов, в ходе которых используется, как конвенциональное оружие, так и оружие массового поражения. В отличии от конвенционального оружия, оружие массового поражения обладает уникальными характеристиками, подходящими для использования в террористических целях. Ярким примером применения оружия массового поражения является теракт в токийском метрополитене 1995 года, организованного сектой «Аум Синрике», последователи которой распылили газ зарин (фосфорорганическое отравляющее вещество, *причисленное к группе смертоносного химического оружия). В результате газовой атаки погибло 12 человек, а 5000 человек получили отравление различной степени тяжести. В данной работе представлен обзор моделей применения международных войск радиационной, химической и биологической защиты*

при использовании химического оружия в террористических целях. При определении критериев выбора модели войск РХБЗ учитывалось мнение экспертов в области РХБЗ, а для получения оптимальных результатов применен метод анализа аналитических иерархических процессов. Полученные результаты могут быть использованы в качестве основы для моделирования войск РХБЗ в международных учениях по радиационной, химической и биологической защите.

Ключевые слова: *международные силы, терроризм, РХБЗ, оружие, ядерное, химическое.*

MODELOVANJE MEĐUNARODNIH SNAGA ATOMSKO-BIOLOŠKO-HEMIJSKE ODBRANE PRILIKOM PRIMENE HEMIJSKOG ORUŽJA U TERORISTIČKE SVRHE

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OBLAST: hemijske tehnologije
VRSTA ČLANKA: originalni naučni članak
JEZIK ČLANKA: engleski

Sažetak:

Ubrzani tehničko-tehnološki razvoj ljudske civilizacije, tokom dvadesetog i početkom dvadeset prvog veka, suštinski je doprineo neravnomernoj podeli ukupnih svetskih resursa. Takva raspodela resursa dovela je do čestih oružanih sukoba koji su imali za posledicu upotrebu konvencionalnog oružja, ali i oružja za masovno uništavanje. Za razliku od konvencionalnog oružja, ovo oružje poseduje jedinstvene karakteristike koje ga čine veoma atraktivnim za upotrebu u terorističke svrhe. Najbolji primer predstavlja teroristički napad u martu 1995. godine, kada je sekta ,,Aum Sinrikjo" u tokijskom metrou primenila sarin (toksičnu hemikaliju iz grupe smrtonosnog hemijskog oružja), zbog čega je umrlo 12, a intoksikovano preko 5.000 lica.

Cilj ovog rada je prikaz modela upotrebe međunarodnih snaga atomsko-biološko-hemijske odbrane (ABHO) u slučaju primene hemijskog oružja u terorističke svrhe. Prilikom određivanja kriterijuma za izbor modela snaga ABHO korišćeno je mišljenje eksperata, a za dobijanje optimalnih rezultata primenjena je metoda analitičkih hijerarhijskih procesa. Dobijeni rezultati mogu se koristiti, kao polazna osnova, za modelovanje snaga ABHO na međunarodnim vežbama sa sličnim sadržajem.

Ključne reči*: međunarodne snage, terorizam, ABH odbrana, oružje, nuklearno, hemijsko.*

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