

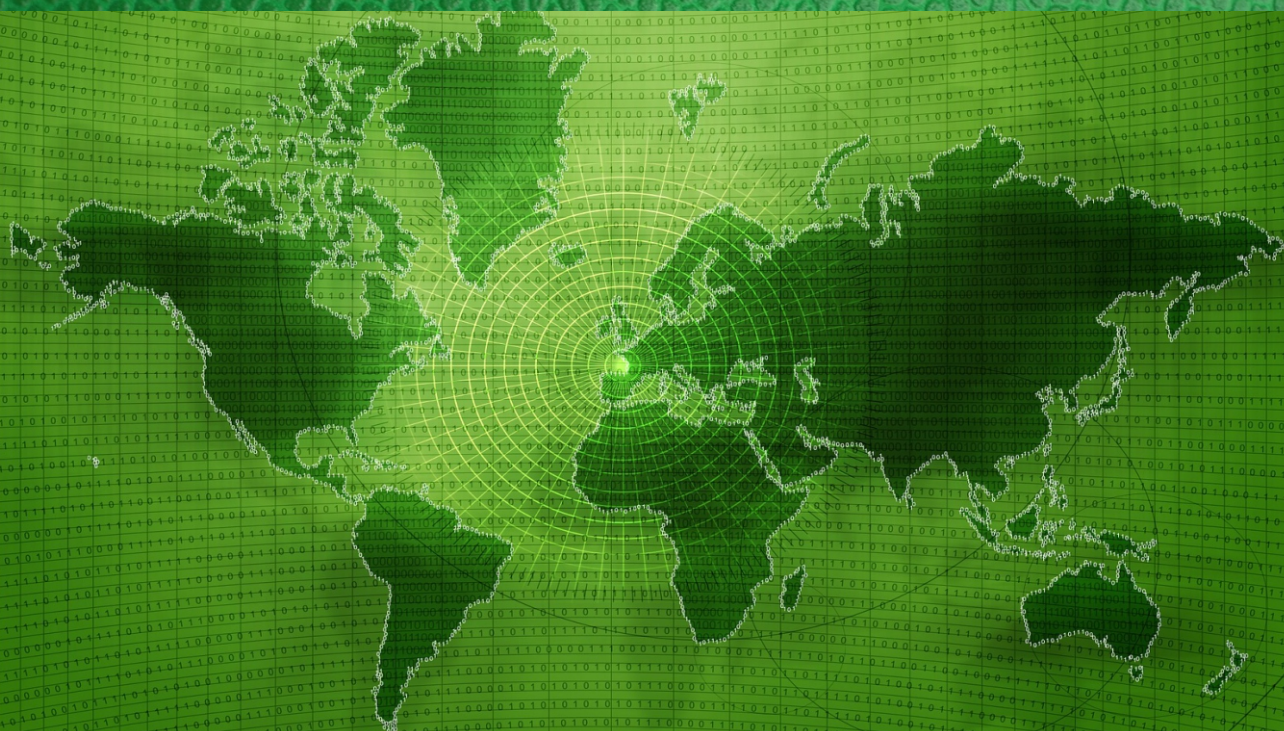
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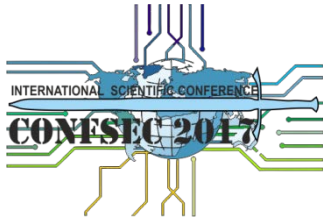
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MATRIX METHOD OF ASSESSING RISK CONFORMITY IN THE CONTEXT OF ENVIRONMENTAL SECURITY

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Abstract: The research offers a simple matrix model of analysis for ranking risk levels in critical and emergency situations. The leading principles, which should be taken into consideration can be arranged in a group of steps, for example the qualification and grading of imminent danger and the level of endangerment of key assets, determining of the processes which can lead to harm and also the value of the structures susceptible to damage and the damage itself.

Keywords: MATRIX, NATIONAL SECURITY, ENVIRONMENT, DEFENSE

1. Introduction

The preliminary assessment of the threats aimed at the security of given process, event or a system is a mechanism creating a variety of tendencies connected with disaster management. The practice said above gives us the ability to engineer a strategy for system control.

Thanks to the processes of planning and forecasting there is an increased chance of reacting adequately and quickly if a disastrous event happens and its boost the future solving of the problem. An example for a decent tool in the field of disaster management is the remote examination of such happenings with the help of artificial satellites.

The usage of man-made objects orbiting our planet's orbit and the methods of their exploitation are crucial for the control of the environment security on the grounds of their precision and supreme scale of effectiveness. With their help a high volume of valuable intel showing the state of the environment is being able to be collected and furthermore the data gathered will aid the long and short-term danger scenarios. [1, 8,12,13,16,18]

2. Prerequisites and means for solving the problem

A supporting instrument in finding a solution to an environmental crisis are hypotheses. They tend to have a more general character in comparison with prognoses due to the fact that they mainly use guesses and ideas as a source that stemmed from risk analysis. [1,2,5,7]

The professional generation of a prognosis for a single case is of utmost importance for the defining of the set of tasks given for achieving a stable level of environment security and its imminent support.

The main approach to overcome the dangers is the usage of prognosis techniques, used mainly for making conclusions and making a review of the needed resources for countermeasuring existing threats. [9,10]

The whole process of combating risks depends on vulnerability and danger measuring and analysis. Risk grading is important for determining the value of resources, their flaws and also the threats themselves, all of whom are able to be realized in the system and lead to ecological risks and compromising the environment. Risk grading exist when the danger is measured and the shortcomings of the resources are classified – a potential entry point for real troubles, and on the other hand the creation of adequate ways to reduce damage to the world's ecosystem. [11,14,15]

Measuring the risk and the risk factor are the first crucial step in threat analysis and management of environment security. Every asset in the security system must be evaluated in terms of its importance to the whole structure of danger control.

Assets should be categorized in different types with respect to their value and influence on the whole anti-risk concept. Of a great concern is the choice of criteria for classification of resources. If we dive deeper into the field of environment security we can see that it

is nearly impossible to put a price on assets like the World Ocean for example. For an effective measurement we should grade the assets on a scale from 1 to 10 and for creating an easier measure method we can arrange resources concerning their quality from "very low" to "very high". The grading must be a responsibility of a team of experts or organization sorting the assets in their respective categories. [1,6,7,17]

3. Solution of the examined problem

Looking at the ISO accepted standard worldwide which regular risk assessment criteries we can come with acceptable terms for quality grading from the standards of informational security and the abovementioned used successfully in the field of environment security due to the lack of ISO algorithm in environment security.

The terms included should be as following: "lowest", "very low" "low", "medium", "high", "very high" and "of critical importance". The range of grading should be prepared by experts in the field and there must be no confusion in the usage of grading terms. The following terms are applicable – primary value, renewing value and exchange value.[1,11,12,13,]

Of a particular importance is the creation of a grading system. The higher the number of grading levels is, the better is the detail itself. In determining the threats we can utilize the recommended approach in Application C of the ISO/IEC 13335-3 standard where Application D contains the threats created by deliberate actions, A – random actions and E – natural threats.[1,17,18]

Table 1: Ecological threats and their grading in accord with the international standard/ISO/IEC TR 13335-3:1998 Annex 1

	THREAT	BIH
1	Earthquake	E, A
2	Flood	E, A, D
3	Hurricane	E, A
4	Lightning strike	E, A
5	Radioactive contamination	A, D
6	Electromagnetic influences	A, D
7	Dust storms	E, A
8	Fire	E, A, D
9	Extreme values of temperature and humidity	E, A
10	Heavy snowfall	E, A
11	Drought	E, A
12	Volcanic activity	E, A
13	Tsunami	E, A
14	Other risks	

It is of great importance in evaluating the threats what question will be given when the asset is rated. For a more simple way of rating a sheet of questions should be created for every group of assets that are important for risk rating and with which risk can be evaluated and the level of vulnerability.

For every answered question in the quiz points will be allocated to the database and the whole asset will be compared with ranks thus giving the threat level (See matrix in 2) [1,17,18]

Table 2: Scale for determination of threat and vulnerability

Asset Value	Threat Level								
	Low			Medium			High		
	Level of vulnerability			Level of vulnerability \ of			Level of vulnerability of		
	L	M	H	L	M	H	L	M	H
0	0	1	2	1	2	3	2	3	4
1	1	2	3	2	3	4	3	4	5
2	2	3	4	3	4	5	4	5	6
3	3	4	5	4	5	6	5	6	7
4	4	5	6	5	6	7	6	7	8

4. Results and discussion

The amount of value of the assets and the threat level and vulnerability, according to every type of influence are inserted in the matrix to determine every combination of the supposed risk level on the scale with a random equation – in cases 1-8. The same are shown in Table 2.

For every asset the vulnerable points and their threats are evaluated. If there are vulnerabilities, but there are no threats or there are threats but no vulnerabilities it is assumed that there is no risk present.

In those cases there is a careful measurement of a possible change in the status quo so unexpected risks are successfully evaded. Afterwards the queue in the matrix is calculated based on the value of the asset and the column adjusted to the value – by the threat and vulnerability level. [1,7,9,15,16,17,18]

The size of the matrix from the point of view of the categories characterising the level of threat and vulnerability of the asset are chosen depending on the specification of the needs of the mentioned case. The value of this method is concluded in the ability to sort threats and dangers alike.

5. Conclusion

For determining the dependence between factors and influence and the possibility for a threat to happen (with considering the character of vulnerability) a matrix can be proposed.

After defining, in the final phase of grading a summary grading of the risk must be done. The risk shows itself as a stat of the vulnerability of the system and his value is influenced by the resources, threats, the realisations of possibilities of the dangers in vulnerable points and the existing measures for deterrence and defence, thus lowering vulnerability and threat to the ecosystem.

The goal of the analysis is consisting of the determination and grading of the risks that are influencing the system and its resources with the goal of choosing the adequate countermeasures.

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“NON-LETHAL WEAPONS” – A CONCEPT DIFFICULT TO DEFINE

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Abstract: *More than 50 years after introducing the term "non-lethal weapons" (NLWs) and over 20 years of adopting the non-lethality policy, there is still no commonly accepted definition of this class of weapons, and the term "non-lethal weapons" is still subject to debates. This problem affects almost all aspects in the field of non-lethal weapons and is cause of most incorrect interpretations and contradictions connected to NLWs. The purpose of this paper is to discuss and summarize the purpose, features and potential of NLWs, in order to help clarify some existing ambiguities, thus contributing to the proper understanding of the modern "non-lethal weapons" concept.*

Keywords: NON-LETHAL WEAPON (NLW), NON-LETHAL CONCEPT, NON-LETHAL POLICY

Introduction

The concept of avoiding destruction and minimizing the number of victims of internal and international conflicts was globally accepted over the past few decades under the influence of various political, social, economic and other factors. Present-day military operations differ substantially from wars in the past by principles, purposes and character and most of them are carried out in cities and other densely populated areas. In the context of the new realities the forces conducting law and order enforcement, military, anti-terrorist and other operations need and require tools to successfully perform their missions while providing reduced injuries to civilians and officers, less lethality and collateral damage and shorter duration of the effect than conventional weapons.

Non-lethal weapons (NLWs) has been widely used in the police forces practices over the world since the 1960s and 70s as an alternative or complement to police batons and firearms in controlling the aggressive crowd behavior during public disorders related to anti-war movements, protection of human rights and other causes. The military interest in non-lethality began in the early 1990s in the United States as a result of the changes in international security environment marked by the Cold War end. Technological advances, social and political environment, legal developments, and evolution of institutional structures gave impetus to purposeful and intense activities in the non-lethal weapons development.

The term "non-lethal weapons" has been introduced in the 1960s in regard to a group of diverse technologies, but debates induced by this formulation continue to this day. These debates were particularly heated in the second half of the 1990s after the adoption of non-lethal weapons doctrine by the USA.

According to the international study [1] "Currently there is no commonly, let alone universally, accepted definition for non-lethal weapons anywhere in the world. This problem is pervasive and affects nearly all aspects of the non-lethal field... Much of the confusion and controversy surrounding non-lethal weapons has been attributed to this lack of commonly accepted definitions or terminology - a problem for which no resolution appears to be forthcoming".

As noted in [2], the concept of "non-lethal" weapons is very complex and needs to be examined rigorously so that all its features are understood. A simple definitions is not sufficient since the "Non-lethal" weapons are a phenomenon, not just new types of weapons". That is why, formulating correct definition of non-lethal weapons is difficult and "any analysis of "non-lethal" weapons has to confront difficulties that arise with their definition". Therefore, "Any discussion of NLWs must start with determining exactly what they are. The reader beginning to study the issue will quickly note how many definitions appear in the literature surrounding the subject, ranging from science fiction to the more prosaic". [3]

Earlier terms and definitions describing NLWs

Some of the earlier views on non-lethal weapons sound quite unrealistic at present, revealing lack of proper understanding the NLWs purpose and capabilities, most often overestimating what they can actually achieve, at least at this stage. For example, one of the strongest supporters of the NLWs, cited in [3], defines them as weapons whose intent is to nonlethally overwhelm an enemy's lethal force by destroying the aggressive capability of his weapons and temporarily neutralizing his soldiers. Another formulation cited in [3] reads: "Non-lethality is the use of weapons of mass protection such as nonlethal and anti-lethal weapons and information warfare to project high precision power in a timely fashion, delivering results that are life conserving, environmentally friendly, and fiscally responsible". Though inaccurate, this idea "represents one end of the conceptual spectrum and illustrates the long-standing hope that non-lethal weapons can defeat the opponent without causing lasting harm to almost anything or to anyone". [3]

The subsequent publications do not contain such extreme expectations. Regardless of their wording "it is clear that non-lethality is fundamentally a minimal destruction policy involving different technologies". [3]

The NLWs definition which is most frequently used in the literature is that of the US Department of Defense Directive (DODD 3000.3 of 1996), adopted also by NATO in 1999. According to it, NLWs are "weapons that are explicitly designed and primarily employed so as to incapacitate personnel or materiel, while minimizing fatalities, permanent injury to personnel, and undesired damage to property and the environment". [4]

According to some experts (mainly in the field of law), this definition contains some unclear formulations that are subject to criticism. For example: "First, it supports the conclusion that the term "non-lethal" is misleading because it only refers to "minimizing fatalities". Second, it is not clear whether the objective of minimizing permanent injury applies to all military personnel in a conflict or just members of the U.S. armed forces. Third, the focus in the definition is solely on the intent behind the weapon's development and use with no mention of actual or foreseeable consequences of its use. Fourth, it is not clear what "undesired damage to property and the environment" means. "Undesired" from whose perspective? A desirable or tolerable level of damage from a military point of view may differ greatly from the property owner's or environmentalist's standard of desirability. Finally, the definition as a whole allows for subjective rather than objective analysis of what might be "non-lethal"". [2]

A number of publications, especially in the second half of the 1990s, are devoted to criticism of the term "non-lethal" and many alternatives are suggested as result of attempts to describe the nature of this class of weapons. They offer terms as "less-lethal weapons", "less-than-lethal weapons", "compliance weapons", "pain-inducing weapons", "sub-lethal weapons", "safe weapons", "discriminating power", "disabling systems", "minimal force", "new age weapons", "stabilization technologies", "weapons that do not cross the deadly barrier", etc. The NLWs opponents, considering these weapons

cruel, inhumane and degrading, specially designed to practice torture, call them "worse than lethal". The term "weapons" is also subject to debate, since many means and systems falling within the category "NLWs" could hardly be perceived as weapons.

Since, when using NLWs, there is always a possibility of injury, death or destruction of property, some believe that the attribute "non-lethal" applied to a weapon is both euphemism and oxymoron. For the same reason some find this term „misleading“. Supporters of term "non-lethal" recognize the ambiguity, while pointing out that the term "non-lethal" accurately expresses the user's intention. They find this term to be appropriate and describing clearly enough the essence of NLWs – not to kill or destroy, but to incapacitate personnel and equipment, giving the commanders new operational flexibility in strategy and tactics.

"Arguably, any term selected to represent this class of weapon systems would face the same perception problems that the term "non-lethal" faces". [5]

Contemporary terms and definitions describing the non-lethal weapons

At present, it is widely recognized that the term "non-lethal" refers to the ultimate goal of avoiding fatal accidents and unnecessary destruction. Most countries have formally adopted the term "non-lethal weapons". However, several countries, including USA, still have differences within their own borders - the military community uses "non-lethal weapons", the police - "less lethal weapons" or "minimum force". As noted in [5], even in military circles there has been a significant debate on terminology (the US Army and the Air Force have used the term "non-lethal" weapons, while the US Marine Corps and the Navy - "less lethal"), but ultimately "after many debates, the term that has received benevolence in the Ministry of Defense was "non-lethal"". This is in line with the conclusion of [1] that "the choice of terminology tends to be along the lines of disciplines rather than countries".

Similar situation has been observed concerning the NLWs definitions. In support of the conclusion that there is no universally accepted definition for non-lethal force or weapons the authors of [1] point to some examples:

- Australia: Non-lethal (or less-than-lethal) incapacitation means to render a suspect incapable of action by means of force which is highly unlikely to cause death or serious injury when properly applied.
- Germany: Non-lethal weapons is a technical means whose intention is to obviate (prevent or stop) hostile operations without causing death or lasting injury to human beings. In addition, secondary effects caused by the use of those means to innocent people, property, and environment shall be minimized.
- Israel: Weapons intended to cause those upon whom they are used to sustain injury, without either killing them or causing irreversible damage over time. The function of such weaponry is to deter, confine, remove from activity, paralyze, confuse, stop, neutralize, distract, disperse, isolate, remove from focus or deprive entry of people or vehicles [in a given area].
- UK: "Less lethal" is a term carefully defined to encompass weapons and equipment which, although less likely than firearms to result in a serious or fatal injury, nevertheless carry some degree of risk. The objective is to provide the police with options to allow a use of force commensurate with the threat being faced. And also: "Weapons, devices or tactics designed to induce compliance without substantial risk of serious or permanent injury or death".

Something more, the study of [1] shows that "many versions of the definition of "non-lethal [weapons/force]" exist, even within the various countries surveyed".

The edited version of the US Department of Defense definition (in DODD 3000.3E, 2013), seems to be the most comprehensive and correct to date (it is already used in some last-years publications): "Department of Defense defines non-lethal weapons as **weapons, devices, and munitions that are explicitly designed and primarily employed to incapacitate targeted personnel or**

materiel immediately, while minimizing fatalities, permanent injury to personnel, and undesired damage to property in the target area or environment. Non-lethal weapons are intended to have reversible effects on personnel and materiel." [6]

The second part of this definitions stresses on the NLWs characteristics: "**Unlike conventional lethal weapons that destroy their targets principally through blast, penetration and fragmentation, non-lethal weapons employ means other than gross physical destruction to prevent the target from functioning. Non-lethal weapons are intended to have one, or both, of the following characteristics: 1. They have relatively reversible effects on personnel or materiel. 2. They affect objects differently within their area of influence.**" [6] The latter means that: The targets return to their former state without external help (in case of material targets it is profitable to fully restore their functionality rather than replace them); The NLWs may leave different targets within their range of effect wholly or partially disabled, or totally unharmed.

Comparing the various definitions it can be noted that each of them reflects one or more of the NLWs purposes: to deter or neutralize targeted persons; not to kill and cause permanent or incidental injury; to have temporary and reversible effect; to cause minimum collateral damage on the property and the environment. Despite the differences and comprehensiveness of their formulation, it is evident that: 1) "All definitions share the mandatory requirement that the intention of non-lethal force includes avoiding death or permanent injuries". [7]; 2) No definition includes full assurance of the absence of lethal effects.

Purpose, features and potential of NLWs embodied in the contemporary concept of "non-lethal weapons"

It seems that the existing definitions (especially in the presence of differences in their formulation, and the use of different terminology) are not sufficient to build a accurate and complete view of such a complex concept as non-lethal weapons.

Most confusions and incorrect understanding concerning the NLWs conception arouse from the contradiction between term "non-lethal" and definitions which include "minimizing" fatalities, injuries and damages. Furthermore, many official documents point out that NLWs are not risk free. For instance, the NATO Policy on NLWs states NLWs "shall not be required to have zero probability of causing fatalities or permanent injuries". [8]

It is recognized that some NLWs, especially those used not only in passive and defensive mode but also in active and offensive operations, have the potential to cause serious undesired effects at certain conditions. From other hand, "many lethal weapons, such as rifle bullets and other fragmentation weapons, do not have a 100% lethality rate". [2]

This requires clarifying a few questions: why these weapons are called "non-lethal", since they pose risks of significant injuries and fatal outcomes; why the risks of such consequences can not be completely eliminated; and, in that case, how they differ from conventional weapons. Some other important peculiarities, which are essential for the NLWs conception, will be further outlined.

A widespread criticism of NLWs is that many of them are not really non-lethal and can be highly painful. "Indeed, even improved NLWs would remain weapons and could be associated with various unpleasant consequences, especially if used in ways calculated to have such consequences". [9] Undoubtedly, most inoffensive things or technologies can be used with the intent to kill, while powerful lethal weapons can be used in non-lethal actions, such as warning shots or "show of force". This example supports the perception that not the technology chosen but the user's intention is decisive for non-lethality. NLWs aim to disable, discourage, detain or repel the opponent without causing severe damage.

The label "non-lethal" has been invented to emphasize the intent of these capabilities. There are no guarantees with non-lethal weapons, "rather they represent a dedicated effort to provide additional options when use of lethal force is not desired". [10] The zero lethality is a goal, not a guarantee. Therefore, the term "non-

lethal" should be understood as a function of intent. The emphasis on intent is crucial to the concept of the NLWs and determining factor that distinguishes them from conventional weapons.

According to the Strategic plan 2016-2025 of the Joint NLWs Directorate "At its core NLWs are defined by three tenets: Deliver immediate target response; Provide predictable and intended reversible effects; Minimize undesired collateral damage". Desired effects of a lethal weapon system can be described with regard to target lethality in a certain range or on a particular area. "Similarly, a NLW system's desired effects may be described in terms of a non-lethal outcome, such as denying an area or suppressing individuals, at a certain range, for a specified amount of time, or over a particular area. Those effects are further described in terms of reversibility, a unique aspect in characterizing NLW effects". [11]

The key factors determining the effect of a NLW are: the weapon characteristics, the context in which it is used and the targeted subject characteristics.

In general the complex of characteristics of a NLW should provide an appropriate balance between low probability of fatalities or permanent injuries and minimal collateral damage, and a high probability of achieving the desired effects. To reach such a balance, their future development is geared towards providing greater precision, increased range, repeatable/multiple effects, discriminatory effects and possibility of action from stand-off distance. This development is based on systematic research of the non-lethal weapons effects on humans.

The context in which a NLW is applied (building, open, confined space) plays significant role for its effect on target. A NLW which is fully effective and safety under certain conditions, in others may not achieve planned effect or may cause undesirable outcomes. Environmental factors such as time (day/night), weather conditions (rain, snowfall, fog), presence of screens, etc., also can increase or decrease the effect of some non-lethal technologies.

Understanding the effect on humans is momentous in the NLWs concept. Some compare NLWs effects to those associated with therapeutic drugs: both have desirable effects (disabling - therapy) and side effects (permanent damage - side effects). They can be characterized by the so-called "dose-response curves" - the dependence between the power/dose of the applied NLW/drug and the likelihood of response (desirable/unwanted) – Fig. 1. The difference between upper and lower thresholds (the "non-lethal envelop") is the boundaries within which a NLW can operate.

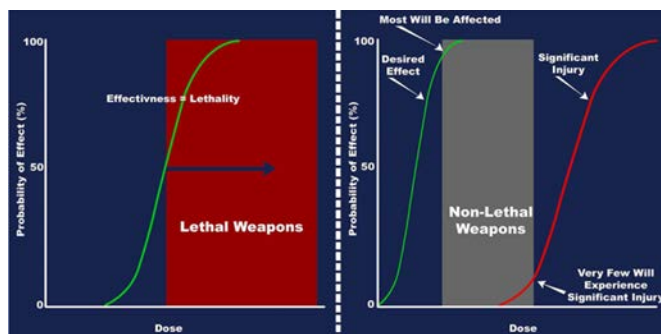


Fig.1. Lethal and Non-Lethal Weapon Trade Space Comparison. [11]

For some NLWs this window is narrow and delivering a dose of high impact and high safety is a serious technical challenge. As noted in [12], even with an "ideal" composition, there will be significant obstacles to non-lethality - delivering an effective but safe dose to each person in a given area, regardless of age, weight and health differences and problems of uneven concentrations and cumulative action of the agent. When applying NLWs within the extremely wide range of diverse surroundings and situations, against persons of various physical states, there is always an inherent, not liable to decrease, risk of accidents. [13] For example, a non-lethal mechanism which would produce a slight indisposition to a young soldier in the open air could be fatal for a child in closed

room or for an elderly person in poor health. Other variables related to the NLW impact are the targeted person mental health, motivation, whether the person is under the influence of alcohol or drugs, the presence of protective counter-measures, etc.

With respect to incidents resulting from NLWs it should be pointed that "problems are rather in tactics, procedures, policies, training and use of NLWs than in technology itself". [14] There are data that many incidents, including amongst weapons users, are due to improper handling. For example, some NLWs, such as Taser's and kinetic weapons, could cause death if directed at wrong part of the human body (the latter also when used at too close distance).

The conclusion to be drawn is that the possibility of unintended fatalities and injuries always exists irrespective of the advancement of technology, security measures and proper use of the NLWs.

Another difficulty in understanding NLWs concept is related to the impressive diversity of technologies and means covered by this category, which operate on differing physical principles and have various design and applications.

The term "non-lethal" at first look seems to be connected with actions against humans (such as crowds control, people disabling, preventing access to certain areas, removing people from buildings or areas, etc.). However, this term includes also anti-material weapons designed for applications against materiel and infrastructure (such as protection of a given area from entry of vehicles, vessels or aircraft, disabling or neutralization of vehicles, equipment or infrastructure, etc.), though, some non-lethal actions against materials which lead to a structure or vehicle failure could have fatal consequences to personnel as well.

The NLW categorization by technologies also may contribute to the conception ambiguities. Various classifications can be found in the literature sources. Most common classification divides them into: kinetic energy technologies; chemical technologies; directed energy technologies; acoustic technologies; electrical technologies; mechanical (barriers and entanglements). Other classifications merge electromagnetic and acoustic weapons into the category "directed energy weapons" and kinetic weapons and mechanical means – into "kinetical-mechanical". In addition, there are NLWs with combined action - affecting two or more human senses, called "multisensory NLWs", which effects include various kinds of technologies (e.g. light-sound, light-sound-chemical, light-sound-kinetic, etc.), sometimes determined as a separate category.

Finally, the label "weapon" seems quite inappropriate to some means included in the category of NLWs, such as malodorous substances, markers, lubricants, barriers, spikes, ropes for stopping vehicles and vessels, and many others.

It is equally important to clarify what the term "non-lethal weapons" does not include. Although essentially of non-lethal nature, the psychological operations, cyberspace operations and electronic warfare are excluded from the NLWs category. A lethal weapon used in a non-lethal way also does not fall into the scope of the non-lethal weapons.

The Strategic plan 2016-2025 science and technology (to the Joint Non-lethal Weapons Program) [15], specifies the NLWs mission as pragmatic use of force which is intended to minimize the loss of life while achieving the military purposes. The use of NLWs aims: avoiding unintended human casualties; controlled levels of physical injuries; expanded capabilities for commanders.

According to the NATO and US DoD directives [4, 6, 8] non-lethal weapons have the potential to increase the opportunities for: deterring, discouraging, delaying or preventing hostile actions or threats; preventing access to buildings and areas, moving or disposing of persons; stopping, disabling, diverting or preventing access to vehicles; adapting the escalation options to the operating environment; implementing capabilities to temporarily disabling people and equipment; mitigating situations in order to exclude the use of lethal weapons; precise targeting; increasing the efficiency and effectiveness of the lethal agents; capturing or incapacitating high value targets; improving protection of own forces.

Currently NLWs are seen not only as potential opportunities for application but as technologies behind which there is an operational need. It is generally accepted that NLWs create options for controlled actions and can prevent the use of conventional weapons in crisis situations where previously used political, diplomatic, economic and other measures have failed. They can strengthen the deterrent effect, providing opportunities for graded counteraction against a wide range of threats and allow an early, thought-out response by gradual, growing and measured impacts without lethal consequences. NLWs have the potential to hold an intermediate position within the force continuum - somewhere between the non-use of force and the use of lethal force.

Finally, the main question related to the expectations which humanists assign to non-lethality, comes: whether it is possible for NLWs to replace conventional weapons and launch a new era without unnecessary bloodshed and suffering?

Many people are convinced that non-lethal weapons are the most humane weapons. Some see them as an alternative to the conventional, and in the near future, even to nuclear weapons. Others claim that NLWs are not more than an extension of force to fill the gap between warnings and deadly force, and lethal weapons will always be available.

Undoubtedly, NLWs play an essential role in today's law enforcement, peace supporting, anti-terrorist and other operations and will become increasingly relevant in the future. They not only offer a complement to the lethal force, but are capable to completely replace its use in a number of situations. In fact, although very effective for performing various operational tasks, they are not adequate in all cases since their success largely depends on the specificity of the situation and the degree of threat. At present their military application is limited to the use of a narrow range of NLWs, for several reasons, including because they are considered to be insufficiently effective on the battlefield in major armed conflicts. Consequently NLWs can not completely replace the use of lethal force at the current stage.

Conclusion

Existing literary sources concerning different aspects of NLWs indicate that some of their features are still not fully understood by non-specialists and the general public. Uncertainties contained in the different definitions, terminologies and classifications significantly contribute to this ambiguity.

Clarifying the concept of NLWs is a complex task requiring consideration of all aspects of the non-lethal weapons. The main features of the NLWs can be briefly summarized as follows:

- The term "non-lethal" refers to the ultimate goal of avoiding fatal accidents and unnecessary destruction which would be caused by conventional weapons used in the same circumstances. The emphasis on intent is crucial to NLWs concept and determining factor that distinguishes them from conventional weapons.
- NLWs use such levels of impact which produce immediate, predictable and planned effect allowing the targeted subject to recover its former functions. They have to disable, discourage, detain or repel the opponent without causing severe damage.
- The effect of a NLW depends not only on technology and weapons characteristics, but also on the context in which it is used, the targeted subject characteristics, the weapon proper use and many other factors. Therefore, there is always a probability of causing undesired outcomes under certain circumstances.
- NLWs create options for controlled actions and can prevent the use of conventional weapons in crisis situations. They can strengthen the deterrent effect, providing opportunities for graded counteraction against a wide range of threats. NLWs fill the gap between the non-use of force and the use of lethal force, holding an intermediate position within the force continuum.
- NLWs are widely employed in law enforcement, peace supporting and other operations, but their capabilities for use in major military conflicts remain underestimated and underutilized.

• NLWs not only offer a complement to the lethal force, but are capable to entirely replace its use in a number of situations. However, NLWs can not completely replace the use of lethal weapons, at least at the current stage.

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FEATURES IN THE TRAINING OF MILITARY UNITS OF SPECIAL OPERATIONS FORCES IN THE FIGHT AGAINST TERRORISM

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Abstract: *Much has been said and wrote during the past year on how best the international community must oppose the expansion of geography of international terrorism. The growth of terrorism to such an unprecedented scale requires the intergration of the forces of the whole civilized world to fight it. For the successful implementation of this struggle is necessary to use all possible means: political, economic, legal and military. This imposes the implementation of a specialized training program of Bulgarian Special Operations Forces.*

Keywords: TERRORISM, SPECIAL OPERATION FORCES, SPECIAL TRAINING

Introduction

Much has been said and wrote during the past year on how best the international community must oppose the expansion of geography of international terrorism.

In his speech at the NATO-Russia conference in Moscow on December 9, 2002, NATO Secretary General George Robertson, said:

"[.... Many analysts stressed the importance of non-military tools such as freezing terrorist finances; coordination of policing; tightened border controls; better inspection activities of cross-border transport of containers and improve intelligence sharing. Let us not doubt at all the correctness of these analyzes. Non-military means and tools are critical to victory in this fight and ignoring them will lead to failure of our efforts.

But the military also have a role to play in this fight ... - NATO must also be ready to act in support of the efforts of the international community against terrorism To meet these requirements NATO makes concrete and quick steps to modernization of its armed forces NATO is about to become more effective partner in the international community's response to the threats of the 21st century].

1 Role, and tasks of the special operations forces in combating terrorism.

The growth of terrorism to such an unprecedented scale requires the integrations of the forces of the whole civilized world to fight it. For the successful implementation of this struggle is necessary to use all possible means: political, economic, legal and military.

A. The role of the military in particular of Special Operations Forces in this fight in the words of Mr. Robertson in his speech of December 9, is determined by:

FIRST [..... fade border clear separation of the terrorism war. Today's terrorism aims to cause mass casualties and in this situation weapons of mass destruction (WMD) with increasingly more likely to fall into the hands of terrorists].

SECOND [..... reduces the difference between internal and external security. We used to provide external security as we have tanks on the borders, leaving security inside in the hands of the police. Henceforth should not rely entirely on such a division of power. Terrorists can slip unnoticed into our communities and using our openness to carry out massive attacks, prevent that require military force, or the consequences are such that they can be managed only by military].

THIRD [..... sometimes it is not possible to protect citizens from terrorist attacks if we use only defense measures. To respond or prevent apparently imminent attack, it may be necessary deployment of military forces against terrorist networks.

For the above reasons, the military had a significant role in the international campaign against terrorism. Over the past century the tasks of territorial defense are obsolete and can not be applied. What is needed is a radical change of idea what to do military to effectively meet new challenges]

Given the specificity of the anti-terrorism Special Operations Forces of the Army with its unique characteristics - effective, modular, compact, maneuverable, combat-capable, independent and comprehensive relatively provided so they should be determined to play an important role in counter-terrorism operations, conducted by units of the Army.

Counter-terrorism, directly or indirectly, involved all national and regional offices of the Ministry of Internal Affairs of Bulgaria. Conducting operations for suppressing terrorist activities in the country is primarily responsibility of the squad to combat terrorism and the specialized units of the national services "Combating Organized Crime", "Gendarmerie", "Border Police" and State Agency for National Security. Usually these structures first respond to signal a terrorist act and conduct initial events to control the situation.

In time of escalation of the crisis, to limit and prevent its expansion and neutralization of significant composition terrorist groups it will be used units of the armed forces, including units from BUSOF, which determines the place and role of these kinds of forces in the building of the anti-terrorism forces of our country.

This place is regulated by Article 49 of the Military Doctrine and Article 68 of the Law on Defence and Armed Forces, according to which in peacetime in declaring a state of emergency, in particular aircraft and BUSOF perform the task of assisting security native authorities in the fight themselves against the spread of weapons of mass destruction, illegal arms trafficking, international terrorism, protecting strategic critical infrastructure facilities, operations to limit terrorist acts. In this type of operation, it is expedient to use in addition the structures of the Service "Security – Military Police and Military Counter- intelligence " of the Military Armed Forces which have functions similar to the structures of the Ministry of Internal Affairs as well as and BUSOF units.

Their specificity, specific personnel, its great quality and defined training suggest their designation as part of Bulgarian Armed Forces with increased combat capability and capacity to perform the tasks of this kind. Their hi mobility facilitates short-term deployment in crisis regions. Readiness for autonomous action of the units makes them the most appropriate unit of the Bulgarian Army to conduct such operations.

C. In his speech of 9 December Mr. Robertson three essential

tasks of armed forces in particular and Special Operation Forces in their fight against terrorism.

[..... FIRST - Counterterrorism: defensive measures to reduce vulnerability to attacks against the population, territory, infrastructure and information and communication systems.

SECOND - prevention of terrorist attacks, offensive measures to reduce, prevent, deter terrorist activities.

And third - management of the entire set of activities to deal with the consequences of terrorist attacks: mitigation and stabilization of the situation after such attacks in support of civilian authorities.

To build security need something more than "perfect" plans and diagrams. What you need are opportunities and possibilities it right. What does this mean? Means the ability to move units quickly to prevent, defend or protect against terrorist attacks. With light mobile podrazdeleniya.S effective air and sea transport.S modern command, control, communications and intelligence and modern military capabilities

..... Is not rare, even when properly formulated order to eradicate terrorism, when the use of inappropriate military units due to lack of specialized training may be no-effect and even counterproductive.

..... Is therefore necessary to develop a rapid response force that can be sent very quickly, where necessary, either to conduct an attack or to respond to such with A compact and more flexible structure suitable for missions detection, prosecution and maintenance of the new security environment. Creation of mobile, well-trained and equipped modern armed forces is extremely important in the fight against terrorism and modern security challenges

..... But above all, this means carrying out the necessary preparation of military units aimed at tackling new tasks. They should be trained to interact with the executive bodies of civilian authority, respect the rights and keep the trust of the population to be defenders of order, peacekeepers and simultaneously fighters

From the foregoing, so far as I can responsibly say that Special Operation Forces, with their specific structure and mobility, their versatile training opportunities for variability and flexibility by their use are closest to those requirements.

The training of Special Operation Forces (SOF) for participation in operations in combating terrorism is linked to the performance of specific missions and tasks. Should therefore be carried out targeted training, both in the middle of studying the occurrence, goals and objectives of terrorist organizations and their assets and practices for implementation of terrorist acts and to conduct training of personnel and SOF units to perform specific missions and tasks such as: intelligence (detection), monitoring and neutralization of terrorist leaders and formations; security of VIP and strategic sites of national and military significance for the security of the country; restraint or seclusion of endangered areas; safety and

prevent the spread of rumors and panic among the population; application of direct strikes against terrorist infrastructures to neutralize them or release of hostages.

2.Features in the training of military units of special operations forces in the fight against terrorism.

For successful implementation of tasks related to combating terrorism personnel of military special operations forces should have a good overall physical endurance and mental sustainability to be able to use hand to hand combat fighting techniques; to camouflage themselves and be able to use the hidden and cover areas of the field, to know to perfection armament, special equipment and technical equipment; to conduct special tactical maneuvers to combat terrorist organizations.

A. Physical training.

Neutralize terrorists requires the possession of a number of attributes such as speed, agility and endurance. Speed is necessary for rapid movement, agility to overcome various obstacles such as fences, stairs, rails, ditches, holes and other. Resilience is a guarantee that, despite all attempts terrorists will be pursued long enough to be neutralized. The possession of these qualities from soldiers from SOF is provided for the successful neutralization of terrorists. That is why the classes in physical training as well as classes in tactical and special training should pay attention to these specify elements and soldiers from SOF to constantly maintain its as a good physical shape.

Neutralize of the terrorists required physical attributes than those listed, and drills up and down rope training to overcome higher obstacles. Similar physical skills and habits are invaluable when necessary hidden to take certain position or take unexpected activities.

B. Hand combat fighting techniques

Knowing the techniques of military hand to hand combat fighting techniques of Special Operation Forces SOF is also one of the conditions for successful completion of the disarming and detention in neutralizing terrorist procedures. In principle, the implementation of such techniques to the greatest extent practicable, when a person is armed with stab knife, ax, and so on. If he is armed with a firearm, the implementation of hand combat fighting techniques disposal techniques and detention can be place only in appropriate situations, for example in a limited space, a short distance (step two) and others.

To be sure personnel that can resolve with such a situation, it is necessary to carry out exactly certain training in martial combat hand to hand fights, where to acquire and to confirm all these conditions. Likely to fall into a similar situation is great, so martial arts are part of the overall training of soldiers by SOF in the absorption of actions to neutralize the terrorists.

C. Shooting training.

Ability to shoot quickly and accurately is a key element in the preparation of the personnel from BUSOF. The use of personal weapon during of a neutralization of terrorists is likely. That's why the shooting training plays an important role in counterfeiting, and in particular the keeping of their lives.

The use of arms is a last resort and is only allowed in exceptional cases where all other measures have been unsuccessful or when it is impossible to take other measures, depending on the situation. When neutralizing terrorists, SOF soldiers must be mentally and physically ready to use weapons, otherwise they or others may become the victims of terrorist act.

During the neutralization of terrorists there are may be circumstances that require open a fire. The shooting, which may be necessary to keep soldiers from SOF, is divided mainly into three groups- fast, instinctive and defensive.

Fast shooting have to be kept the approach to terrorists when they have to be neutralized in case they have revealed the intentions and opened fire. Training in fast shooting was held for the acquisition habits in keeping the fire from the right position or slightly crouched. Also kneeling, prone, and behind disguises, making short runs to insure better opportunity for fire.

Instinctive shooting is as we call for survival. Training of instinctive shooting is conducted on quite short distance (2-7 m).

Defensive shooting is led by one or two members of the SOF group . This training aims to acquire the habit of maintaining to members of fire group who perform immediately task to perform neutralization. Its training is the ability to use long-barreled rifles weapon type "pump" machines, sniper rifles and more.

Requirements arising from actions in neutralizing terrorists to shooting skills of servicemen from SOF are great. Therefore programs for shooting training must include various kind of shooting to ensure maximum level of the shooting skills of soldiers, which will lead to ensure maximum safety for them and others if similar situations occur. Furthermore, in the training must be considered and the following features:

- Keeping coolness under all circumstances;
- Ability to conduct rapid and efficient shooting at limited visibility - night, snow, rain, fog, dark room and other condition;
- To achieve a good balance between speed and accuracy of shooting;
- Ability to conduct a fast shooting with movement with brief stops;
- To achieve automatic skills of personal weapon protection in physical contact with the detainee with subsequent immediate use - shooting at close range;
- Safe handling of weapons in compliance with all safety measures and to save the lives of the people around him ;
- A will to eliminate the opponent, regardless of the situation;;
- A knowledge of the dynamics of the firefight in which the danger for life is great;
- A knowledge of tactics for proper movement and camouflage ukri-vane to reduce the efficacy of protiv-nikovoto resistance and the likelihood of his goal;
- Applying different techniques to deceive the opponent about their own source of action.

The soldier from SOF is must be the most adaptable fighting machine that was invented today, but also the most demanding, with regard to providing it with outfits and weapons. They may be his best ally (friend), but may also become his enemy.

Equipment and armament (individual and collective) of special operations group (teams) should be as good as possible and not interfere with the mobility of the personnel. They should allow for long-term residence under all weather conditions, to assist the actions of Fighters in all extreme situations, day and night.

Technical sources to be able, timely and accurate, to reveal the existence and location of the targets and objectives, to be able to provide reliable connection inside the detachment and with senior staff, to enable reporting of the obtained information in real time in short terms. And do not be influenced by the characteristics of the relief.

The successful solution of the outcome of the fight against terrorist formations played an essential role ability of personnel in proper selection and best equipment of main and reserve operating bases. These bases are generally selected, equipped and concealed (hidden) in military areas (barracks), police stations or other suitable for this purpose facilities occupied by the local military or police units or other services. The bases are selected, equipped and maintained by the battalion headquarters of the Special Forces or the exported command of the SSO component and its assigned logistics module.

Group (squad) for SOF must be able to be invisible and be able to better mobility, which requires, depending on the task (mission) and the number should be from 5-10 to 20 people (a group, platoon to detachment, and two platoons).

During the movement to the crisis area or forward operate base of the Special Operations Forces they should be able to act silently and concealed without any traces (no food waste, cans, broken branches, broken stones or shores, etc.).

The specificity of the combat training is determined by the main means of action of the units of Special Operations Forces in neutralizing terrorist formations. They can be: conducting surveillance, set up ambushes, raids (search) clearing and neutralize the terrorists. These may be applied alone or in combination.

D. Observation

Observation of ordered area or object (or subject area probable location of a terrorist formation) is the most common means of obtaining information. It is, in itself, to gather information on the presence and nature of the actions of terrorist groups throughout the region from temporary or stationary surveillance posts in complete disguise and secrecy. The SOF personnel are trained to conduct circular and continuous observation in a hostile environment throughout the completing of the task.

Crucial for the success of surveillance is very good camouflage of assessment points, patience and endurance. The limit of patience of the personnel in their ability to stand long time in the position without any movement of the body, in cold or heat condition, pain, insomnia, hunger, thirst, is not boundless, but this level of the experienced well trained fighter should always be higher than the peasant, citizen, intelligent member of a terrorist formation. In the anti-terrorist struggle defeated patient and enduring.

Achieving this capability must be the result of an integrated approach in classes in physical, tactical and special training and it is targeted training in extreme conditions and a specially constructed polygons, tactical and special fields and bands for psycho-physical hardening

The site (place) in the action area is being studied punctually; it is scouted about the presence of terrorist groups, the routes for their movement, their water sources and the hidden approaches to them. On the area should be able to conduct surveillance on the daily activities of the local population with particular attention to discover of couriers, connections, facilitators and supporters. A very important point is the ability to organize good cooperation with the police forces and in particular the use of information from their operative sources. This mode of action is very effective in keeping complete any technical communication silence, working undercover in this area and interacting with special operations forces. To achieve these skills in personnel from SOF need to enhance of their training and their ability to work undercover.

In some cases, SOF personnel must be able to combine observing with the key tracking, to trace the activities of terrorist organizations in certain time.

This method fulfills continuously or periodically maintaining of "contact" with a terrorist groups in order to specify its composition, activities, directions of movement and probable plan or course of action.

Under certain conditions - at night, limited visibility, and good concealment when the SSO is proximately close to the terrorist formation, it should be able to overhear through audible eavesdropping to determine the location and character of the terrorist group.

Once the area has been thoroughly researched and the objectives and targets for direct action are identified, the exact coordinates are identified; they are reported to the senior command to organize the interaction with Land Forces and Air Force. The successful destruction of fire armament of Land Forces and Air Force depends on the excellent training of the personnel from SOF in determining the exact coordinates of aims and objectives. For this purpose an important role in the training plays military topography. It can be used the old methods as well and modern technical equipment or devices (GPS, laser pointers).

Direct action operations are carried out in the form of ambushes, raids, clearing and neutralization of encircled (blocked) terrorist groups.

E. Set up ambushes.

As a means the ambush concludes in advance and concealed deployment of Special Operations teams on routes for movement of terrorist groups.

The main objective in preparing units for SOF is achieving skills to set up ambushes with small terrorist group as a composition with only one purpose- to raid and to capture people alive.

The camouflage must turn the formation into practically invisible. Mandatory condition is every ambush must be trained in all possible and impossible conditions. These workouts are conducted in specially equipped areas, simulating a situation as close as possible to the real one.

In preparation, special attention is paid to the ability of the ones moving at the head of the column to liquidate silently with silent shooting devices or to disarm with knives and the aim is at everything must be silent. No traces are allowed Captured and killed are exported as fast as it is possible away from the ambush site. Captured should be questioned immediately, while still had not recovered from the stress. Those who are silent must be sending in senior headquarters for questioning.

Personnel from SOF must be able to catch bloodless prisoners near the bases of the terrorist groups near to latrines and places for waste disposal (pits).

The target of the ambush can be also capturing of the couriers on rendezvous points. Couriers know too much and should evacuate for interrogation in the fastest way in the headquarters. Through interrogation of prisoners and local residents can clarify important questions about the strength, composition and course of action of terrorist groups and to make important conclusions to support command making decisions. Data obtained from prisoners and locals must be checked and adjustments because the information obtained by interrogation may contain partial or complete misinformation, exaggeration, deception or ignorance.

The SOF teams must be trained to set an ambush to a larger terrorist group during their movement on a route. The purpose of arranging such an ambush is not so much to neutralize the given formation as to fail the course of action. The SSO teams must be able to choose the place according to the locality so that the column of the formation is pressed by the relief or limited by one side and without capability for fast deployment.

Places, more or and less, enabling the concealment must be equipped with a remote control mines or target-oriented mines.

Column of terrorist group formation is a moving target and concentrated fire from machine guns, rifles, sniper rifles and rocket-propelled grenades at it, combined with the striking effect of these mines are very effective. The whole firearm should not be longer than 10-15 seconds then the unit must withdraw in the fastest way. It is well known that the fire back opens maximum of seventh-eighth second and the organized strike back begins between the twentieth and twenty-five seconds.

The withdrawing route from the ambush is selected in advance and the order of withdrawing is worked out thoroughly by practicing all possible action options. Concealment of the withdrawing should be done by security team. The position of that team should be chosen in a safe area.

The SOF team must do its utmost to avoid open combat fight, thus depriving the terrorist formation of its major advantage - its more numerous compositions. The limited visibility in the forest or the populated places makes it impossible to accurately assess the situation if whether prosecution is taken or surrounding maneuvers. The SOF team must be necessarily retreat from the area of ambush as soon as possible. Achieving such skills in personnel is only after repeated workouts to obtain automatic reaction.

If a terrorist group undertakes a prosecution, then SOF team should organize a second ambush for misleading purposes. This option also is trained in advance prepared for this purpose training ranges.

F. Search (research).

This method is widely used in the fight against terrorist organizations. Using of different methods for searching of the areas with the sole purpose to determine the location and make contact with a terrorist entity. The SOF teams train not to only the various search (research) methods but also the ability to reorganize after the contact in neutralizing (destroying) forces using the advantage - maximum support of Land Forces and Air forces suppressive fire. Maintaining contact with the enemy is an important aspect of this type of operations. The execution of the task search (research) ends with the neutralization of the terrorist group.

G. Combat building clear.

Combat building clearing is a complex of tactical actions to lookout (search) of the area in which terrorist formations are trapped or isolated in order to neutralize or destroy them. The special operations forces teams may be used only in exceptional cases to clear the areas that small terrorist groups are blocked by Land Forces or only after Land Forces artillery strikes or Air Force support. The clearing is carried out with full interaction with the blocking teams and units and the precise identification of the responsibility zones of each participant in the operation (blocking, submitting and clearing) with mandatory reporting of the current situation in the clearing area.

To conduct tactical clearing, the SOF team conducts training by dividing in pairs, respecting the rule that the distance between pairs during the movement should be not less than 50 m maintaining direct visibility and allowing fire support from neighbor teams when needed.

During training, should be paid a special attention to overcoming open areas or other obstacles (rocks, pits, etc.) and pairs should be able to regroup in two so while one overcomes the area or obstacle, the other covers it from a sudden assault, raid or terrorist group.

Participating in cleaning and blocking should know very well that all the seats in mountain woodland and settlements that cause instinctively cluster obstacles, as well as those that can serve as shelter in a sudden fire (pits, ditches, ravines, fallen trees, large stumps, rocks, fences, entrances of buildings, etc.) is always mined by terrorist organizations.

The pairs, during the movement and clearing, prophylactically shoot any suspicious bush, a darkened area of the forest or windows and entrances to buildings even without visible targets. The wide paths, the meadows and the slopes, the junctions, between the living quarters and the buildings must be explored in detail.

Moving in a mountainous and wooded area or hi-cross terrain, as well as through a populated area, often breaks intervals between pairs and clearing can take the form of a group raid (search, research). SOF fighters must be able to align themselves on the regulation point if the relief or built-up areas have led them to the most unexpected places, they should be able to quickly regroup with readiness for a sudden head-on fight with enemy militants or other members of the terrorist group.

H. Features in action in urban environment.

The SOF personnel and units for reconnaissance, search (research) and clearing in populated areas must learn the different techniques of concealed Techniques for overcoming obstacles in urban environment have their peculiarities, especially the overcoming of walls, the open areas at the crossroads, the crossing of streets, the inter-living spaces and the movement along the buildings, passing through their windows, doors and more. This training must include besides movement along the buildings and

move through buildings, as this method should also be given due preference. Especially attention should be paid to the most commonly encountered mistakes- inappropriate camouflage of equipment (barrel, surveillance equipment, radio antennas, etc.).

I. Eliminating the terrorists in the building areas.

Tactical actions to neutralize the terrorists in the building are perhaps the most complex and dangerous. Their complexity is due to the limited visibility, the presence of many rooms, furniture, hidden places, entrances and exits.

This kind of operation is conducted by SOF with certain purpose to capture and neutralization of terrorist leaders or to destroy the headquarters and bases of the terrorist organizations. The SOF personnel and the units, designed to accomplish such operations lead its training in specially equipped areas with different configurations of rooms, corridors, doors and room furnishings.

The training is conducted on the infiltrate of the building, a search of the person, a movement to the area where he is located or is supposed to be located. Movement becomes silent, with readiness for action if a wanted terrorist appears. The training focuses on what should be the movement in a corridor, what is the correct position in front of the doors, what is necessary to check the rooms, how to open the door and how to infiltrate with a loaded, climbing the stairs and slowly moving along the wall, and to watch out for the appearance of a terrorist. During the training concerning building clearing, it is most appropriate to be trained the "top-down" clearing method because it gives the opportunity the terrorists to be forced to leave the building and be neutralized. If the opposite cleaning method "bottom-up" is used, the terrorists can either strengthened on the top floor or retreat to the roofs of neighboring buildings. This is a complex training that aims to achieve automatism in actions and without the right training conditions, it is impossible to achieve the desired results.

Features in preparation in neutralizing terrorists during night time

The preparation of SOF teams for operations in night-time should take into account certain features which affect the performance of the task.

First: the SOF team must be equipped with the necessary special tools such as flashlights, night vision devices, flares, grenades, etc;

Secondly: to pay attention to the formation (order) of the SOF team during the movement into darkness and how to use a flashlight in proper way- besides of the body and not to illuminate the partners;

Thirdly: if it is necessary to open a fire to shoot at a target rather than intimidation, because it is possible to be affected accidental citizens. It should be keep in mind that firing at night condition is less effective and therefore should shoot at a closer distance and, above all, emphasize of intuitive shooting training.

CONCLUSION:

The collapse of artificially created multinational states and inter-state unions in the past has led to the expansion of the border of international terrorism and it has made it a prime threat to the Balkan region.. This is a region with complex ethnic problems and significant influenced by organized crime. It is an important crossroads for drug trafficking, which are one of the sources of financing of terrorist organizations.

The illegal trafficking of human beings particularly from the unstable regions of the Caucasus, the Middle East and Middle Asia across the Balkans to other parts of the world is a serious prerequisite for infiltration of terrorist structures, establishing their bases, and using them to penetrate European countries.

The complete victory over terrorism can be achieved only after the causes generate terrorism have been removed, which at the present stage is an insoluble problem. This necessitates a clear identification of the problems, developments of a strategy , special training of forces, means and effective struggle on a national and global level in close interaction. The struggle, despite the invested resources is prolonged and with varying success. From all this logically arises the question to what extent is realized the neccesserity of a more recent update of combat training of the SOF and the more recent equipping for a successful completion of the mission in fighting against the terrorism. Building a unified system between Special Operation Forces, Land Forces, Air Forces, Border Police and Department of Internal Affairs.

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TACTICAL READINESS IN EXTREME CONDITIONS

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НАЧИНИ ЗА АКТУАЛИЗИРАНЕ НА ТАКТИЧЕСКАТА И ОГНЕВАТА ПОДГОТОВКА В БЪЛГАРСКАТА АРМИЯ И ПОДРАЗДЕЛЕНИЯТА ОТ МВР

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Abstract: This paper discusses tactical readiness as a complex of knowledge, skills and habits for the application of tactical means and methods of action in extreme conditions, individually and in small groups and formations on the enemy's territory, or in situations when being surrounded or have fallen into captivity, escape from captivity and from the opponent's territory under a complex impact on their part.

Keywords: EXTREMISM AND TERRORISM, TACTICAL MOVEMENT AND SHOOTING, HABITS AND WAYS OF IMPROVEMENT.

1. Introduction

In today's conditions, the development and maintenance of In the second decade of the 21st century, the world exists under conditions of increasingly difficult control of crime, extremism and terrorism, the proliferation of weapons due to local conflicts of a different nature.

2. Results and discussion

Tactical shooting takes place after the tactics classes. Their aim is to improve the tactical actions of the MoD and MoI personnel and to organize tactically teams at executive and management level in case of necessity of using firearms as well as to increase the psychological resilience of the personnel.

In his report, Zhelyazkov comments that „Using the effectiveness of small group tactics in a number of hot spots can hardly be defined as accidental. Many analysts define this phenomenon as a migration to successful tactics, techniques and procedures.“ [12] These words confirm our idea that tactical readiness in extreme conditions is very important and it is an integral part of the training of the servicemen to counteract various terrorist acts.

In the context of what has been said so far, Krustev's words can be quoted: „The Armed Forces prove that they are an essential part of the multinational efforts to prevent the danger for societies emerging from social armed conflict to be involved in it again.“ [6]

The analysis shows that by creating conditions for their existence and development and satisfying their needs, people constantly influence the surrounding world and thus provoke a response. Interaction between individuals and the relationship between them represents the society, whose safety is one of the important tasks for the citizens and the state.

It is especially in ensuring the safety of the citizens and the state that the police officers of the MoI system and the servicemen from the Bulgarian Army find their place. They develop and perfect their habits and skills during the shooting training at the firing range. The purpose of these exercises is to carry out an up-to-date shooting training, which is a result of the new realities and is related to the modern combat tactics. It is conducted in extreme conditions, in the absence of time, under great stress, impossibility of reconnaissance of the targets, the instantness of the shooting with or without using measuring apparatus. The tactical scenarios for action and training at the the „house“-type firing range can be various and they are only limited by the imagination of the supervisor or the instructor. Such

scenarios for action and training can be at the following levels: **individual level, team level - two servicemen and team level - four servicemen**. These scenarios are basic, and when a higher level of training is achieved by the personnel (the servicemen), more complex scenarios for action in extreme conditions are created.

Practical shooting provides the necessary practical knowledge, skills and habits for handling weapons and readiness for its instant use in extreme situations; forms psychological resistance to deviating impacts; develops coordination, speed and force physical abilities, develops skills to differentiate dynamic efforts, spatial and temporal characteristics.

Practical shooting, unlike the traditional one, is not based on the eye-hand system but on the whole complex of motor skills and psycho-physical characteristics. It requires coordination of movements, concentration and switching attention, sharpness of the visual receptors, hand and finger dexterity, self-control and restraint. For preparation and training at the „house“ - type range, the targets shown in Figure 1a and 1b can be used.

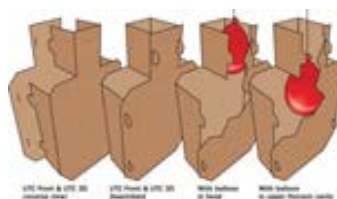


Fig. 1a Silhouette target with a balloon for accurate and effective shooting

The second type of targets is Silhouette of IPSC with a balloon to measure the accurate and effective shooting, it is marked so that the serviceman can easily recognise and assess the threat.



Fig. 1b Silhouette target for recognition and assessment of the threat by the personnel

For the supervisor or the instructor, it is of utmost importance to relate the scenarios of action to the basic rules and principles that need to be taken into account when preparing and conducting training at the „house“-type firing range, and they are: a **move towards the target** and **taking positions**.

Moving towards the target – a rule of action against the targets in the area where the serviceman directs straight towards the target that is recognized as a threat. The same is done by the next servicemen who access the site, they place their attention on the next identified targets/targets. The aim is not to allow the enemy to resist. By heading directly towards the target, the servicemen should aggressively impose their control using the appropriate forms of coercion (verbal attack, aids, physical force, weapons). The advantage of this technique is the quick targeting bringing them under obedience. On the one hand, identifying the targets and posing an impact on them is done by just one or two servicemen. The others in the area do the same with the other targets if there are any. Everyone or all work independently on an individual target. On the other hand, the presence of more people in the area requires more staff to counteract and control them, observing the tactical minimum rule for the detention and disposal of one person - two servicemen. That is, it is necessary to find a way in which the impact on the target (s) is not directly dependent on the number of servicemen operating on the site.

The area should be controlled in a way that allows for visual and shooting control of the object and the targets, which is performed according to certain rules and procedures.

If there are a lot of targets in the area and servicemen head directly to the first seen, tactically it will enable the other people in the area to resist the next incoming servicemen.

Taking a position – a rule of action whereby officers, when entering the premises, first move to certain positions in the premises, then impose control over the object and the targets. The occupation of positions should be such to form „L-shaped“ control over the premises.

The occupation of these positions takes place through the so-called „movement along the walls“, i.e. moving along the walls and past the furniture in the area, and not going across the room. Once these positions are occupied, control is required on all targets within the area.

The control of targets does not depend on the number of personnel in the premises. At the same time, the aggressive movement in several directions, taking advantage of tactical control positions, confuses the enemy and does not allow for effective opposition from their side.

The advantages are related to the possibility to quickly put the premises under control from several directions, besides that a limited number of employees can fulfill the task and it enables the interaction between the personnel.

When the first serviceman enters the „light zone“, i.e. in the direction he sees and hence controls since the opening of the door to the room. He also has an impact on targets that continue to move in the opposite direction or sideways and is more difficult to hit. At the same time, the serviceman committed to handling the threat as he is not directly attacked, is able to respond adequately and accurately to the attack. The second serviceman who enters the room, if he is at the opposite end of the door frame, also enters his light zone and enjoys the same benefits. If he is positioned just behind the first who entered, he enters the „dark zone“ where even there is an enemy, his attention has already been engaged by the first serviceman.

Taking positions is crucial to the implementation of the task and does not depend on the number of attackers, the attention of the servicemen is not distracted by individual targets, but allows for an overall perception of the situation and control by securing the respective areas of responsibility and hazardous areas.

Control on premises and conducting actions in confined area is a complex and risky process. The performance of this kind of actions should be subject to clear and simple rules in order to avoid any confusion in the actions of the personnel.

3. Conclusion

Based on the results of the comparative analysis it may be concluded that **well-developed tactical readiness imperative for achieving high professional readiness for actions under extreme social conditions**

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GEOENERGETIC ASPECTS OF THE TERRITORIAL DISPUTE BETWEEN THE REPUBLIC OF SLOVENIA AND THE REPUBLIC OF CROATIA

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Abstract: The report analyzes the territorial dispute between the Republic of Slovenia and the Republic of Croatia in the context of the development of the main energy projects in Eastern Europe. An emphasis is placed on the Final Award of the Permanent Court of Arbitration regarding the maritime border between the two countries in the Piran Bay and especially on the decision for establishment of a "Junction Area", allowing physical connection between the territorial sea of Slovenia with international waters, through the territorial sea of Croatia and the influence of this decision on the opportunities for implementation of energy projects in the region. Additionally, the importance of the North-South Gas Corridor is presented as well as how it relates to the Baltic Pipe project and the Southern Gas Corridor. The report highlights the competition between some of the energy projects in the region. As a result, it is revealed that behind the territorial dispute between Slovenia and Croatia, falsely perceived as an insignificant, lay the confronting interests of USA, Germany and the Russian Federation, further transferred to the regional level, including through the interests of powerful energy corporations as ExxonMobil, Gazprom and OMV, turning the local dispute into a geopolitical vortex.

Keywords: ENERGY SECURITY, INTERMARIUM, LNG, PIRAN BAY, NORTH-SOUTH GAS CORRIDOR, BERLIN PLUS

1. Introduction

The lack of significant amounts of energy resources in Europe is generating a constant strive of the countries on the continent toward finding a resolution of this crucial problem for their security, stemming from the need of energy at competitive prices. The total production of primary energy in Europe has fallen from 904.2 million tons of oil equivalent in 2005 to 766.6 Mtoe in 2015¹. At the same time the Russian Federation remains the main source of solid fuels, crude oil and natural gas for the European Union². This shared challenge is forcing the member states to seek a common approach aimed at dealing with this vulnerability.

Despite this, very often the European Union energy policies are falling victim to the national interests of member states or the rivalry between the major geopolitical actors. This creates an extremely complex situation in which the local energy priorities are interwoven with the global objectives pursued by the most powerful states in the world. As a result, the economic logic of energy supplies is subordinated to the geopolitical interests of parties, external for the European continent.

In this situation the European countries are faced with the dilemma whether to seek reliability of energy supplies at the expense of dependency or to pursue diversification, hiding the risk of higher prices or even complete termination of supply. Within this context the current article explores the implications of the territorial dispute between the Republic of Slovenia and the Republic of Croatia for the European energy security.

The methodology used in this research is based upon the critical thinking framework developed by Linda Elder and Richard Paul³. The main question raised before the current article is "Why the Federal Republic of Germany is supporting the Republic of Slovenia in its territorial dispute with the Republic of Croatia?". The reasons behind this formulation of the main research question as well as the origin and the characteristics of the territorial dispute between the two countries, are presented in the next section of the article.

2. The territorial dispute between the Republic of Slovenia and the Republic of Croatia in the wider context of the Three Seas Initiative

The dissolution of Yugoslavia arose the problem of determining the border between the Republic of Slovenia and the Republic of Croatia, especially in its maritime sector and the Piran Bay. On the 4th of November 2009 both countries signed an Arbitration Agreement, facilitated by the European Commission, according to

which Slovenia lifts its "reservations as regards opening and closing of negotiation chapters (between EU and Croatia) where the obstacle is related to the dispute" and that the Permanent Court of Arbitration will determine "the course of the maritime and land boundary between the two states"⁴.

As a result, the Republic of Croatia joined the European Union in 2013, but the resolution of the dispute has remained an unachievable goal. Furthermore, in 2015 the Croatian media revealed telephonic conversations between Dr. Jernej Sekolec, the arbitrator appointed by Slovenia and Ms. Simona Drenik, agent of Slovenia, linked to the deliberations of the Tribunal⁵. This led to the withdrawal of the Croatian side from the Arbitral process, which it described as "tainted" and "gravely damaged", while at the same time Slovenia confirmed that "the Tribunal should continue to fulfill its mandate"⁶.

On the 29th of June 2017 the Permanent Court of Arbitration issued its Final Award on the territorial dispute between Slovenia and Croatia. The Ministry of Foreign and European Affairs of Croatia announced that "the arbitral award does not in any way bind Croatia and Croatia shall not implement it"⁷. On the other side, the prime minister of Slovenia declared that his country will implement the arbitration ruling and expects Croatia to do the same⁸. The understanding of the aforementioned positions as well as the actions of the external for the region actors requires taking into consideration the details of the Final Award, rendered by the Permanent Court of Arbitration.

The Final Award determines⁹:

1. The geodetic lines of the land border between the two states, mainly in the disputed areas around river Mura and the Istrian peninsula.
2. The geographic coordinates of the so-called closing line (dividing internal waters from territorial sea) of the Piran Bay. The internal waters are distinguished by the territorial sea according to the status of the Bay – the Tribunal finds that "it had the status of internal waters prior to the dissolution of the SFRY and determines that it retained that status after the independence of Croatia and Slovenia".
3. The geographic coordinates of the maritime boundary between Croatia and Slovenia.
4. The geographic location and the usage regime of the so-called "Junction Area". It represents a corridor that connects the Slovenian territorial sea with the area that is beyond the 12 NM territorial sea limits of Croatia and Italy (the "High Sea") (Fig. 1). Furthermore, the Tribunal determines that in the Junction Area a special regime of usage shall be applied,

including mainly "freedom of (transport) communication to all ships and aircraft, civil and military, of all flags or States of registration, equally and without discrimination on grounds of nationality, for the purposes of access to and from Slovenia, including its territorial sea and its airspace".

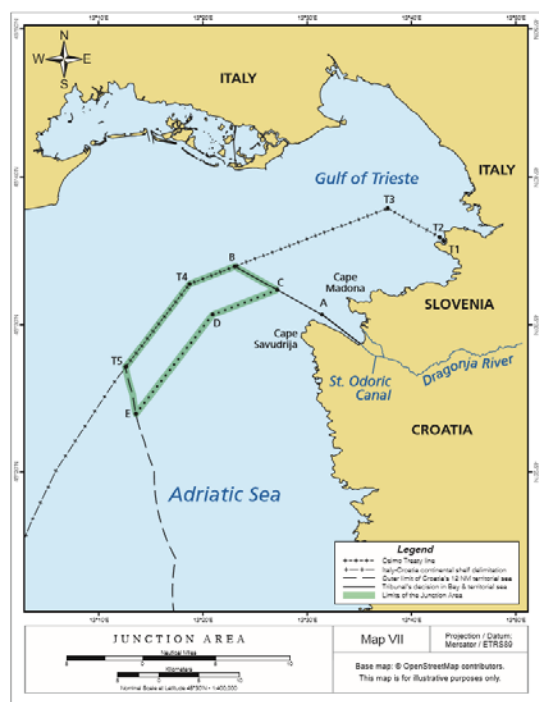


Fig. 1 Geographic location and limits of the Junction Area.

This Junction Area allows the Republic of Slovenia to establish a physical connection between its territorial sea and international waters. The significance of this decision is related to and stems from the local and regional energy projects. Therefore, firstly, the research requires clarification of the position of Croatia on the energy map of Eastern Europe.

In Croatia the transit gas pipelines are maintained and operated by the company "Plinacro". The end-user natural gas transmission system, on the other side, is being controlled by 36 distribution companies. The largest importer of natural gas in Croatia is the private company "Prvo plinarsko društvo" - PPD. It is a subsidiary of the consortium "Energia naturalis" (ENNA), which also operates in the neighboring Hungary, Slovenia, Bosnia and Herzegovina, and Serbia. PPD delivers to the Croatian market around 800 million cubic meters of natural gas per year from Gazprom, representing 75% of the total imports of natural gas in the country.

The main supply route is through Hungary via the interconnector Varosfeld (HUN) - Dravaszerdahely (HUN) - Donji Miholjac (CRO) - Slobodnica (CRO). Another supply route passes through Slovenia via the interconnector Rogatec (SLO) - Zabok (CRO) - Zagreb (neighborhood Lučko), by which natural gas from Western Europe is being delivered (small quantities from Norway) and again Russian gas, from "Nord Stream". In addition, the country has a gas storage facility with capacity of 533 million m³, positioned in Central Croatia (village Okoli). It is maintained and operated by the state company "Podzemno skladište plina".

An alternative to the Russian natural gas is the planned terminal for liquified natural gas on the island of Krk (port Omišalj). The EU and the USA are looking at this project for a LNG terminal as an opportunity to decrease the dependency of Croatia on Russian natural gas, and therefore strongly support its implementation. It is expected that most of the natural gas imported through this terminal will be delivered by USA and after the process of regasification, transited to Serbia, Hungary and Austria along the existing interconnectors.

The interests of Russia and Germany in relation to Croatia overlap in their desire to block all opportunities aimed at providing an alternative energy supply routes for Europe, in order to ensure the profitability of "Nord Stream" and its planned expansion, which guarantees the leading role of Gazprom on the European natural gas market and establishes Germany as the main European energy hub. Also in this direction should be understood the insistence of the US Congress to extend the sanctions against the Russian Federation, which will mainly affect the European energy companies, involved in the construction of "Nord Stream 2". In this regard, the initiative of USA and Poland to forge a new Intermarium, an alliance of the central and eastern European countries, can be seen as a tool, by which to counter the opportunity for unification of the German and Russian interests in the region.

Intermarium in the form of the Three Seas Initiative, a reincarnation of the Międzymorze proposed by Józef Piłsudski nearly a century ago, held its first summit on 25th August 2016 in Dubrovnik, Croatia. It was attended by the heads of states of Croatia, Hungary, Poland, Bulgaria, Lithuania and Slovenia, and ministers from Austria, Czech Republic, Estonia, Latvia, Romania and Slovakia. The common between these countries is that they are all dependent (to a varying degree, but above 50%) on the imports of energy resources from the Russian Federation.

The second summit of the Three Seas Initiative, held on 6th and 7th July 2017 in Warsaw, Poland, was attended by the President of the United States of America. Donald Trump underlined the US readiness to export LNG to Eastern Europe and that "USA will never use energy to coerce your nations, and we cannot allow others to do so"¹⁰. The third summit of the Initiative will be held in 2018 in Bucharest, Romania. The Three Seas Initiative has two major objectives: 1. Development of the LNG terminals in Poland and Croatia and connecting them by the North-South Gas Corridor, and 2. Construction of the North-South highway "Via Carpathia", extending from Lithuania to Greece.

If we look at the Final Award of the Arbitral Tribunal in the territorial dispute between Zagreb and Ljubljana through the prism of Intermarium, we can say that it serves the interest of Germany and Russia, which with their support for Slovenia gain access to a "warm" sea (by guaranteeing access to and from the Slovenian port of Koper to international waters). The decision of the Permanent Court of Arbitration is decreasing the importance of the competitive Croatian ports, thus, indirectly, the feasibility of energy projects from south to Central Europe through Croatia (including the project for LNG terminal on the island of Krk), is being restricted.

The interests of Moscow coincide with the Germany's strive for expansion of its influence in Slovenia, as such development might decrease the US and British pressure in the region and thwart the Polish plan for establishment of "Three Seas" buffer zone. On the other side, the plan of Poland collides with the German strategic concept for development of the region along the west-east axis, implemented through the EU Strategy for the Danube Region. At the same time Germany seeks to include the non-integrated countries from the Western Balkans into regional integration processes. Such a project is the supported by the Serbian President, Aleksandar Vučić, initiative for Balkan Customs Union, which is part of the German plan for the region "Berlin plus".

The United States are against the formation of pro-Russian or pro-German centers of influence in the countries of the former SFR Yugoslavia, and especially in Serbia. For this reason, the regional integration initiatives of Washington gravitate around the establishment of Adriatic partnerships on the periphery, with leading countries Albania, Montenegro and Croatia, where the Russian and German influence is much weaker.

Furthermore, in the context of the Three Seas Initiative, it is interesting to explore why Hungary temporarily (from 21.7.2017 to 28.9.2017) expressed the position that the BRUA project should not be realized in its originally envisaged form (cutting off the access of this pipeline to CEGH Baumgarten, Austria). Firstly, this behavior

of the Hungarian state might have been directed to the satisfaction of the Russian energy interests in the region with a view to achieve a better position in the forthcoming negotiations with Gazprom in 2021. This fact transforms Hungary into an unpredictable partner from the US viewpoint. Turning BRUA into BRU would have deprived this pipeline of the possibility to transfer natural gas from CEGS Baumgarten to Southeast Europe. As a result, this infrastructure would have lost one of its main functions and could have even been used to transfer Russian natural gas from Greece, supplied via Turkish stream.

Also by this move Hungary might have pursued a violation of the interests of the companies developing the gas fields in Romania (ExxonMobil and OMV). The potential removal of the connection between this source of natural gas and the CEGS Baumgarten turns the investment in the Neptun gas field far less profitable. Additionally, by such an attempt the Hungarian political leadership might have considered the possibility to limit the potential markets for the Romanian natural gas and thus to ensure for itself better conditions for its purchase in the future. Overall, Hungary wanted to show its capabilities to influence the energy configuration in the region, but its main interest is and will continue to be an increase of the significance of the Central Eastern European Gas Exchange (CEEEX) trading hub.

3. Importance of the North-South Gas Corridor for the energy security of Eastern Europe

The North-South Gas Corridor is the leading project of the Three Seas Initiative, due to its potential to counter the Russian influence in Eastern Europe, which is closely related to the supply of energy resources. This project relies on the overall development of energy infrastructure in the region. In the south, of particular importance is the construction of the LNG terminal on the island of Krk, which initial capacity will be limited by the capacity of the gas transmission system of Croatia - 2.6 bcm of natural gas per year¹¹. After 2020 the capacity of the terminal can be upgraded up to 7 bcm of natural gas per year¹².

This in turn requires improvement of the interconnectors between the participating countries – Croatia, Hungary, Slovakia, Czech Republic and Poland (Fig. 2). The current interconnector between Croatia and Hungary (built in 2011) with capacity of 7 bcm of natural gas per year, enables gas supplies only from Hungary to Croatia. By March 2019, the Croatian side will build the infrastructure, necessary to allow reverse flow capability between the two countries¹³. The interconnector between Hungary and Slovakia (built in 2014) also requires further improvement. Its annual capacity of 4.5 bcm does not meet the ambitions of the North-South Gas Corridor project, especially considering the lower transmission capacity in the Hungarian-Slovak direction¹⁴.

Slovakia on the other side is highly concerned with the possible ending of Russian gas supplies to Ukraine as this will deprive her of the revenues from pipeline charges for the natural gas transited to the Czech Republic, Austria and Germany¹⁶. As a result, Bratislava is highly interested in the development of the North-South Gas Corridor, not only due to its dependency on Russian natural gas but also because this project will allow the country to avoid being isolated by the future major energy infrastructure in the region. The interconnector between Slovakia and the Czech Republic (Lanžhot) has reverse flow capability and capacity of around 27 bcm of natural gas per year¹⁷. In addition, interconnector between Slovakia and Poland should be constructed by 2021 with technical capacity of 4.7 bcm/y in the direction from Poland to Slovakia and of 5.7 bcm/y in the direction from Slovakia to Poland¹⁸. The interconnection between the Czech Republic and Poland is intended to have a capacity of 5 bcm/y (possibility of increase to 10 bcm/y) in both directions but its completion date remains unclear (2019-2022) due to Poland's concerns that "Nord Stream 2" will render this infrastructure unviable¹⁹.

In the end, whether or not the Czech Republic will be partially "bypassed" by the North-South Gas Corridor, this infrastructure should connect its northern side with the LNG terminal in Świnoujście, Poland, getting access to 5 bcm/y of natural gas (the capacity of the terminal will be expanded to 7.5 bcm/y by 2020). There is a possibility for connecting the North-South Gas Corridor with the proposed floating LNG terminal in Gdansk Bay, which capacity will be between 4.1 and 8.1 bcm/y. The floating LNG terminal in Klaipėda, Lithuania, probably will remain unconnected to this energy infrastructure, due to its focus on the Baltic States market. As a result, the North-South Gas Corridor will have initial access to 7.6 bcm/y of LNG imports with realistic increase to 14.5 bcm/y and maximum increase up to 22.6 bcm/y.

The current capacities for LNG imports are insufficient to affect profoundly the energy security of the countries, participating in the NSGC. Therefore, this project is highly dependent on the implementation of two other energy infrastructures - the Baltic Pipe and the Ionian-Adriatic pipeline, the last in turn, relying on the construction of the Southern Gas Corridor. The Baltic Pipe (expected completion in 2023) will have capacity of 3 bcm/y to Denmark and Sweden, and 10 bcm/y of natural gas to Poland. IAP (expected completion not earlier than 2020), on the other side, must be able to deliver 5 bcm/y to Croatia but it should be taken into consideration that the future of the whole Southern Gas Corridor remains unclear. Despite the recent political and financial support for this project it is very probable that it might share the destiny of "Nabucco" pipeline.

Consequently, by 2023 the NSGC, optimistically, will have access to 15 bcm/y of natural gas supplied by pipelines. Such scenario underlines the importance of this project, as a total of 29.5 bcm/y of natural gas flowing along the participating states, with the possibility of export to other eastern European countries holds the potential to gravely threaten the Russian interests in the region.

4. Hypotheses, answering the main research question

Since the Final Award of the Permanent Court of Arbitration, regarding the dispute between Slovenia and Croatia, was issued, the German Embassy in Croatia, the German Foreign Minister and even the German Chancellor expressed the position that the ruling of the Tribunal must be respected and implemented, thus indirectly supporting the Slovenian side. The analysis made in the previous sections of the article allows us to return to the main research question: *Why the Federal Republic of Germany is supporting the Republic of Slovenia in its territorial dispute with the Republic of Croatia?*



Fig. 2 Route of the North-South Gas Corridor (blue dotted line)¹⁵

First, the decision of the Arbitral Tribunal imposes an undeniable connection between the territorial sea of Slovenia and international waters, thus preserving the opportunity for construction of LNG terminal in the country. This entirely correlates with the German interests in the region as the implementation of such a project, or simply the possibility for this action, has the potential to weaken the importance of the North-South Gas Corridor. The construction of a competitive LNG terminal in Slovenia may be used by Germany as a tool for undercutting the price of the LNG exported by the United States to the region.

As a result, this will render the deliveries from USA economically unviable and will drive them out of the market. It is very unlikely for the US companies to subordinate their own interests to the priorities of the government and will rather continue to target markets with the highest gas prices (the European is not one of them). Therefore, such a chain of events might be seen as desirable by the German state, especially considering that a direct competition between the Russian natural gas, imported by "Nord Stream" and the US LNG, is avoided, and instead a narrative closer to the market logic is being presented.

There had been an idea for the construction of a LNG terminal in the Northern Adriatic since 2004. The project for such an energy infrastructure in Trieste (Zaule) had been rejected in 2013 after protests from the Republic of Slovenia. In the light of the aforementioned interests of Germany, the construction of a LNG terminal in a state as Italy, able to withstand to a greater degree external political and economic pressure, is not as valuable as positioning this infrastructure in a much smaller state as Slovenia. The last scenario gives more freedom to Berlin to use such a terminal as a tool to achieve its own interests of blocking the US LNG deliveries to Europe. The possible reason for adherence to the outlined behavior is preservation of the competitive advantage, being derived by the "special energy relations" between Germany and the Russian Federation. These special relations are expressed in some of the lowest prices of Russian natural gas for the German market, as in 2013 in only five countries this energy resource was cheaper (Belarus, Armenia, Great Britain, Moldova and Netherlands) (Fig. 3). Three of them are subjected to significant Russian influence, one is a prospective market for "Nord Stream 2" and the last is still a major natural gas producer.

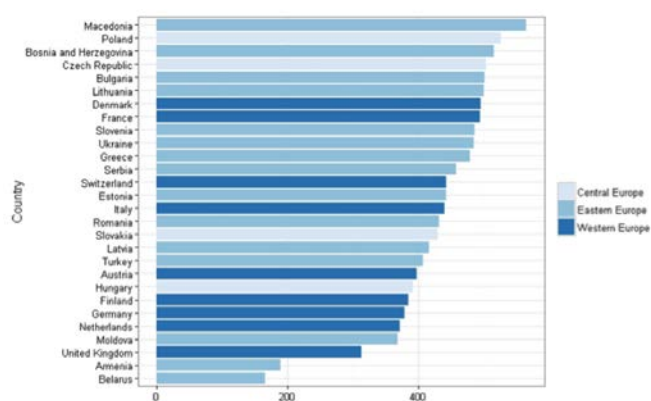


Fig. 3 Average natural gas price paid to Gazprom by country in 2013 (in Euro per 1000 m³)²⁰

Second, Germany wants to prevent the US becoming an actor in the European energy market, as this may initiate a chain of events ending with a drop of Russian natural gas prices for the Eastern European countries and thereby indirectly undermining the German foreign trade interests. There is a clear opposition between, on one hand, Germany and Austria, and the US and Poland, on the other, with regard to the construction of the "Nord Stream 2" project. For Germany, this project, despite it leads to almost complete dependence on Russian natural gas (hypothetically it can reach 100%), is the most advantageous option, because Gazprom offers lower prices than the other competitors, and the concessions to

Berlin derive not only from the market logic, but also from the geopolitical interests of the Russian state. In order to avoid complete isolation, Moscow is forced to seek ways by which to maintain and improve its relations with the German political leadership.

In addition, Germany is Gazprom's main market in Europe, which in turn gives rise to an opposite dependency for the Russian side as well. Furthermore, account should be taken of the fact that the Russian Federation is dependent on German supplies of high-tech products. As a result, Russia is not able to use natural gas deliveries to Germany as a means of influence in the way it does with Poland, Bulgaria, Lithuania, Latvia and Estonia. US LNG supplies to the Eastern European countries also limit the possibility for Germany to resell natural gas to these markets. If "Nord Stream 2" is built, Germany will have a surplus of at least 30 bcm/y of natural gas (without considering the deliveries through Yamal and Transgas). This surplus may be diverted toward the countries participating in the North-South Gas Corridor project (attention in this respect deserves the route OPAL-Gazelle-Stork II), as long as the access of this infrastructure to natural gas sources is successfully blocked.

The NSGC alone is useless if it does not connect to Norway from the north via the Baltic Pipe, Azerbaijan to the south through the Southern Gas Corridor and the Ionian-Adriatic pipeline, and without building the floating LNG terminal "Adria" on the island of Krk, and an increase to both its capacity and the capacity of the gas transmission system of Croatia. Expansion of the capacity of the LNG terminal in Świnoujście is also a prerequisite for further increase of the significance of the NSGC. In the moderately optimistic case, along the NSGC will flow around 30 bcm/y of natural gas. It is in the interest of Germany that this does not happen.

Third, the development of such a large-scale energy infrastructure as the NSGC and all of its accompanying projects, which bypasses Germany and Austria and is not linked to the Central European Gas Hub in Baumgarten, is at best viewed by Berlin and Vienna as unbeneficial. The natural gas flowing through the Southern Gas Corridor can reach Baumgarten via Italy and the TAG pipeline, or Germany and France via Switzerland and the Transgas pipeline. Initially, the natural gas flowing through the Trans-Adriatic pipeline at best would be around 10 bcm/y (as long as no quantities are being diverted through the Ionian-Adriatic pipeline), and at a later stage 20 bcm/y. But such capacity cannot be used, as the Trans-Anatolian natural gas pipeline will start operation (2018) at a capacity of 16 bcm/y, which might be expanded up to 22 bcm/y by 2023 and 31 bcm/y by 2026.

Even if the latter figure is accepted, 6 bcm/y of natural gas would be used by Turkey, further 4.4 bcm/y might be diverted through the BRUA pipeline and if another 5 bcm/y are being directed to the Ionian-Adriatic pipeline, then no more than 15.6 bcm/y of natural gas will reach Italy. In the initial stage of operation of TANAP and TAP, the quantities of natural gas reaching Italy would not exceed 4 bcm/y (considering that BRUA's initial capacity of 1.75 bcm/y and IAP are operational). Therefore, Germany may perceive IAP and BRUA projects as diverting quantities that otherwise would have reached its territory or CEGH Baumgarten. In this situation, Germany might seek to block the implementation of the IAP project and to reduce the NSGC to construction of bi-directional interconnectors, without providing real access to alternative natural gas sources.

Furthermore, Germany may attempt to hinder IAP and BRUA projects in order to support Russia's interests related to the construction of "Turkish Stream" to full capacity and the accompanying Easting and Tesla pipelines. In return, the Russian state may (continue to) offer more favorable prices for the natural gas sold to Germany. Berlin earns double from this - ensuring Russia's benevolence in the supply of energy resources (including crude oil, 34% of the crude oil imported to Germany in 2016 is

from the Russian Federation), and preserving the access to the Southern Gas Corridor capacity via Italy. In this respect, account should be taken of the fact that Italy's gas transmission system is already loaded with the task to transport along the south-north axis large quantities of natural gas from the Trans-Mediterranean pipeline and Green stream. Hence, its ability to transfer larger quantities from the Southern Gas Corridor may be questioned.

And lastly, by creating difficulties to the realization of the North-South Gas Corridor, Germany may seek blockage of the Polish state intentions to build a gas hub on its territory.

5. Conclusion

The study successfully outlined hypotheses, answering the main research question raised before the current article. They may form different combinations to explain the actually observed situation, but more importantly, in the course of the work it was revealed that behind the territorial dispute between Slovenia and Croatia lay the interests of the major geopolitical actors, that further interweave with the aspirations of powerful energy corporations. As a result, emerges a situation in which Friedrich Naumann's "Mitteleuropa" is opposed to Józef Piłsudski's "Intermarium", and the intersection between political and economic more often becomes expressed by the energy issues, whose geopolitical dimensions remain the most accurate indicator of the strategic priorities pursued by the most powerful states in the world. The examined local dispute is just a small piece of the greater geopolitical puzzle stemming from the struggle for configuring the Eurasian space.

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MEASUREMENTS OF SPEED AND DIAMETERS OF DROPLETS OF FOGS WITH DEVICES, OPERATING ON THE BASIS OF THE SURFACE PHOTO-CHARGE EFFECT

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Abstract: This work is related to development of a new type of fog sensors and measurement devices. We study fogs, their properties, and especially their ability to clean different contaminants from the air, such as chemical, biological, radiological and nuclear (CBRN) agents. In that sense, fog can be used for effective counteraction to terrorist attacks and for prevention of industrial accidents and disasters. In this paper, we present the possibility for measurements of fog parameters using the Surface photo-charge effect (SPCE) and some results obtained in that way concerning size and speed of droplets. Knowledge of these fog parameters is important in order to gain a more practical insight about the optimization of the penetration and cleaning properties of fogs used for large scale decontamination.

Keywords: DROPLETS DIAMETER, FOG, CLEANING PROPERTIES, SURFACE PHOTO-CHARGE EFFECT

1. Introduction

Fog is a natural phenomenon consisting of a large amount of small liquid water droplets (wet fog) or ice crystals (ice fog) suspended in the air near the ground. When the air cools down to its dew point, it becomes fully saturated with water vapour. This vapour condenses around tiny microscopic particles in the air, such as dust, and forms water droplets with diameters under 100µm. When the amount of water droplets is sufficient, fog is made. In general, the cooling of the earth overnight allows condensation and, hence, fog. Fog can form over ground and over water and is essential for the Earth's climate. The required conditions for fog formation that must be fulfilled are high relative humidity, low temperature and mild wind.

The fog property of great interest for our experiments is the ability of the fog droplets to scavenge boundary layer pollutants and remove them from the atmosphere. A brief example for the importance of fog for human health is the finding [1] that fog inhalation is capable of inducing cough and changes in breathing patterns in healthy subjects. In urban areas, polluting technologies provoke more frequent and longer-lasting fog called smog that can cause allergies in the human population. Fog has effects on plants, microorganisms, public transport and aviation, too. Our data is consistent with other research findings about the smog in towns [5, 6] which state that denser fog events correlate with the amount of polluting substances in the air. This also leads to the conclusion that the amount of fine particles in the air is an important premise for dense fog events.

2. Preconditions and means for resolving the problem

The national security can benefit from the fog property to collect chemical, biological, radiological or nuclear agents. In case of air pollution, fog can be used as an effective and non-expensive method for capturing the pollutant and cleaning the atmosphere. In crowded areas, such as public or private buildings, open space areas in town centres, this is a non-expensive and risk-free method for achieving this goal. This requires the installation of fog generating systems on key buildings in order to reach the maximum of a contaminated area. Some of their components are illustrated in Fig. 1 and Fig. 2. For the optimal use and settings of these devices, we must acquire detailed information about the droplets' size and speed in order to scavenge a variety of substances. Thus, previous studies have shown that the fog ability to collect contaminants depends on the water droplets size and speed.

A new possible solution to this problem is the development of sensors operating on the basis of SPCE which could help us determine the values of many fog parameters, such as presence of

the fog in a particular area, diameter and speed of the fog droplets. Such sensor functions as following: The interaction of samples with electromagnetic radiation in the visible region results in generation of an alternating electric signal - surface photo charge effect (SPCE). SPCE is shortly defined as the interaction of every substance with electromagnetic field, which induces a measurable electric, alternating potential difference between the irradiated sample and the common electric ground of the system, with the same frequency as the frequency of the incident field. The measurement is contactless and fast. In contrast to other similar effects, the SPCE is present in any solid body [4].

3. Solution of the examined problem

In the past, the question of how to measure the optimal fog parameters, such as particles diameter and speed, was investigated by other scientists and different particles sizing techniques were invented. Some of them are the interferometric particle imaging, global phase Doppler [2], differential centrifugal sedimentation (DCS), and nanoparticle tracking analysis (NTA) [3]. Most of these methods require lasers, which measure the intensity of the emitted light after the interaction with the particle and deduce from the difference in the intensity the diameter of the particle. Such sensitive apparatus is typically not suited to measure data outside of the controlled conditions in a laboratory. In comparison to this, the devices we work with do not need any specific training for the staff operating them and are less expensive.

In order to test our new method, we developed different devices that provide information about the speed and size of the fog droplets. Such devices are, for example, Fog Detector 2 and 6 and they are displayed in Fig. 1 and Fig.2. Each of them has a different arrangement of components, but they are all capable of giving information about the presence of fog and its properties.



Fig.1. Fog Detector 2

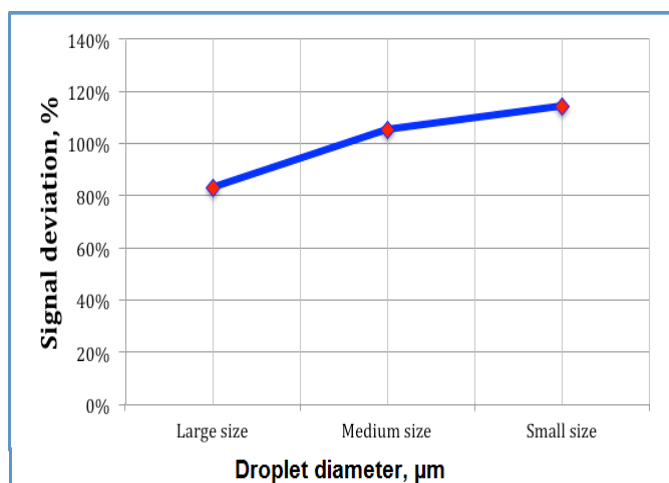


Fig.2. Fog Detector 6

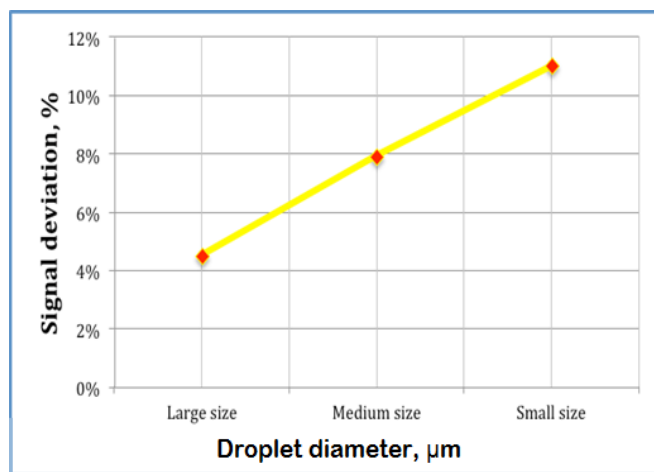
4. Results and discussion

Due to the sensitivity of our devices for a variety of parameters, including the surface of a probe, the size and speed of a droplet also effect the data we receive from them. It is known from previous studies that smaller fog droplets have greater cleaning properties and capture more impurities from the polluted air. The theory behind this fact is that smaller droplets capture also molecules of polluting chemicals unreachable for larger droplets and so manage to scavenge larger assortment of substances. In order to optimize the cleaning process, we need to be able to control the diameter and speed of the water droplets. We conducted many experiment with the fog detectors which showed that it is possible in principle to obtain this information with our devices. To demonstrate this, we provide some of the data in form of diagrams below. It is important to note that using the FD-2 and FD-6 that we mentioned before, we can achieve our goals – to alarm the occurrence of contaminants in the air, to control whether the fog has reached all areas of the area being cleaned, and to receive information about the diameter and speed of fog droplets. Using the SPCE we detect the presence of fog of distilled water in the examined area.

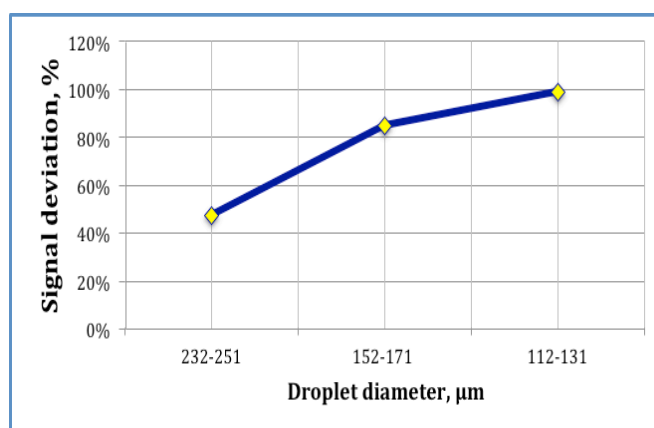
We conducted the experiment with different devices with similar results. In general, the value of the measured deviation from the initial signal irradiation the probe depends on the tested substance and its surface. The results from our experiments are displayed in Figures 3a – 3d.



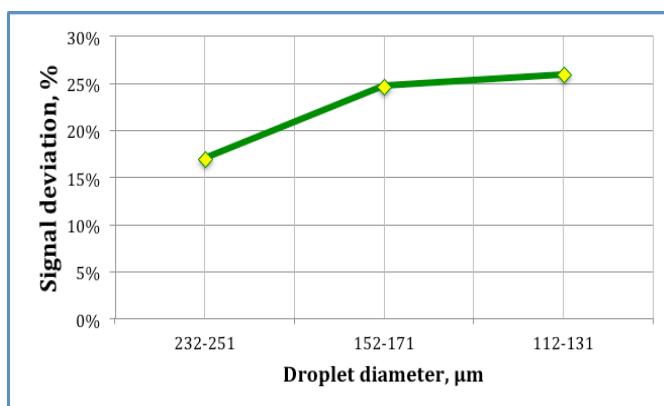
3.a



3.b



3.c



3.d.

Figure 3. Influence of droplets' diameter

Here we illustrate the dependence between the droplet diameter and the deviation from the initial signal when dispersing the fog. For the test results displayed in fig. 3a was used FD-6, in 3.b - FD-2, in 3.c - FD-3 and in 3.d the data comes from FD-4. The distance between the active and passive blocks of FD-3 was 1 m, distance from the nozzle to the optical line was half a meter. In Fig. 3.a and 3.b, large and medium size correspond to particles' diameters of 232-251 μm and 152-171 μm , respectively. The four diagrams state that smaller droplet cause a larger deviation from the initial signal compared to bigger droplets. Probably, the reason for this is that the number of smaller droplets is greater per unit volume than the number of bigger ones.

The second component we must take into account is the speed of the droplets and we measured its influence in a different experiment. Outside of the controlled environment in the scientific laboratory, wind is a common natural phenomena

and it is important for us to understand how it changes the values we measure. The data we received from this experiment is plotted in figure 4 below.

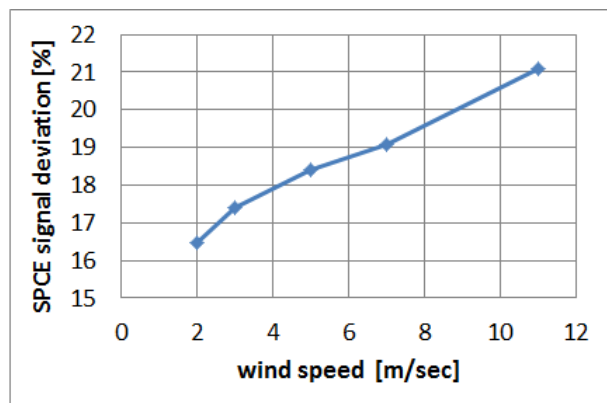


Fig.4. Signals deviation as a function of wind speed with FD6

On this diagram, we have shown the signal deviation in dependence of the wind speed (corresponding to the speed distribution of the droplets). The data clearly states that faster winds cause bigger deviation. A probable explanation for this is that greater speeds of the droplets allows a greater amount of them to interact with the sensor per unit of time.

5. Conclusion

In this paper, we briefly discussed the role of droplets size and speed over fog detectors working with the Surface photo-charge effect. The size and speed of water droplets in the fog influence many fog properties, such as scavenge and clean particles from a particular polluted area. Fog with predominant larger particles' diameter shows smaller deviation in the received by our devices signal in comparison to fog with smaller water droplets. This phenomena could influence the fog ability to collect effectively impurities and how our devices measure this process. The second parameter that has effects on the system in natural conditions is the droplets' speed. Greater droplets' speed interferes with the measurement and permits interaction between larger quantity of droplets and the sensor, which leads to stronger deviation from the initial signal.

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INVESTIGATION OF VARIOUS COMBINATIONS OF MATERIALS USED IN ARMORED VESTS FOR KNIFE PENETRATION PROTECTION

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Abstract: The report presents investigation of the protective characteristics against knife penetration of several combinations of materials used in armored vests. Experimental results for each combination obtained by testing with two types of knives at various energies of impact are analyzed and interpreted.

Key words: *blade, energy, penetration*

INTRODUCTION

The problem of the individual protection is of exceptional relevance in the contemporary complex international and internal situation, related to the occurrence of local conflicts, terrorism, violations of the personality, migration phenomena and others. This necessitates adequate measures of opposition from the security and defense authorities to maintaining the health and safety of soldiers, security personnel, controlling public disorders, police operations, personal protection and critical infrastructure protection.

The use of new materials and their effective combinations is important in this respect, in order to provide resistance to the wide variety of weapons - firearms and cold weapons.

EXPERIMENTAL PART

For the past two to three decades there has been remarkable progress in the experimental and theoretical study of dynamic processes in the penetration of solids bodies in different environments. The accumulated factual experimental material characterizes the physical-mechanical properties of a large number of different types of solid screens for which different model environments have been proposed to describe the movement in a multi-component environment.

Test equipment and procedure

The experimental equipment for conducting tests of the armored vests resistance against stabbing with a knife consists of a specially designed test stand and speed measuring equipment.

The stand is designed to meet the requirements of the two leading standards in the field - NIJ 0115.00 and HOSDB 2007 - Part 3, regulating the test requirements for piercing bulletproof vests and the criteria for determining the respective levels of protection.

The construction of the stand is built so that it can be used for testing all levels of protection regulated in the aforementioned standardization documents. Coverage of a given level of

protection is ensured by performing a number of penetrations with a specified impact energy that must be provided by free fall of the piercing blade from a height calculated for that purpose. The integral testing system is carefully designed to allow the mass to fall under its own weight and to hit the test piece of a bulletproof vest at the specified point of impact. The guides do not allow rotation of the falling mass around its vertical axis, thus keeping the orientation of the falling body unchanged until the end of the test.

The tests were conducted under the conditions and in the order, described in the methodology developed for this purpose, for the protection levels specified in *Table 1*.

Table 1. Protection levels

Protection level	Energy of impact „E1“, J	Maximum allowable penetration of the blade, mm	Energy of impact „E2“, J	Maximum allowable penetration of the blade, mm
1	24±0.50	7	36±0.60	20
2	33±0.60	7	50±0.70	20
3	43±0.60	7	65±0.80	20

Level 1 provides protection against low energy threats with impact energy ranging from 24 J ± 0.50 J to 36 J ± 0.60 J. The armor must withstand a break with energy of impact of 24 J with the maximum allowable penetration of the blade not greater than 7 mm. After that, a power impact test of 36 J was performed, where the maximum allowable penetration of the blade must not be more than 20 mm.

Level 2 provides protection from medium energy threats with impact energy ranging from 33 J ± 0.60 J to 50 J ± 0.70 J. The armor must withstand puncture impact energy of 33 J with the maximum allowable penetration of the blade not greater than 7 mm. A power impact test 50 J was performed, where the maximum allowable penetration of the blade must not more than 20 mm.

Testing was carried out with engineering knives (high-quality, factory-made knives with cutting edges). Two types of blades were used - type P1 and type S1, which are the two types of sharpened weapons most commonly used in attacks.

Blade type P1 (*Fig.1*) is representative of a simple small knife, it is smaller and thinner and has one sharpened edge, whereas a blade type S1 (*Fig.2*) is representative of a knife used

by the commandos, or a large kitchen knife - it is bigger, thicker and has two sharpened edges. Both types of test blades are hardened, with Rockwell hardness, scale C, within the range 50–140 HRC and have a pointed tip and a stable base.



Fig.1. Test blade type P1.



Fig.2. Test blade type S1.

The tests were carried out at a meeting angle of the test blade and the test specimen 0° relative to the normal.

Before the tests, the impact energy was calibrated by calculating the fall height required for achieving the desired speeds corresponding to the impact energy, for each value of impact energy and for each type of test blade, using the equation (1).

The drop height is measured from the tip of the test blade to the surface of the bulletproof test specimen.

$$h = E/mg \quad (1)$$

where:

h is the height of the fall, m

E is the kinetic energy of impact, J

m is the mass of the falling shuttle, with the test blade with accuracy of 1 g

g is the gravitational acceleration, m/s^2 .

The places of penetrations were marked on the armor. Then the bolster material, indicator paper and the test sample of a armored vest were placed, ensuring their immobility tightening them to the base of the stand by means of elastic straps of width, fastened with Velcro® strips. After that the test blade was mounted.

An correct measurement of the impact velocity was provided by a pair of photoelectric light screens mounted at a distance of $25 \text{ mm} \pm 2 \text{ mm}$ from the point of impact of the test sample of the armored vest, providing measurement with an accuracy up to $\pm 0.2 \text{ m/s}$.

When conducting the puncture resistance tests to meet the requirements at a given level, a series of tests according to Table 2 were performed for each combination of materials composing a flexible ballistic panel of a armored vest.

Table 2. Test conditions

Number of punches	Angle of meeting	Test blade type	Energy level
6	0°	P1	E1
6	0°	P1	E2
6	0°	S1	E1
6	0°	S1	E2

The measured results were converted to the depth of penetration according to the penetration depth conversion tables. The results were recorded in a test report.

The average arithmetic values of the measured penetration depths were determined using the equation (2).

$$dcp = \frac{1}{n} \sum_{i=1}^n di \quad (2)$$

where:

d is the depth of penetration, mm

n is the number of experiments conducted

i is a sequential experiment number.

Test samples

Tests have been carried out to determine the protective properties of flexible ballistic flasks of armored vests in terms of their resistance to penetration, made up of different combinations of materials.

The tested samples of flexible ballistic panels were divided into three groups, depending on the materials used and their combinations.

A packet of Dyneema® SB51 sheet with a density of 253 g/m^2 was used for the core packet of each group. The base packet weight was 4.807 kg/m^2 .

The additional packages represent a certain combination of materials and are different for each specimen.

The main and additional packs were placed in an outer 100% Polyester pouch weighing 0.165 kg/m^2 .

For all specimens, the face (impact) surface was on the side of the additional package.

First group of samples

To the base package is added an additional package made up of a different combination of Dyneema® SB51 based materials on which SiC, Al_2O_3 and polyvinyl chloride were strewd. For bonding between the two materials resin is used.

Second group of samples

To the base package is added an additional package made up of a different combination of Kevlar® XP based materials on which SiC, Al_2O_3 and polyvinyl chloride were strewd. For bonding between the two materials resin is used.

Third group of samples

An additional package is added to the basic package, made up of a different combination of textile-based materials on which Al_2O_3 and SiC were strewd. For bonding between the two

materials resin is used. To some combinations Kevlar® XP or Dyneema® SB51 were added.

EXPERIMENTAL RESULTS ANALYSIS

As a result of the analysis, evaluation and comparison of the results from the conducted tests for penetration resistance of the samples, it was obtained, as follows:

- For the First group of samples:

Sample 1.1 covers the penetration requirements for level 1 and for level 2 only with a test tip S1. Using a P1 test blade, the protection levels are not covered.

Sample 1.2 covers level 1 for both types of test blades (P1 and S1). Level 2 is only covered with a test blade type S1. This is the lowest weight sample of the group, which shows the best puncture resistance. The sample has been subjected to a ballistic resistance test for the protection level IIIA tested.

Sample 1.3 covers level 1 with both types of test blades (P1 and S1). Level 2 is only covered with a test blade type S1.

Sample 1.4 covers the penetration requirements for protection levels 1 and 2 only with a S1 test blade. Using a P1 test blade, the protection levels are not covered.

- For the Second group of samples:

All samples in this group (Sample 2.1, Sample 2.2, Sample 2.3 and Sample 2.4) meet the penetration requirements for Level 1 and Level 2 with a type S1 test blade only. Using the P1 type test blade, the protection levels are not covered.

Sample 2.2 has the lowest weight of this group. It also exhibits the best puncture resistance. This sample has been subjected to a ballistic resistance test for the protection level IIIA tested.

- For the Third group of samples:

Sample 3.1 and Sample 3.4 meet the penetration requirements for protection levels 1 and 2, both with the type S1 test blade and the type P1 test blade.

Sample 3.2 and Sample 3.3 meet the penetration requirements for level 1 with both types of blades (P1 and S1). Level 2 is only covered with a test blade type S1.

Sample 3.4 has the lowest weight of this group. It also exhibits the best puncture resistance. The sample has been subjected to a ballistic resistance test for the protection level IIIA tested.

CONCLUSIONS

1. It was found that from all tested samples the best protective properties with respect to puncture resistance and ballistic resistance are shown by Sample 3.4, which has the lowest overall weight of the panel.

2. In the process of improving the resistance of bulletproof vests various materials can be used such as Dyneema SB51, Al₂O₃, SiC, which, in the tested combination (Sample 3.4), show optimum results in weight of the panel and the protective properties against piercing.

3. The specimens additionally tested for ballistic resistance cover the requirements for level of protection IIIA,

according to NIJ 0101.04 and NIJ 0101.06, further supporting a 7.62x25 FMJ RN cartridge.

4. An armored vest by materials of the combination used in Sample 3.4 is manufactured, which will meet the requirements of the Ministry of Defense of the Republic of Bulgaria and those of the Police of the Republic of Bulgaria in terms of weight and protective properties and will be competitive on both the national and the international market.

LITERATURE

- [1] NIJ 0101.04
- [2] NIJ 0101.06
- [3] NIJ 0115.00
- [4] HOSDB 2007

AN EXPERIMENTAL INVESTIGATION OF THE 122mm ARTILLERY SYSTEM FIRING ACOUSTIC FIELD

ЕКСПЕРИМЕНТАЛНО ИЗСЛЕДВАНЕ НА АКУСТИЧНОТО ПОЛЕ ПРИ СТРЕЛБА СЪС 122ММ АРТИЛЕРИЙСКА СИСТЕМА

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Abstract: In the recent years, the battlefield acoustic exploration acquires a new dimension. This is due to the fact that modern weapons have a significantly increased distance of defeat, but the intelligence cannot detect such weapons at a sufficiently distance. In this connection the purpose of the present study is to investigate the near acoustic field of 122 mm artillery system firing. The collected with advanced technology equipment raw data were analyzed with the harmonic and wavelet analysis tools.

Keywords: ACOUSTICS, ARTILLERY SYSTEMS, MICROPHONES, WAVELET ANALYSIS, SCALOGRAM

1. Introduction

Weapon acoustic analysis has practical applications in many fields such as security, gun control or military tactics. Thus, the acoustic signature produced by explosive propelled weapons has been subject of study from many years now [1]. In the recent years, especially in The Middle East and Afghanistan this field has become more relevant mainly due to the development of sniper detection, heavy weapons and localization systems. The biggest problem in this field is the strong dependence on the shooter's location and orientation shown by the recorded waveforms, mostly because the acoustic disturbance created by firearms is highly directional and its short time duration makes it behave like an impulse.

Our work describes analysis and results of measurements of the 122 mm 2S1 howitzer conducted at Markovo training range on the 05 of October 2017. The measurements were made at distance of 24 m from the muzzle of the weapon. This is one of the noisiest weapons in the Bulgarian army, and as such represents a limiting factor when planning firing ranges and training fields. The 2S1 was placed at Markovo training range just southeast of the City of Shumen, and there were two targets. The right one was at 1200 m from the howitzer, and the left one was at 1050 m, Fig.1.



Fig.1. 122 mm 2S1

2. Preconditions and means for resolving the problem

2.1 Theoretical Model

2.1.1 Continuous wavelet transform method

Continuous wavelet transform (CWT) is used to analyze the structure of sound signals. The scalograms made up by this method ensures better visualization of the local characteristics of the signals.[2,5].

Like the Fourier transform, the continuous wavelet transform uses inner products to measure the similarity between a signal and an

analyzing function. In the Fourier transform, the analyzing functions are complex exponentials, $e^{j\omega t}$. The resulting transform is a function of a single variable ω . In the CWT, the analyzing function is a wavelet, ψ . In contrast to traditional power spectral method, the continuous wavelet transform method is a joint time-frequency analysis method which can decompose a time series into time and frequency spaces simultaneously. The continuous wavelet transform can be defined as:

$$W_x(\tau, a) = \int_{-\infty}^{\infty} x(t) \Psi_{a,\tau}^*(t) dt \quad (1)$$

where W_x is the wavelet coefficient, $x(t)$ is the time series of experimental signal, $\Psi_{a,\tau}(t)$ is the wavelet function, and the symbol * denotes the complex conjugate. The wavelet function is obtained by varying the wavelet scale a and the time delay τ of the mother wavelet function $\Psi(t)$ as:

$$\Psi_{a,\tau}(t) = a^{-1/2} \psi\left(\frac{t-\tau}{a}\right) \quad (2)$$

Multiplying each coefficient by the appropriately scaled and shifted wavelet yields the constituent wavelets of the original signal. There are many different admissible wavelets that can be used in the CWT. While it may seem confusing that there are so many choices for the analyzing wavelet, it is actually strength of wavelet analysis. [2]

2.2 Experimental setup

The experimental layout is pictured in Fig. 2.



Fig.2 A part of hardware for data acquisition of pulse acoustic signals

The hardware and accessories are listed in Table 1.

Table 1: Hardware and accessories.

Laptop Lenovo Think Pad E540
Laptop Toshiba Satellite C650D-112
1/2" Pressure-field Microphone 4193, Brüel & Kjær
Data Acquisition Unit 3560-B-110, Brüel & Kjær

The records were made using microphone Brüel & Kjær Type 4193, with the following features:

- Sensitivity: 12.5 mV/Pa
- Frequency: 0.07 Hz-20 kHz
- Dynamic Range: 19- 62 dB
- Temperature: -30 to +300°C (-22 to +572°F)
- Polarization: 200 V [3]

and processed by the Multi-Analyzer System Type PULSE 3560-B-110, Brüel & Kjær with features:

- Frequency Range - from 0 Hz to 25.6 kHz;
- Aux. Channels - 16 Aux Input, (10 samples/s, 2 Digital Output);
- Simultaneous Channels - 5 Input, 1 Sine Output;
- Connectors – LEMO, BNC;
- Input Type – LEMO - Direct/CCLD /Mic. Preamp1 Tacho Conditioning
- BNC - Direct/CCLD/1 Tacho Conditioning. [4]

The microphone was placed 4,5 m above the ground, 24 m. away from the muzzle of the howitzer and at an angle of approximately 120 degrees from the muzzle direction. Single shots and salvo were recorded during the firing exercises.

2.2.2 Acoustic source

The acoustic pressure field was generated by a self-propelled field Howitzer – 2S1 "Gvozdika". This has a 122 mm barrel with a maximum chamber pressure approximately 40MPa. The ammunition modules were 3VOF5, each containing 3.67 kg propelling charge. The data were collected from four blasts.

2.2.1 Meteorological conditions

The weather was still with no cloud cover, and stable over the entire measurement period. No temperature or pressure profiles were recorded. The conditions are summarized in Table 2.

Table 2: Meteorological overview

Quantity	Value
Temperature	22°C
Atmospheric pressure	1027 hPa
Humidity	40%
Wind speed	2 m/s

2.2.2 Measurement and results

Explosive propelled weapons produce their characteristic sound as a result of the rapid expansion of gases at the end of their barrel, formally known as muzzle blast. The second component is the shock wave created by supersonic projectiles. It is commonly called N-wave due to its characteristic geometry and, unlike the muzzle blast, it has a local influence since it only appears at distances close enough to the trajectory of the projectile. In close range recordings, ground reflections from both muzzle blasts and shock waves, along with the sound produced by the firing mechanism of the weapon, are most likely overlapped with the direct signal. Fig. 3 illustrates

recorded muzzle blasts from two 2S1 howitzer firing simultaneously.

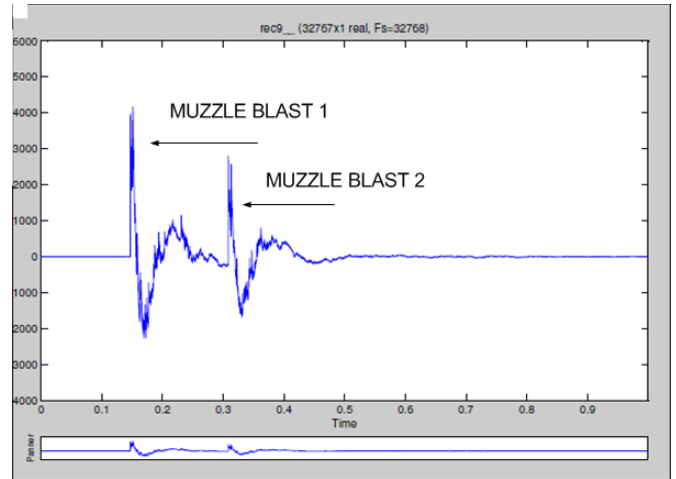
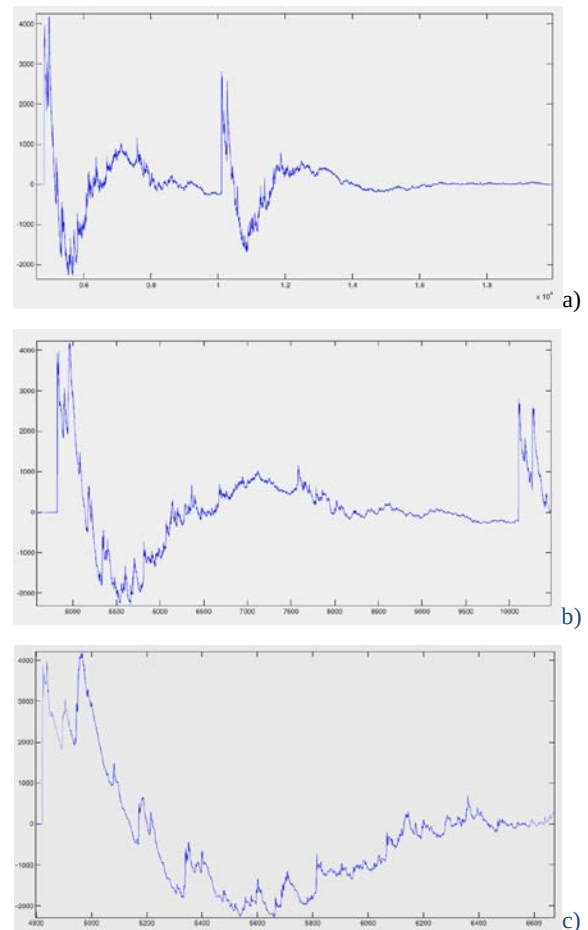


Fig. 3 Recorded muzzle blasts.

The data from the training range, collected during the tactical exercises, on the 05 of October 2017, were exported from PULSE platform as *mat* files and *wav* files, to be processed in MATLAB®. The signals, captured from the microphone, were analyzed in time-frequency domain and time-scale domain.

A four parts time signal from the first blast from 122 mm 2S1 howitzer ("Gvozdika ") is illustrated on Fig.4, where a) is the signals captured from two blasts from the two howitzers ("Salvo"), b) is the first from two blasts , c) is the first 1800 samples and d) first 300 samples, $F_s = 2^{16} \text{ samp./sec}$.



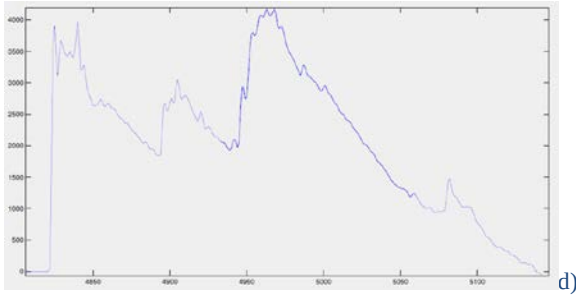


Fig. 4 Some pulse acoustic signals. a) the signals captured from two blasts (“Salvo”), b) the first from two blasts, c) the first 1800 samples and d) the first 300 samples, $F_s = 2^{16}$ samp./sec.

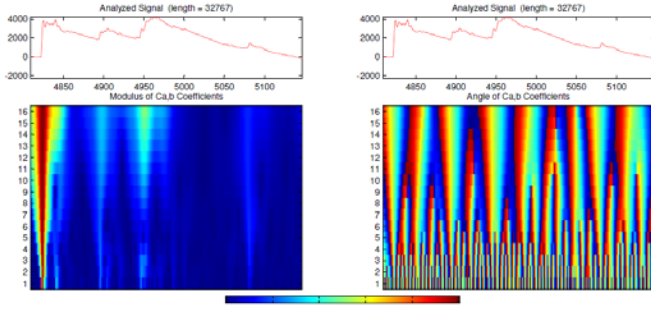


Fig. 5 Contour plot of the Gauss wavelet coefficients, complex wavelet $cgau3$, $a=16$, sampling period 2 to 16

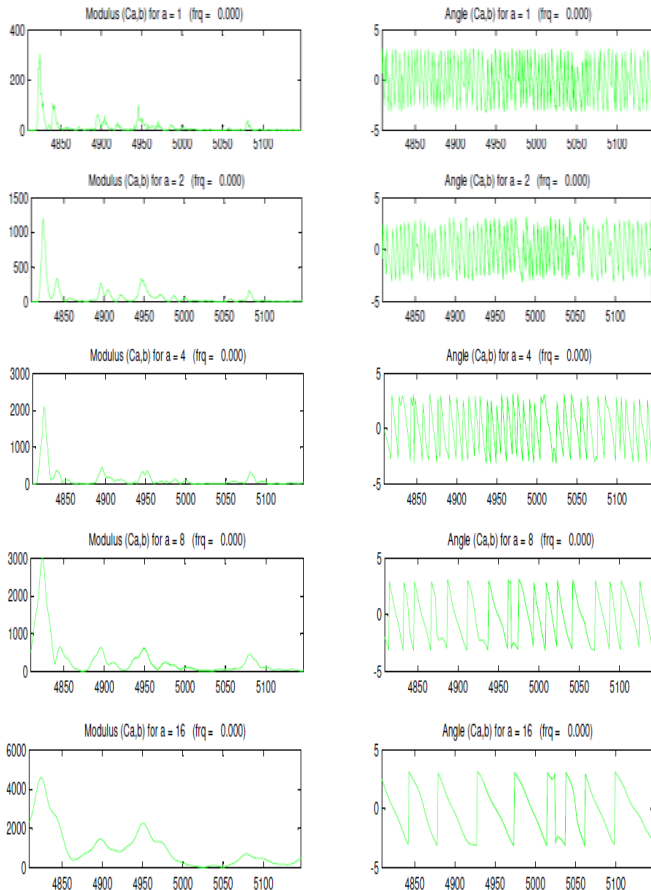


Fig. 6 Coefficients lines for complex wavelet $cgau3$, $a = 1, 2, 4, 8$ and 16.

It is known that the complex Gaussian function family is built starting from $C_p e^{-ix} e^{-x^2}$, [6]. C_p is such that the 2-norm of the p^{th} derivative of Ψ is equal to 1, $\|f^{(p)}\|^2 = 1$.

A complex wavelet function such as Gaussian complex wavelet return both amplitude and phase information. When this wavelets for the time signal is applied, the result is shown in Fig.5, and it contains useful acoustic information.

The coefficients lines for some scale parameter values, $a = 1, 2, 4, 8$ and 16, are displayed in fig. 6 and the maxima lines for $a = 1, 2, 4, 8$ and 15, are displayed in fig. 7.

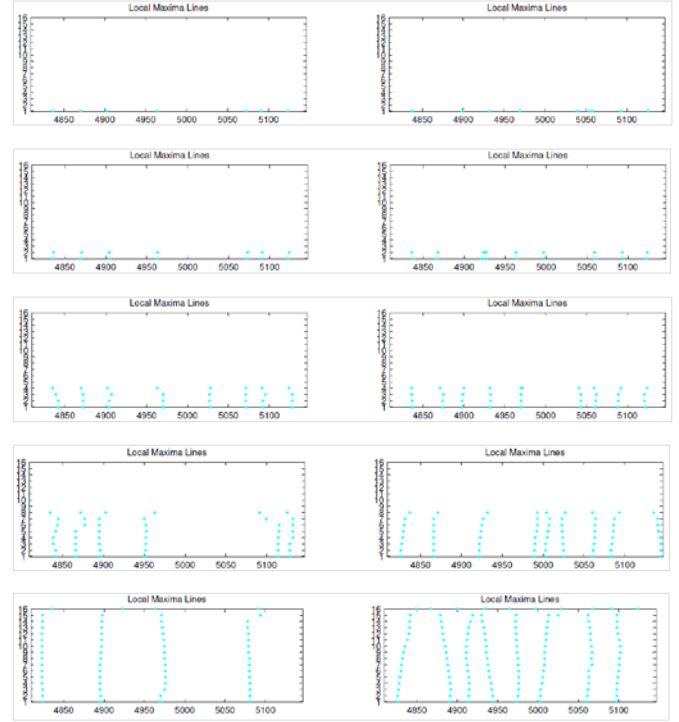


Fig. 7 Maxima lines for complex wavelet $cgau3$, $a = 1, 2, 4, 8$ and 15 (in the top, $a=1$, the bottom $a=15$, in left modulus in right angle)

3. Conclusion

The complex wavelet function transforms and its application in shooting analysis are discussed in this paper. The complex Gaussian wavelet transform was used for analyzing the time captured signals. It was demonstrated that this transform was appropriate to detail analysis the characteristics of blast acoustic signals.

4. Acknowledgments

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COMPARATIVE ANALYSIS OF THE ARMAMENT AND EQUIPMENT SUPPORT MODULES IN THE FIELD OF COMMAND AND CONTROL INFORMATION SYSTEMS OF NATO ARMIES

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Abstract: In the paper is made a comparative analysis of the armament and equipment support modules in the field of information systems for command and control of NATO armies and the main functions of each information system for maintenance of the logistical assurance.

The classification of information systems is made depending on the integration capabilities with Microsoft products, as well as depending on the capabilities of deploying emerging technologies such as remote monitoring, remote control, and more.

Keywords: EQUIPMENT, MAINTENANCE, INFORMATION SYSTEMS, CLASSIFICATION

1. Introduction

Command and management information support is designed to assist with decision making by assessing the suitability, feasibility and eligibility of defined action options through the use of information systems.

The informational support for the exploitation of armaments is an aggregation of activities for the creation and implementation in the work of the military formations and headquarters of computer networks and systems, as well as various coherent high-performance technical devices (sensing and for disclosure) with corresponding possibilities for information and programming to ensure the effectiveness and efficiency of the NATO Army weapons management process.

The purpose of this paper is to analyze the existing information systems for the management of the operation of the armaments and equipment, both in the Bulgarian Army and in some other NATO member states. On the basis of this analysis the characteristics and the possibilities for their classification will be determined, depending on the possibilities for integration with different software products, as well as depending on the possibilities of applying the incoming technologies, such as remote monitoring, remote control etc.

2. Information systems for managing the use of material resources in the civil sector.

An information system in an organization helps reduce the cost of upgrading and maintenance of equipment in a workable condition. With an appropriate information solution, production processes can be synchronized so as to avoid forced inaction, reduce repair times, schedule maintenance and replacement of equipment without suffering production. The software products that are capable of doing this are developed in accordance with several popular concepts: for resource management (Enterprise Asset Management(EAM)), computerized service and repair management systems (Computerized Maintenance Management Systems (CMMS)), Plant Maintenance and more.

The concept of business asset management was introduced by the Gartner research company in the late 1990s.¹ It implies the integration of tools for controlling technical service and repairs with the most widely used modules (finance, production, etc.) of Enterprise Resource Planning (ERP) systems as asset management information systems and repair activity, which is Enterprise Asset Management.

In fact, EAM develops the idea of Computerized maintenance management system (CMMS), which have been developed over the past 20 years, designed primarily to reduce equipment maintenance costs and increase productivity.

The basic functionality of CMMS systems includes:

- Data maintenance for equipment, technical installations, components;
- Registration of technical parameters, specifications for installation, repair and servicing of the equipment;
- Planning of prevention and repairs by generating execution orders;
- Accountability for the activity performed – volume, materials used, time spent, etc.;
- Managing warehouses for materials and spare parts;
- Managing the supply of materials and spare parts;
- Report statistical information.

To all this, EAM systems add:

- Process modeling tools for technical maintenance and modernization of equipment;
- Capabilities of managing the supply of equipment;
- Management of the staff involved in the repairs, qualification analysis and required competence;
- Data collection with external sensors, etc.;
- Registration of all costs of repairs in the financial system (materials, time, labor) and comparison with the values that are planned for them etc.

Companies often use their EAM solutions in combination with other modern information technologies - for example: business analysis tools-means; remote monitoring; remote control based support; mobile solutions and more. For example, the Targets Related Infrastructure Management (TRIM)² program provides enterprise infrastructure management that contributes to achieving its strategic goals. The TRIM complex and the solutions based on it implement modern management methods and refer to the already mentioned and the following classes of software (systems): Enterprise Asset Management - management of core business funds; Maintenance, Repair and Overhaul (MRO) - maintenance, repair and modernization; Computerized Maintenance Management System; Business Process Management System (BPMS); E-procurement - e-commerce. An element of it is also a Maintenance, Repair and Operations system (MRO).

In many Bulgarian companies EAM solutions have been implemented³. For example:

- In the ContourGlobal Maritza East 3, the maintenance and repair of the machinery and equipment is monitored and managed with the Q4 PowerEngineering and Q4 Safety modules implemented in 2005. For each facility, specifications are defined for scheduled repairs, the steps that have to be carried out, the devices and the details (products) that it consists of (Bill of Materials) and the parts that are subjected to repair and replacement. Q4, however, does not provide resources for long-term planning of activities as well as for the effective management of current tasks in modules and technological dependency of activities from one another. Therefore, in 2010, MS Project Server 2007 was introduced as a tool for effective management of repairs planning. This solution provides centralized management of activities related

to the renovation planning. Later, in 2011 the iShare portal was realized in the company. The solution is based on MS SharePoint Server, the primary purpose of which being to provide tasks and processes management and to facilitate collaborative work. The portal is divided into sites with different targeting, one of which (Maintenance) manages a shared calendar of the department "Repair Planning", and provides task information with the respective person that is responsible, the end date, technology dependency, and so on.

- In Sofia Med, since the beginning of 2010 is being used the Infor Enterprise Asset Management support system (planning and management system of maintenance). The solution consists of several modules, including "Machine Management", "Maintenance and Repair Management", "Preventive Maintenance". The system provides a systematic registry of interruptions, preventive repairs and other issues. An important advantage of using the solution is that any activity such as repair or maintenance of a machine can be bound to spare parts and it's time to become valuable. This in turn provides a basis for analyzing and finding the most effective approach.

- ITW Israpconrols Bulgaria launched the implementation of an EAM system in the summer of 2011. The Bulgarian subsidiary of the leading US producer of electrical components for household appliances has made its decision based on the Infor EAM system ⁴. The project envisages-predicts the introduction of functionality for the planning of preventive maintenance, company asset management and day-to-day control of emergency repairs. Infor EAM is a scalable asset management application that can improve the service, through its forecasting as well.

- At Titan Gold Panega Cement, where for 10 years, has been used an SAP ⁵ based ERP solution, in early 2011 new system modules were introduced to provide EAM functionality.

Now the Preventive Maintenance (PM) module ensures the preventive maintenance and repair process and provides a set of useful mechanisms and accompanying structures in order to improve the planning and control of repairs, both from a pure technical and engineering perspective, as well as a financial one. The second SAP Material Requirements Planning module connects planning processes with the even and tracked material spending, the timely booking in warehouses or ordering as needed.

3. Information support for the operation of arms in the Bulgarian army.

The information support for armaments management is expressed as support to decision-making on its operation by defining, forecasting and registering regulatory activities by assessing the suitability, feasibility and eligibility of specified options for the necessary service activities through the use of information systems.

The essence of the information system of the Bulgarian Armed Forces, which is related to the maintenance of the armament in an organizational aspect, can be defined as an organizational and technical union of organs, information resources (forces, means and systems), procedures and documents to ensure the processing, storage and provision of information on the operational support of the missile-artillery armament of the Bulgarian Armed Forces, coordinated by purpose, tasks, place and time for the accomplishment of the assigned tasks according to the different modes of operation.

The Bulgarian Army has put into operation two information systems that serve different functional regions involved in the arms exploitation process - the automated subsystem NIKE and the information system "Logistics of the Bulgarian Army".

The automated Nike Subsystem records and reports on the availability, qualitative and quantitative status of battle and blank stock and their elements by unit code, production data, components

and category, control of combat and blank stockpiles allowed during the school year, and report on the launching, their operation and control of the prohibited BPs and their elements from the level of "reporting unit" to the central security body (CST) for peace time.

A specific central insuring establishes regulatory information on subordinate reporting units, new unified material codes for battle and blank and their components, their technical characteristics, the periodicity of technical review, technical maintenance, repair, regulatory work, laboratory and field tests, a list of the prohibited for shooting combat supplies and the values of the current price lists.

The report of the active (battle) and blank stock and their elements in the automated subsystem "Nike" is based on the entry reporting of the cost-effectiveness documents that are inserted into the logistic structures of the formations, which documents carry the primary information.

Information System "Logistics of the Bulgarian Army" is an integrated information system for monitoring, management and control of material and financial resources used by the Ministry of Defense and the Bulgarian Army. In order for these tasks to be accomplished, a unified, integrated work environment is created for all management levels and all logistics procedures are unified.

The Information System "Logistics of the Bulgarian Army" implements a number of functionalities directly related to the management of material and financial flows, such as:

- Management of the Material Resources - Maintaining the required quantities of material means in warehouse stores, and solving operational tasks;
- Planning and budgeting – Defining the hierarchy of programs / tree structure / and limits of individual paragraphs through elements of the hierarchy. There are seven areas of planning: material, ammunition, use of transport, railway services, utilities and release, material insurance, construction and construction services. There are also included processes for request submissions, aggregation, drafting of material and technical support plans, generation of a single material plan and budget for its implementation-realization, a plan to buy material means following a single material plan (SMP) are included. An important point is that the implemented areas of planning are integrated into a single process;
- Negotiation and purchase – registration of the SMP purchase contracts and reporting the invoices and payments in relation to this these contracts; ;
- Delivery and storage - service of external and internal supplies; allocation and decommissioning-deduction of material resources (MR) under different warehouse operations; re-categorization and change of parameters;
- Out-of-demand (Off-plan) requests and deliveries – serving emerging needs that are not predicted in the SMP;
- Utilization of the material resources - transmission and decommissioning, transmission for consumption, reporting of the use of ammunition, transmission of fuels and lubricants, reporting of the delivered for repairs material resources;
- Composite products - registration of hierarchical structures of the constituent composition of elements of serial and batch materials;
- Maintenance - monitoring of the performance of material means and preparing a schedule for carrying out certain maintenance activities when certain values of these indicators are being reached;
- Individual Substantial Provision – preparation, aggregation and inclusion of individual Substantial Queries in the SMP. Providing and selling through the system of territorial points to provide servicemen with tangible property.
- Reporting and Accountability - A set of reports on the quantity, status and value of MR based on data from other groups of processes;

- Financial control - budget control, accounting operations in relation to invoices, payments and implementation of the accounting cycle in the system.

Suite The Bulgarian Army Logistics Information System is built on the basis of a ready-made software product Oracle e-Business Suite⁶ adapted to the needs of the Bulgarian Army.

In the presence of a large number of maintained logistic procedures and processes, the information system provides the necessary reporting and analytical requirements on an administrative, operational and management level. Despite the satisfactory organizational and structural scope of the system, there is no provision to monitor document flow in the logistics support armament, which is the backbone of the accompanying operating accounting processes.

As a result of the analysis of the information systems for the management of the operation of the armaments in the Bulgarian Army, together with their characteristics, it can be summarized that these are systems, procedures, organizational structures, staffing, technical and programming means for introducing and administering performance data designed to assist commanders and headquarters in the organization and management of logistics, in particular the operation of arms.

On the other hand, besides being adjusted to the needs of Bulgarian Army in peacetime, the information systems for the management of the armaments operation must ensure operational and technical compatibility with those of the allies and provide:

- Integration with other modules for logistics support to automated command and control information systems;
- To hold information on the residual resources of the missile-artillery armament of the tactical formations, their characteristics and the history of each product's function from all stages of its life cycle (entry, diagnosis, malfunctions and damage, repair and release);
- Based on the residual resource of each individual item, automatically to generate a plan for maintenance and repair of the armaments and based on that to determine the needs for consumables and spare parts;
- Analysis of the data that summarizes the individual operational parameters of the armament, analysis of the errors and defects;
- Report of input materials for maintenance and repair;
- Providing the means to manage and control the real-time logistical processes on the armament of the Bulgarian Army;
- Providing each user with access to a set of references and reports related to their activity.

4. Information systems for the management of the use of weapons used by the logistics authorities of NATO countries.

NATO's main automated logistics systems are a Logistics Functional Area Services subsystem (LOGFAS)⁷ logistics functional subsystem.

The components of LOGFAS are: Logistics Database (LOGBASE), Movement and Transportation (M&T), Allied Command Resource Optimization Software System (ACROSS), and Logistics System accounting (Logistic Reporting (LOGREP)).

The LOGBASE Logistics Database includes⁷: Geographical Data Manager (GeoMan), LOGFAS Data Management Module, and Sustainment Planning Module. It is described in the Supply Distribution Model (SDM). The main tools for working with LOGBASE are currently M&T, ACROSS and LOGREP.

The Resource Optimization Software System ACROSS maintains the work of planning the allied forces stockpiles in the field of land, naval and air operations. This automated system uses a threat-based methodology. There are opportunities to threaten the

alliance's combat capabilities in order to prepare the necessary reserves of ammunition needed to destroy this threat by conventional means.

The logistics system LOGREP is the tool for ensuring that the exchange of information meet the requirements as outlined in Chapter 6 - Operations logistic planning of the NATO Logistics Handbook. Regarding operations, LOGREP is a tool for timely provision of up-to-date material and mission information for all functional areas in logistics. NATO commanders and their respective headquarters parties receive transparency for logistics and planning in peacetime as well as for the logistics insurance for each operation.

The Mobility and Transport System (M & T) is used to plan, assess and monitor transport and transportation operations when insuring NATO missions. The system assists authorities that are responsible for planning the transport in developing plans to deploy and verify their feasibility by rapidly preparing, resolving conflicts and distributing plans between NATO and NATO Commands. In addition, during the implementation, planners can monitor the progress of the planned activities and adjust the plans to meet the operational objectives.

Modules in the LOGFAS program:

- User Management Module (UMM) - for user management using "LOGFAS" applications. It provides the user with access rights to the various LOGFAS applications.
- Supply Distribution Model (SDM). SDM is a decision support tool that allows logistics planners to try re-procurement and support policies within the scope of the "what-if" scenarios.
- Data Migration Tool (DMT).
- Administrator for installing Logfas Connection Manager (LCM).

The armament in the NATO armies includes field communication and information systems. Almost all field systems^{8, 9, 10, 11} have logistics management modules that support and process information about:

- reinforcing, imparted and redeployed forces and material means;
- maintenance of reorganization, pre-placement and allocation of material resources, etc.

They are based on database models that are continually evolving as a result of the Multilateral Interoperability Program (MIP). The original Generic Hub (GH) Data Model becomes Land Command and Control Information Exchange Data Model (LC2IEDM) in 1999. For example, the Field Integrated Communication and Information System 8 uses a Land Command and Information Exchange Data Model (LC2IEDM) Data Sharing Model that is part of a common NATO armament data model standard defined by the Army Tactical Command and Control Information System Task Force (ATCCIS).

The development of this model is in the Command and Control Information Exchange Data Model (C2IEDM) in 2003. It's unification with the NATO Corporate Reference Model led to the emergence of the Joint Command, Control and Consultation Exchange Data Model (MIP JC3IEDM) 12.

The concept underlying the design of the JC3IEDM model is to present a common set of data for exchange in the command and management process. The data model describes all objects in the field of military operations - organizations, people, logistics infrastructure, equipment, facilities, geographic objects, meteorological phenomena, etc.

From the data model analysis of logistics infrastructure systems, it appears that only information on the type of equipment and consumables (ammunition, clothing, medical supplies, fuels, food and water) is maintained, which is not enough to manage the operation of the weapons and technology.

5. Classification of information systems of the arms exploitation management.

As a result of the analysis carried out, the main functions of an information system (information system module) for the management of the exploitation of armaments and equipment can be summarized as follows:

- Management of the organization of forces;
- Management of the operational material and technical situation;
- Introduction of a material part – consumables (ammunition, clothing, construction materials, food, medical supplies, water, fuels, etc.) no cost materials (vehicles, combat machines, weapons, etc.);
- Report and description of the maintenance and repair facilities;
- Creating and using a stockpile and materials guide;
- Planning of periodic maintenance and repair work;
- Reporting of stocks in inventories;
- Forming of spare parts and materials needs;
- Order of spare parts for repair and restoration work;
- Shaping of revenue / expense of deliveries;
- Keep a log of planned and executed maintenance work;
- Registration, classification and analysis of defects, keeping a diary of defects and refusals;
- Reporting for the execution of the planned works and defect repair work;
- Output of the spare parts used in the process of work;
- Formation of inventory acts;
- Reporting of the processing of equipment by counters;

- Registration of the current meanings of the technical parameters for the condition of the equipment;
- Performance report of the equipment;
- Define and analyze performance indicators for maintenance planning and repair;
- Analysis of failures, their types, causes, consequences and criticality;
- Keeping the technical documentation;
- Other.

The analysis of the available IT management and repair information systems allows them to be classified according to several criteria, namely - used software products (systems), Microsoft software products / Microsoft integration capabilities, basic functionality and capability for using advanced technologies such as remote monitoring, business analyzes, mobile solutions, and more, as well as and some additional signs (figure 1).

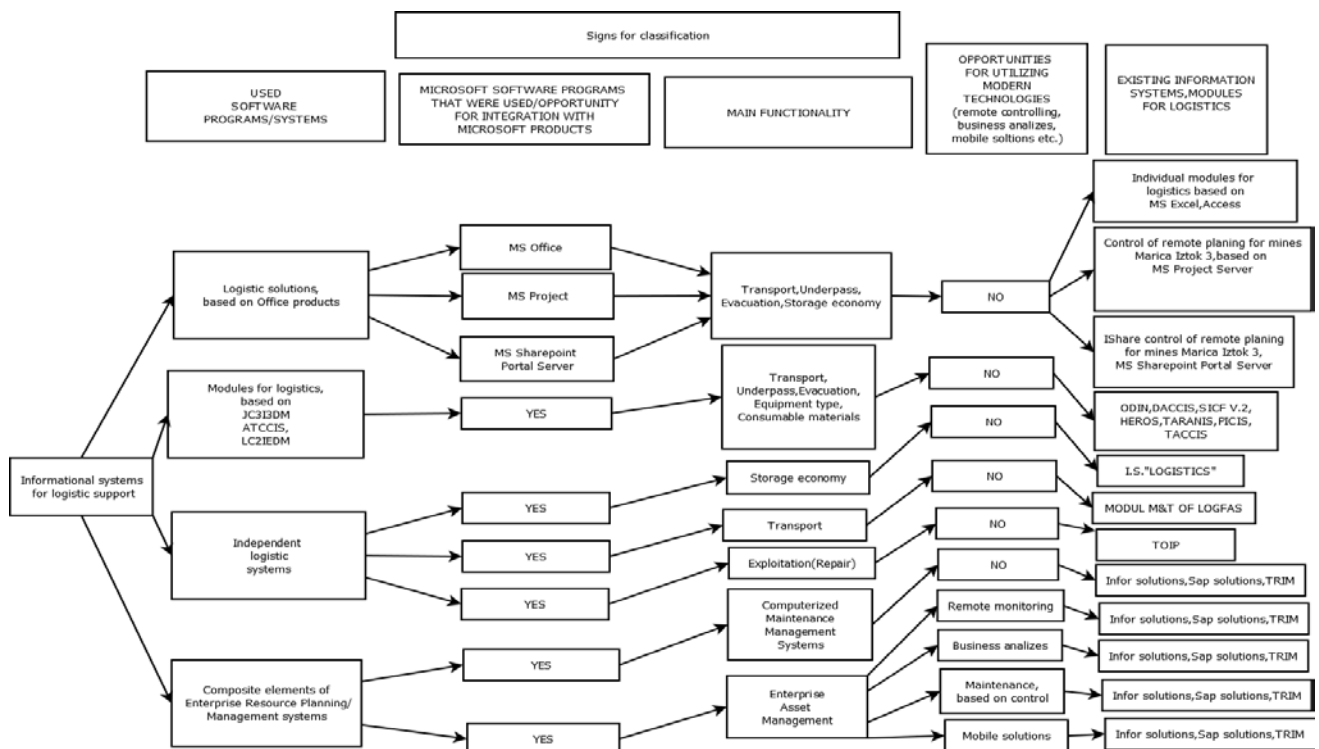


Fig. 1. Classification of information systems (information system modules)

Conclusion.

The effective Bulgarian Army governance in the context of collective security systems requires the acquisition of special capabilities, consisting of a streamlined system of tied, interdependent and growing responsibilities for managing the operation of armaments and armament techniques. The analysis carried out in the present work provides the basis for the following conclusions:

1. In the Bulgarian and most NATO armies there is no developed document management application in the arms exploitation process. No automated reporting of the technical condition of the armaments and the risks associated with the occurrence of possible malfunctions is conducted;

2. Not all field communication-information systems have capabilities to record and report on arms exploitation activities. The data models used, do not provide the ability to maintain the necessary management data used for maintenance and repair of armaments and equipment.

3. The contemporary-current practice makes successful attempts to master IT excellence, applied in the management of sophisticated organizations, including in the management of the operation of the technique. Specially developed exploitation reporting systems are costly, and the variety of databases, system and application software makes it difficult to select an information system for managing the operation of armaments and equipment as well as the training and preparation of the service staff.

4. For the automation of the arms exploitation process, there can be used: MS Office applications (Excell and Access), MS Project Server and / or collaboration tools such as MS Sharepoint Portal Server.

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THE RESULTS OF BLAST LOADING OF REINFORCED CONCRETE SPECIMENS WITH VARYING FIBRE TYPES AND CONTENT

РЕЗУЛТАТИ ОТ ВЗРИВНО НАТОВАРВАНЕ НА УСИЛЕНИ БЕТОНОВИ ЕЛЕМЕНТИ С РАЗЛИЧНИ ВИДОВЕ ФИБРИ И СЪСТАВ

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Abstract: The experiment report presents the results of the field tests of fiber-reinforced concrete (FRC) and reinforced concrete specimens which were performed by research team from Faculty of Civil Engineering, Czech Technical University in Prague, Czech Republic in cooperation with the Czech Army corps in the military training area Boletice. The tests were performed using real scale reinforced concrete precast slabs ($6 \times 1.5 \times 0.3$ m) with varying fibre content, fibre type, fibre strength and concrete strength class and 25 kg of TNT charges placed at a distance from the slab for better simulation of real in-situ conditions. The slabs were recorded using a high speed framing camera during the blast loading. The instrumentation enabled us to study the propagation of the blast shock wave through the material, propagation of the cracks on the soffit of the specimen and the final collapse of the middle part of the slab exposed to blast loading. The sequence of the structural behaviour is documented in detail and verified by numerical modelling using the LS-DYNA solver.

KEYWORDS: BLAST LOAD, RC STRUCTURES, STEEL FIBRES, POLYPROPYLEN FIBRES, EXPLOSION, BLAST WAVE

1. Introduction

According to recent publications, from 2006 to 2016 there were more than 23,000 terrorist attacks around the world, which took more than 127,000 human lives. The attacks were targeted mainly on the technical and civic infrastructure, like governmental buildings, bridges, etc. Due to improved ductility, fibre-reinforced concrete (FRC) shows better performance under blast and impact loading compared to conventionally reinforced concrete. Also higher concrete strength shows better blast performance.

Due to improved ductility, fiber-reinforced concrete (FRC) shows better performance under blast and impact loading compared to conventionally reinforced concrete, as mentioned in many sources.

The experiments from year 2016 replicate the previous test results from 2010, 2011 and 2013. They determine blast performance of FRC with low strength and low ductility steel fibers (strength 400 MPa).

2. Specimens and material

Dimensions of the specimens were designed in real scale of a small span bridge as concrete slabs, 6 m long, 1.5 m wide and 0.3 m thick.

Six specimens were made in total, where three of them were made of C30/37 grade concrete ($f_{c,cyl} = 30$ MPa) (specimen No.8, 9 and 10), three of C55/67 grade concrete ($f_{c,cyl} = 55$ MPa) (No. 6, 7 and 11).

Steel fibers (FE) 25mm long with strength 400MPa and polypropylene (PP) 50mm long synthetic fibers with strength 600MPa were used.

The fiber dosage was following: specimen No.6 80kg/m^3 FE fibers, No.7 40kg/m^3 FE + 4.5kg/m^3 PP fibers, No.8 40kg/m^3 FE + 4.5kg/m^3 PP fibers, No.9 40kg/m^3 FE fibers, No.10 80kg/m^3 FE fibers and No.11 40kg/m^3 FE fibers.

The dosage of the fibers was kept low as it can be achieved on-site.

The layout of the experiment is shown on fig. 1.



Fig. 1 Layout of the experiment.

The timber frame with string grid of 100mm was used to measure area and depth of concrete spalling and puncture. The method of data evaluation can be seen in Fig. 2.



Fig. 2 Timber frame with string grid to experiment data evaluation.

3. Results and discussions

The experiments were focused on the effect of fibres (fracture energy), concrete compressive strength and its combination on blast performance of concrete. By means of performance it is understood the dimensions of puncture and spalling of concrete. The differences in puncture and spalling of concrete on the soffit of the slabs can be found in Table 1. In this section, the findings presented in Table 1 are described in detail.

The materials of all specimens were tested for compressive strength. The results of tested cubes can be seen in Table 1.

The specimen No.1 is determined as a reference specimen and is marked by “*”.

The specimen No.11, C55/67, 40kg/m³ FE fibers, was approximately equally damaged. The area of the puncture is 0.36m², volume 0.11m³, which represents 4% of the total volume of the specimen. Total volume of the damaged concrete (puncture + spalling) is 0.27m³, which represents 10% of the total volume of the specimen. The area of puncture was reduced by 16% in comparison to specimen No. 1, total volume of damaged concrete was increased by 17% in comparison to specimen No.1. The damage of the left side of specimen No 10 was reduced by more than 80%, the damage of the right side was reduced by more than 65%. The deflection was 320mm. The shape of deflection was similar to deflection from point loading in the mid-span of the specimen. The deflection was increased by 3% in comparison to specimen No.1.

Table 1: The results of the experiments.

Specimen №	1*	6	7	8	9	10	11
Concrete	C30 /37	C55 /67	C55 /67	C30 /37	C30 /37	C30 /37	C55 /67
Concrete strength (cube), MPa	49.90	62.70	58.20	45.50	48.40	46.50	65.30
Fibers, kg/m ³	-	80	40+ 4.5	40+ 4.5	40	80	40
Puncture – top Surface, m ²	0.43	0.32	0.30	0.30	1.03	0.35	0.36
Concrete spalling (soffit) - < concrete cover, m ²	2.35	1.78	1.94	1.73	2.39	1.94	2.14
Concrete spalling (soffit) - > concrete cover, m ²	1.72	1.47	1.64	1.40	2.13	1.42	1.78
Concrete spalling (top surface) - < concrete cover, m ²	0.43	0.82	0.68	0.76	1.30	0.77	0.86
Concrete spalling (top surface) - > concrete cover, m ²	0.43	0.77	0.64	0.75	1.23	0.70	0.82
Concrete spalling (left side) - < concrete cover, m ²	0.52	0.05	0.04	0	0.24	0.06	0.06
Concrete spalling (left side) - > concrete cover, m ²	0.35	0.04	0.09	0	0.37	0	0.20

Concrete spalling (right side) - < concrete, m ²	0.34	0.07	0	0	0.24	0.11	0.06
Concrete spalling (right side) - > concrete cover, m ²	0.23	0.11	0.03	0.03	0.30	0.17	0.14
Volume of crushed concrete, m ³	0.23	0.20	0.25	0.26	0.45	0.24	0.27
Permanent Deflection, m	0.31	0.31	0.30	0.45	---	0.45	0.32

The specimen No.10, C30/37, 80kg/m³ FE fibers, was approximately equally damaged. The area of the puncture is 0.35m², volume 0.11m³, which represents 4% of the total volume of the specimen. Total volume of the damaged concrete (puncture + spalling) is 0.25m³, which represents 9% of the total volume of the specimen. The area of puncture was reduced by 16% in comparison to specimen No.1, total volume of damaged concrete was increased by 9% in comparison to specimen No.1. The damage of the left side of specimen No.10 was reduced by more than 85%, the damage of the right side was reduced by more than 75%. The deflection was 450mm. The shape of deflection was similar to deflection from point loading in the mid-span of the specimen. The deflection was increased by 45% in comparison to specimen No.1.

The specimen No.9, C30/37, 40kg/m³ FE fibers, was completely damaged. The area of the puncture is 1.03m², volume 0.35m³, which represents 11.3% of the total volume of the specimen. Total volume of the damaged concrete (puncture + spalling) is 0.45m³, which represents 16.7% of the total volume of the specimen. The area of puncture was increased by 131% in comparison to specimen No. 1, total volume of damaged concrete was increased by 95% in comparison to specimen No.1. The damage to the sides was 100% because area of puncture intervened over the whole width of slab. Cross-section of slab in mid-span was represented by steel reinforcement only.

The specimen No.8, C30/37, 40kg/m³ FE + 4.5 kg/m³ PP fibers, was approximately equally damaged. The area of the puncture is 0.30m², volume 0.09m³, which represents 3.3% of the total volume of the specimen. Total volume of the damaged concrete (puncture + spalling) is 0.26m³, which represents 9.6% of the total volume of the specimen. The area of puncture was reduced by 31% in comparison to specimen No.1, total volume of damaged concrete was increased by 10% in comparison to specimen No.1. The damage to the sides was completely reduced by 95%. The deflection was 450mm. The shape of deflection was similar to deflection from point loading in the mid-span of the specimen. The deflection was increased by 45% in comparison to specimen No.1.

The specimen No.7, C55/67, 40kg/m³ FE + 4.5 kg/m³ PP fibers, was approximately equally damaged. The area of the puncture is 0.30m², volume 0.09m³, which represents 3.3% of the total volume of the specimen. Total volume of the damaged concrete (puncture + spalling) is 0.25m³, which represents 9.3% of the total volume of the specimen. The area of puncture was reduced by 31% in comparison to specimen No.1, total volume of damaged concrete was increased by 9% in comparison to specimen No.1. The damage to the sides was reduced by 85%. The deflection was 300mm. The shape of deflection was similar to deflection from point loading in the mid-span of the specimen. The deflection was reduced by 3% in comparison to specimen No.1.

The specimen No. 6, C55/67, 80kg/m³ FE fibers was less damaged. The area of the puncture is 0.32m², volume 0.09m³, which represents 3.5% of the total volume of the specimen. Total volume of the damaged concrete (puncture + spalling) is 0.20m³, which represents 7.5% of the total volume of the specimen. The area of puncture was reduced by 28% in comparison to specimen No.1, the total volume of damaged concrete was reduced by 13% in comparison to specimen No.1. The damage of the left side of specimen No.6 was reduced by more than 80%, the damage of the right side was reduced by more than 50%. The deflection was 310mm. The shape of deflection was similar to deflection from point loading in the mid-span of the specimen. The deflection was the same in comparison to specimen No.1.

4. Conclusion

Results from the experiments leading to determine blast performance of fiber reinforced concrete with low ductile steel fibers are described in this paper.

There is no positive effect of added FE fibers to damage of specimens in comparison with reference specimen No.1.

All specimens (No. 6–11) were more damaged at top surface than reference specimen No. 1.

The extent of damage of all specimens (No. 6–11) was approximately the same as reference specimen No. 1.

The extent of damage slightly decreased with increased fiber content, increased fiber strength and increased concrete strength. Combination of shear strength and fracture energy is decisive index of blast performance.

All specimens with PP fibers had better fragmentation properties – less compact fragments flew out after the blast.

5. Literature

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RESEARCH ALGORITHM FOR THE EFFICIENCY OF AN INDEPENDENT POWER SOURCE

АЛГОРИТЪМ ЗА ИЗСЛЕДВАНЕ НА РАБОТОСПОСОБНОСТТА НА НЕЗАВИСИМ ИЗТОЧНИК НА ЗАХРАНВАНЕ

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Annotation: It has been created an algorithm that tracks the stages of constructing an independent chemical power source. It has been given consideration to the selection and design of the composite components, as well as the solving of construction tasks. Attention is paid to the mechanical-dynamic and climatic tests, which are carried out in order to prove the working capacity for both of the components and the whole unit as a final product.

Keywords: chemical power source, efficiency, working capacity

1. Introduction

In the safety context, the process of construction of a stable, in terms of power and according to energy viewpoint, independent chemical power source has great meaning for the performance of the end product. The normal functioning of the energy source ensures stability of the implementation of the assigned tasks in the conditions of need for an independent power supply. The proposed algorithm aims to describe the steps, their designing and testing passes through – fig. 1. The main purpose is related to the need to confirm the correctness of the design solution and getting the requirements of the final product working.

2. Algorithm for evaluating the performance of a power source

The proposed algorithm examines the construction principle and the test sequence of a battery / power source /. A consistent reliability assessment is performed using the algorithm, from making the design decision about the type and sequence of the chemical elements / cells /, going through the building of physical samples and ending with their mechanical-dynamic test and exposure to environmental factors. The main task is to detect and eliminate the errors and drawbacks made in the development of the power supply in advance.

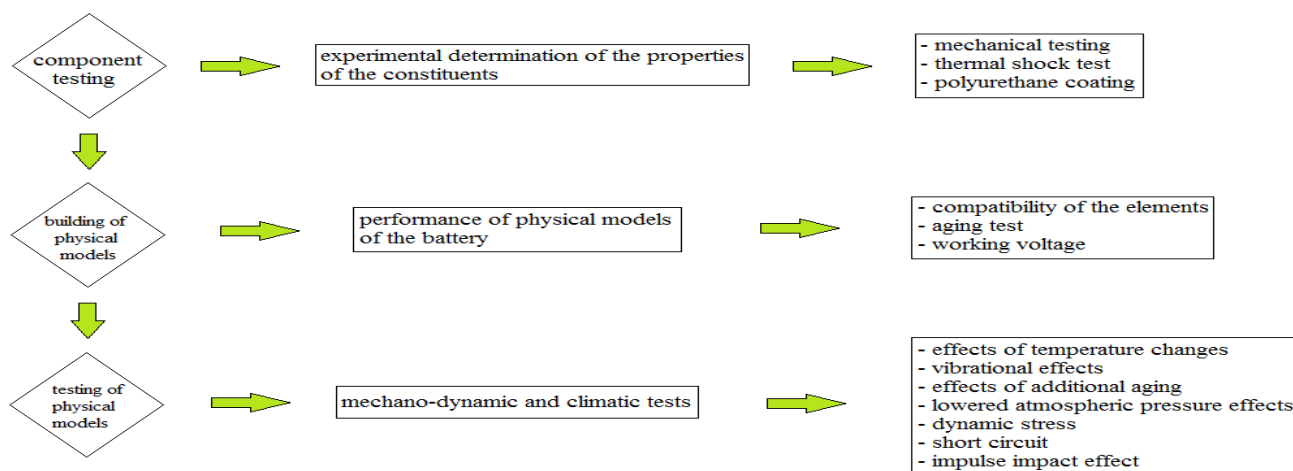


Fig. 1. Algorithm for conducting a feasibility study of an independent power source

The proposed algorithm is exemplary and the additional tests can be used to specify a particular feature of the developed battery or accumulator. The specificity of physical model testing /temperature range of operation, vibration effects, dynamic stress and others/ is determined by the application of the final product.

3. Determination of the constituents of the power source

The determination of the constituent elements of the power source is considered from two points of view: the first is related to solving a constructive task, regarding the gauges and power of the product and the second relates to the type of the electrochemical system that is used.

3.1. Solving a constructive task regarding the power source parameters

The produced and marketed chemical sources of electricity are characterized by a wide variety, different size, shape, voltage, capacity. Solving a question about choosing the right element begins with the design of the product, its purpose and the climatic conditions of use. The engineers and constructors of the final product, intended for use with an independent power source, determine: the available space in the shell; the requirements of the climate zone; the possibility of transportation and safe work. They make proposals that are being considered by a research team.

The starting point for solving the design task is related to the application of the final product and the power consumption requirements. When characterizing the operation of the chemical power sources the following parameters are used: power P and output power P_{outp} .

The power is equal to the product of the current and the voltage:

$$(1) \quad P = IU \quad [W \text{ or } J/s]$$

The output power is determined by the formula:

$$(2) \quad P_{\text{outp}} = \frac{UI}{m} \quad [W/kg]$$

$$(3) \text{ or } P_{\text{outp}} = \frac{UI}{t} \quad [W/l]$$

where: m – amount of substance, obtained or consumed, of the electrodes, respectively in kg or l.

All stress-increasing factors lead to an increase in the power of the chemical power sources /CPS/.

When connecting the element to a voltage device, this is when it is subjected to voltage, an electric circuit is formed. The change in voltage is reflected to a large extent also by the current flowing through the element:

$$(4) \quad U = E - \Delta\varepsilon - I r_{\text{inner}}$$

where: U – element voltage, V;

$\Delta\varepsilon$ – element polarization, V;

I – size of the electrical current, A;

r_{inner} – the inner resistance of the cell, Ω .

In this way the working voltage of the chemical power source /CPS/ is always less than the electromotive forces /EMF/. In turn, the polarization $\Delta\varepsilon$ [V] can generally consist of electrochemical, chemical and concentration constituents:

$$(5) \quad \Delta\varepsilon = \Delta\varepsilon_{\text{el}} + \varepsilon_{\text{chm}} + \varepsilon_{\text{conc}}$$

The ways of reducing the constituents of polarization and thus increasing the tensions of the CPS are associated with an increase in the surface of the electrodes, temperature increase and the concentration of the reagents or the use of catalytically active electrodes [3] [5].

3.2. Determination of the type of electrochemical system subjected to testing

The type of the electrochemical system that is used is determined on the basis of the manufacturer's data or the available markings on the packaging. Primary attention is paid to the features of the elements / cells / constituting the power source – electrodes, electrolytes, separators, and where possible the chemical reactions.

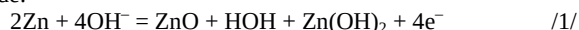
It is convenient to use three electrochemical systems when building physical models in relation to the determination of their working capacity and conducting a subsequent comparative analysis:

a/ Manganese-zinc currents with salt electrolytes **Zn|NH₄Cl|MnO₂**, the battery casing is an **anode** at the same time / built of Zn/, the active substance of the **cathode** is an electrolytic manganese dioxide /MnO₂/ or a chemical manganese dioxide; NH₄Cl, ZnCl₂, or a mixture of the two substances, are used for an **electrolyte**. The electrolyte is located in the thickened areas or in a microporous separator. Corrosion inhibitors are added in order to reduce the corrosion rate of the zinc in the electrolyte. The advantages of these batteries are related to the low price and the large number of type sizes, the relatively easy production technology and the readiness to be used immediately. The deficiencies are related to the descending discharge curve in operation, the relatively low specific separated energy and a significant drop in performance at high stress and low temperatures [1] [2] [4].

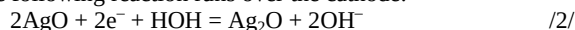
The Manganese-zinc power sources are also produced with an alkaline electrolyte **Zn|KOH|MnO₂**. Powdered Zn serves as an **anode** and MnO₂ as a **cathode**. The **electrolyte** is a gel solution of KOH or KOH in a matrix. Inhibitors of corrosion are included in the composition of the anode and electrolyte. Compared with the salt electrolyte power sources, those with alkaline have greater capacity and energy density during operation, especially at high stress and low temperatures, but have a higher price.

b/ In the silver-zinc primary cells **Zn|Ag₂O** or **Zn|KOH|Ag₂O,Ag⁺** powdered zinc is used for an **anode**, for **cathode** – silver oxide, and for **electrolyte** – a solution of KOH or NaOH. Silver is reduced over the cathode from Ag(I) to Ag(II), when operating the battery, in discharge mode, as the alkali electrolyte is used as a donor to hydroxyl groups and the following electrochemical processes occur:

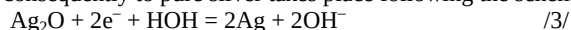
- the oxidation reaction of the zinc metal is carried out on the anode:



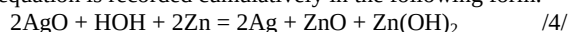
- the following reaction runs over the cathode:



a reduction reaction of the divalent silver ion to a monovalent ion and consequently to pure silver takes place following the scheme:



the equation is recorded cumulatively in the following form:



The silver batteries of this type have a horizontal discharge curve, high energy density and a low self-discharge. They can work under high stress, but the high cost of the building components is a disadvantage.

c/ The reducing agent in the primary lithium power sources **with a solid cathode and an aprotic electrolyte**, is lithium, and the oxidant – metal oxides, sulphides or fluorocarbons. **Electrolytes** are the solutions of lithium salts (LiClO₄, LiBF₄, LiBr) in aprotic solvents. In the lithium power sources **with a liquid or dissolved oxidant Li|LiBr|SO₂** and **Li|LiAlCl₄|SOCl₂|SOCl₂**, the **cathodes** in the power source are insoluble and are made of carbon materials, deposited on aluminum (for SO₂), based on nickel steel or stainless steel. The **electrolyte** in the lithium cells with sulfur dioxide is LiBr, dissolved in acetonitrile; in the elements with thionyl chloride and sulfuryl chloride – LiAlCl₄ SOCl₂ or SO₂Cl₂ with supplements [6].

The primary lithium power sources have greater capacity and energy density, a wider range of operating temperatures, better performance at lower temperatures and a lower self-discharge rate compared to the same parameters of manganese-zinc energy sources. A major disadvantage is the cost of this type of electrochemical systems. The primary lithium power sources are used in medicine, industrial and military electronics.

4. Functionality of the physical samples

The constructor of the final product must combine power source, power and functionality in a certain volume. Attention is drawn to the possibility of recharging the power supply when built by Secondary Cells and prolonging its life. Provided the final product is intended for single use, the power source should be built by Primary Cells. Each power source, depending on its type, is characterized by a particular operating mode of dilution at an average current and pulse current. They are key factors in determining its capacity and associated security circuits.

A neglected factor is the initial or shock current that occurs when the equipment first switches on. High currents run through it in a very short time until the chain reaches a steady state of operation. Avoiding this negative effect is achieved by programming a delay. The purpose is to stabilize the electrochemical discharge and resistance of the power supply system.

The working capacity of the power source depends on another two factors – dilution depth and self-discharge ability. Dilution depth mainly refers to power sources that are designed to store energy, obtained alternatively / from the sun or the wind / and it has to be given up by providing constant power, when the primary energy source is missing or uncontrolled and interrupted. These power sources must provide deep dilutions and multiple charge-discharge cycles.

Self-discharge is related to the loss of charge over time by the power source. In this connection, it is necessary to know how long the batteries or accumulators are stored before they are not used by the user. The primary batteries have a large self-discharge, so the downtime should be minimized after they are delivered to the user (including delivery time, installation time, stock inventory time and storage) or by selecting cells with poor self-discharge mode. The secondary batteries / accumulators / usually have a higher self-discharge mode, but they can also be recharged.

5. Mechanical-dynamic tests and environmental conditions

Mechanical-dynamic tests aim to establish the performance of chemical power sources after impacts, vibrations, mechanical-inertial impacts and others. Basically, these tests are related to the transportability of the final product and its operational safety.

Power sources have a limited range of operating temperature /from minus 30°C to plus 40°C/. Operating them beyond these limits will result in a permanent reduction of their working capacity or a complete refusal. In determining the technical characteristics these limits should therefore be taken into account. It should also be noted that the actual operating temperature of the power supply is higher than that of the environment. It is determined by the heat generated by the operation of the power supply itself and the heat removed from it by conduction and radiation. If the end-product temperature requirements foresee the exceeding of the operating range of the

power supply, it is necessary to include a heating or cooling subsystem as required.

6. Conclusions

1. The algorithm, developed to determine the performance of the chemical power sources is used to track and describe the preparation steps, testing and systematizing the obtained results.

2. The power sources go through design solutions that are related to their power, capacity, mass and life cycle, which can be accomplished by a wide range, based on their different electrochemical structure.

3. The chemical power sources efficiency is also determined by their dilution depth, self-discharge and cyclic mode of operation, to which they are subjected, and the climatic conditions have an impact on the duration of operation.

4. Knowing the priorities of the end product is an important factor in determining the technology that should be used for the construction of chemical power sources.

7. Literature

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