The Central Research institute
of the Armed Forces of Ukraine

Military Science. Vol. 2 No. 1 (2024)

DOI: 10.62524/msj.2024.2.1.10

Methodological approach to determining the nomenclature of mobile assets for acomplishment the tasks of nuclear threat detection and assessment

Kostiantyn Furmanov
PhD in Military Science, senior staff scientist
Chief of scientific-research derectorate
The Central Research Institute of the Armed Forces of Ukraine
03049, 28B Povitroflotskyi Avenue, Kyiv, Ukraine
e-mail: k.furmanov16@gmal.com
ORCID: 0000-0002-0049-8959

Oleh Hutchenko
PhD in Military Science, senior staff scientist
Chief of scientific-research branch
The Central Research Institute of the Armed Forces of Ukraine
03049, 28B Povitroflotskyi Avenue, Kyiv, Ukraine
e-mail: gutchenko.oleg@gmail.com
ORCID: 0000-0002-1724-6918

Kateryna Hutchenko
PhD in medicine
Scientist
The Central Research Institute of the Armed Forces of Ukraine
03049, 28B Povitroflotskyi Avenue, Kyiv, Ukraine
e-mail: dr.gutches@ukr.net
ORCID: 0009-0008-6377-7745

Abstract. The relevance of the article is due to the fact that in the context of countering large-scale aggression, Ukraine's actions to de-occupy the captured territories and implementing its strategic course to join the European community and NATO, there are potential threats from the russian federation. Continuing its hostile rhetoric, terrorising Ukraine with missile strikes, the russian leadership threatens to use nuclear weapons, which poses the highest level of danger and can lead to large-scale radiation contamination (Lessons of the russian-Ukrainian war 2022: military aspects, 2022).

Taking into consideration this state of the security environment, it is necessary to respond effectively to nuclear threats and ensure reliable protection of troops, which, in their turn, should be ready to act in radiation contamination conditions. This requires the Armed Forces of Ukraine to effectively train military units of chemical, biological, radiological and nuclear defence capable of performing their assigned tasks and, in the further future, to be ready to detect and assess nuclear threats in joint actions (operations) with the units of NATO member states. All this requires solving problematic issues related to the nomenclature of chemical, biological, radiological and nuclear defence equipment of the Armed Forces of Ukraine to ensure the required level of protection of troops. Especially challenging tasks in the current environment are the detection and assessment of the chemical, biological and radiological situation of the movement routes and areas of troops' concentration, the covering of troops and facilities of the Armed Forces of Ukraine from reconnaissance and destruction by modern precision weapons, and the liquidation of the chemical,

biological and radiological contamination consequences. To a large extent, the maximum reduction of troop losses during actions in conditions of chemical, biological and radiological contamination is ensured by the application of existing and prospective assets of chemical, biological, radiological and nuclear defence However, it is impossible to make reasonable decisions on the nomenclature of mobile chemical, biological, radiological and nuclear defence equipment without determining the amount of losses of chemical, biological, radiological and nuclear defence equipment during the conduct of tasks in the operations of the Armed Forces of Ukraine in accordance with the trends in the development of the Armed Forces of Ukraine, forms and methods of warfare, and assets of combat actions.

To solve this problematic issue, we propose a methodological approach to determining the nomenclature on the example of mobile assets to fulfil the scope of tasks for detecting and assessing nuclear threats.

The methodological approach will allow to formulate substantiated practical recommendations regarding the procedure for determining the nomenclature of chemical, biological, radiological and nuclear protection assets. The article presents the nomenclature of nuclear threat detection and assessment, which depends on the scope of detection and assessment tasks and the capabilities of assets used to accomplish these tasks. The materials of the article may be useful for officials of military command and control bodies involved in planning chemical, biological, radiological and nuclear (CBRN) defence during combat actions..

Keywords: nuclear threats, assets, scope of tasks, capabilities, nomenclature, characteristics.

Introduction

The adoption of the Treaty on the Non-Proliferation of Nuclear Weapons in 1970 divided the world into those countries that were the official possessors of nuclear weapons and the rest of the states. About 90% of the world's nuclear arsenals are approximately equally distributed among two of these countries - russia and the United States.

At this time, russian federation's nuclear arsenal is part of the nonstrategic nuclear forces (NSNF) (land, air, and sea components), which include units of the land forces, the air space forces, and the navy, which are equipped with operational-tactical (tactical) nuclear weapons.

The russian armed forces have about 2,000 non-strategic nuclear warheads in their arsenal, and 760 warhead can be mounted on cruise, anti-submarine and anti-aircraft missiles, torpedoes and submarine depth charges, aircraft carriers, cruisers, destroyers, frigates, corvettes, aircraft and naval aviation helicopters, 570 warhead on aircraft, including Tu-22M3, Su-24M and Su-34 aircraft. All of these aircraft can carry free-fall nuclear bombs, and the Tu-22M3 can also carry the X-22 Burya.

The targets of the russian federation's nuclear weapons can be defence areas in enemy breakthrough areas, cities that are conducting circular defence, and buildings of the state administration (defence forces), with the aim of breaking through the defence, impairing control and destroying the state leadership.

russian NSNF have on their armament:

nuclear artillery ammunition – a supplement to conventional artillery, capable of qualitatively increasing its capabilities and effectiveness against enemy defensive formations, rear area objects, as well as in counterbattery combat;

tactical missiles (operational-tactical missiles), which form the basis of the tactical nuclear weapons arsenal.

The most dangerous is the use of tactical nuclear ammunition that can be mounted on ballistic and cruise missiles such as Iskader-M, Tochka-U, Kinzhal and Kalibr-PL (NK) with a yield of more than 10 kt in TNT equivalent, which can lead to the total destruction of structures within a radius of up to 1 km, damage to up to 80% of personnel and the population not in shelters, as well as failure of

radio-electronic and electrotechnical equipment within a radius of up to 2.5 km (Methodology for Assessing the Situation in Technogenic and Natural Emergencies, 2018).

This testifies to the relevance and importance of detecting and assessing nuclear threats to troops in order to create favourable conditions for successful training and combat actions.

The detection and assessment of nuclear threats is organised and conducted to timely inform troops about the factors of destruction, in particular radioactive contamination at command posts, travel routes, supply routes, evacuation routes, in areas of concentration and operations of troops. (Doctrine on Chemical, Biological, Radiological and Nuclear Protection of Troops (Forces), 2020). The task is conducted by regular and specially trained non-staff chemical, biological, radiological intelligence units by collecting data on the chemical, biological, radiological (CBR) situation along the routes of advance, areas and directions of troops' actions.

Despite the possible scale of nuclear threat consequences and their negative impact on military operations, currently that the Armed Forces of Ukraine (AFU) have a full nomenclature of nuclear threat detection and assessment capabilities assets to perform the full scope these tasks requires clarification.

This affects the completeness of nuclear threat detection and assessment to support decision-making by military command and control bodies. Thus, it is obvious that the detection and assessment of nuclear threats in the current conditions of combat actions is of special importance.

Thus, in order to increase the provision of the Armed Forces of Ukraine with the full nomenclature of protection assets against nuclear threats, there appears a necessity to resolve the task of determining the number of assets for detecting and assessing nuclear threats of the *i*-type, taking into account the current peculiarities of the conditions for performing these tasks in an operation (combat actions). For this It is proposed to expand the list of indicators for assessing the functioning of nuclear threat detection and assessment assets by implementing additional time indicators and completeness of nuclear threat detection and assessment tasks (on the example of chemical, biological, radiological intelligence), and to improve the method of determining the capabilities of these assets using the importancy coefficients of individual samples of assets. This will allow to determine their nomenclature for performing the scope of tasks in conditions of a high level of threat of use of nuclear weapons by the enemy.

Materials and Methods

As part of the methodological approach to determining the nomenclature of nuclear threat detection and assessment assets, the indicators and criteria for determining the nomenclature and number of these assets were selected and substantiated.

As the criteria, the minimum cost of the c_i i -type CBRN protection asset is adopted, which characterises the degree of goal achievement, which is to perform tasks on detection and assessment of nuclear threats in a timely manner and in a full scope.

The methodological approach to determining the nomenclature of CBRN protection assets, in particular nuclear threat detection and assessment assets, involves four stages of calculations.

At the 1st stage, the initial data required for calculations are generated, in particular: the nuclear threat detection and assessment tasks to be performed; operational force grouping (OFG) total operational square, *S*, km2; cost of one machine for detection and assessment of nuclear threats c_i , *i*-type, UAH; given time for detection and assessment of nuclear threats, T_{det}, hours; value of nuclear threat detection and assessment machines' relative losses per one hour of functioning, k_{loss}.

For determining the degree of compliance capabilities of nuclear threat detection and assessment equipment vailable nomenclature with the scope of tasks assigned to them (on the example of CBR reconnaissance tasks), the approximate capabilities of the available CBR reconnaissance units of the CBRN Defence Battalion (bCBRNd) of the operational force

grouping (OFG) and the required scope of CBR reconnaissance tasks during combat operations were determined (Tactical calculations of service tasks CBRN Defence, 2017):

the capabilities of CBR intelligence units of the bCBRNd OFG are: $S_{розвід}^{можл} = 6100\ км^2$;

the approximate scope of CBRN reconnaissance tasks (square of radiation reconnaissance of OFG combat areas) where as a result of tactical nuclear weapons use is accepted $S_{розвід}^{потр} = 8640\ км^2$.

Table 1 shows an example of radioactive contamination zones' average values size resulting from explosions of tactical nuclear weapons of the 3VB4 (3VB11) type with a yield of 2 kT in TNT equivalent by deploying 240 mm 2S4 Tulip self-propelled mortar. The 2S4 Tulip self-propelled mortar has a 20-round ammunition capacity.

Table 1. Sizes of radioactive contamination zones as a consequence of tactical nuclear weapons type 3B4 (3B11) explosions with a yield of 2 kT in TNT equivalent (example)

Conditions	Average size value of the radioactive contamination zone as a result of a nuclear explosion, km^2			
	Zone A (moderate contamination)	Zone B (highly contaminated)	Zone C (dangerous contamination)	Zone D (extremely dangerous contamination)
Contamination at wind speeds of 3-5, m/s	up to 14 km in length, up to 9.3 km in width, with a total area of up to 44.1 km^2	up to 4.8 km in length, up to 4.5 km in width, with a total area of up to 15.1 km^2	up to 2.4 km in length, up to 2.3 km in width, with a total area of up to 7.5 km^2	up to 1.2 km in length, up to 1.3 km in width, with a total area of up to 3.5 km^2
Radiation doses that personnel may receive in the case of open location on the ground, Rad	23	245	410	1300

At the 2nd stage, "Capabilities determination of nuclear threat detection and assessment assets and scope of tasks" is conducted:

in block 2.1, where the capabilities of available nomenclature and number of assets for detection and assessment of the *i*-type $\left(i = \overline{1,5}\right)$ nuclear threats are calculated:

$$S_{розвід\ i}^{можл} = v_{i\ розвід} \cdot x_{i\ розвід} \cdot (1 - k_{втр}) \cdot T_{розвід}\ , \qquad (1)$$

where $S_{розвід\ i}^{можл}$ – is an area's size to be reconnoitered by the available assets for detecting and assessing nuclear threats of the *i*-type; $v_{i\ розвід}$ – is capability of detecting and assessing nuclear threats with a one *i*-type CBR reconnaissance vehicle, km^2/hour; $x_{i\ розвід}$ – is an *i*-type CBR reconnaissance vehicles' available number, units; $k_{втр}$ – is a value of relative losses CBR reconnaissance vehicles per hour of nuclear threats detection and assessment; $T_{розвід}$ – is the set time for CBR reconnaissance, hours;

in block 2.2, where the necessary area of reconnaissance *i*-type CBR's areas (the scope of nuclear threat detection and assessment tasks) in the area of combat actions of the OFG is calculated:

$$S^{потр}_{розвід\ i} = \sum_{\alpha=1}^{k} S_{розвід\ \alpha i}, \quad (2)$$

where $\sum_{\alpha=1}^{k} S_{розвід\ \alpha i}$ – is areas' sum of k-operational areas of OFG units (components), km^2; $\left(\alpha = \overline{1,k}\right)$.

Further, the value of the necessary scope of tasks for detecting and assessing nuclear threats $S^{потр}_{розвід\ i}$ is compared with the capabilities' value $S^{можл}_{розвід\ i}$ of the i-th type available number of assets. If the accepted conditions $S^{можл}_{розвід\ i} \geq S^{потр}_{розвід\ i}$ correspond, it is considered that the capabilities of the available nomenclature and number of i-type nuclear threat detection and assessment assets to ensure OFG are sufficient.

If the mentioned condition is not fulfilled, we determine the nomenclature and nuclear threat detection and assessment assets' number that are capable of fulfilling the scope of nuclear threat detection and assessment tasks, for which purpose, at the **3rd stage**, we conduct "Importance coefficients' determination of of nuclear threat detection and assessment assets according to their indicative tactical and technical characteristics (TTC) by the taxonomy method" (example) by using CBR reconnaissance vehicles TTC (Table 2) (Zahorka, 2004).

Table 2. Value matrix α_{ij} of *i*-type CBR reconnaissance vehicles

CBR reconnaissance vehicle's type, i, $\left(i = \overline{1,5}\right)$	j-vehicle's TTC, $\left(j = \overline{1,5}\right)$				
	Radiological situation control radius, km	Capabilities for detecting the radiological situation in the areas, km^2	Capabilities to assess the radiological situation, areas, km^2	Power reserve, km	Engine power, HP
RKhM-4-01	$\alpha_{11}=2$	$\alpha_{12}=30$	$\alpha_{13}=9$	$\alpha_{14}=500$	$\alpha_{15}=250$
RKhM-4	$\alpha_{21}=3$	$\alpha_{22}=32$	$\alpha_{23}=10$	$\alpha_{24}=600$	$\alpha_{25}=260$
RKhM-1K	$\alpha_{31}=1$	$\alpha_{32}=36$	$\alpha_{33}=11$	$\alpha_{34}=400$	$\alpha_{35}=240$
BRDM-2cbr	$\alpha_{41}=4$	$\alpha_{42}=40$	$\alpha_{43}=12$	$\alpha_{44}=750$	$\alpha_{45}=140$
Kozak-2M1	$\alpha_{51}=6$	$\alpha_{52}=50$	$\alpha_{53}=20$	$\alpha_{54}=650$	$\alpha_{55}=300$

Since the matrix elements have different units of measurement, they are brought to a standardised (normalised) form using the formula:

$$\alpha^{*}_{ij} = \frac{\alpha_{ij} - \alpha_{j\eta\theta}}{\sigma_j}, \quad (3)$$

where is the arithmetic average of the matrix *j*-column elements according to Table 1:

$$\alpha_{j\eta\theta} = \frac{\sum_{i=1}^{5} \alpha_{ij}}{5}; \quad (4)$$

unbiased estimate of the average square deviation (dispersion) from arithmetic average of these elements (TTX) of matrix each column, Table 1:

$$\overline{\sigma}_j^2 = \frac{\sum_{i=1}^{5} \left(\alpha_{ij} - \alpha_{j\eta\theta}\right)^2}{5}. \quad (5)$$

Results of reducing to a standardised form the technical characteristics of a OFG CBR reconnaissance vehicle (assets) by using formula (3) are summarised in Table 3. The noted results indicate that after centring $\alpha_{ij} - \alpha_{j\eta\theta}$ and normalisation ($\overset{*}{\alpha}_{ij}$) obtained elements α^*_{ij} the obtained elements can already be compared with each other, in contrast to the initial comparability of element values α_{ij}.

Table 3. Normalised values α^*_{ij} of CBR reconnaissance vehicle (asset) technical characteristics

CBR reconnaissance vehicle's type, *i*, $\left(i=\overline{1,5}\right)$	*j*- vehicle's TTC, $\left(j=\overline{1,5}\right)$				
	1	*2*	*3*	*4*	*5*
RKhM-4-01	$\alpha^*_{11}=0,62$	$\alpha^*_{12}=0,95$	$\alpha^*_{13}=0,77$	$\alpha^*_{14}=0,59$	$\alpha^*_{15}=0,20$
RKhM-4	$\alpha^*_{21}=0,10$	$\alpha^*_{22}=0,70$	$\alpha^*_{23}=0,54$	$\alpha^*_{24}=0,14$	$\alpha^*_{25}=0,37$
RKhM-1K	$\alpha^*_{31}=1,14$	$\alpha^*_{32}=0,20$	$\alpha^*_{33}=0,31$	$\alpha^*_{34}=1,33$	$\alpha^*_{35}=0,03$
BRDM-2cbr	$\alpha^*_{41}=0,41$	$\alpha^*_{42}=0,30$	$\alpha^*_{43}=0,09$	$\alpha^*_{44}=1,25$	$\alpha^*_{45}=1,65$
Kozak-2M1	$\alpha^*_{51}=1,45$	$\alpha^*_{52}=1,56$	$\alpha^*_{53}=1,72$	$\alpha^*_{54}=0,51$	$\alpha^*_{55}=1,04$

After using formula (3), a normalised matrix with dimensionless elements is formed:

$$A^* = \left\| \begin{matrix} \alpha^*_{11}\alpha^*_{12}\alpha^*_{13}\alpha^*_{14}\alpha^*_{15} \\ \alpha^*_{21}\alpha^*_{22}\alpha^*_{23}\alpha^*_{24}\alpha^*_{25} \\ \alpha^*_{31}\alpha^*_{32}\alpha^*_{33}\alpha^*_{34}\alpha^*_{35} \\ \alpha^*_{41}\alpha^*_{42}\alpha^*_{43}\alpha^*_{44}\alpha^*_{45} \\ \alpha^*_{51}\alpha^*_{52}\alpha^*_{53}\alpha^*_{54}\alpha^*_{55} \end{matrix} \right\| = \left\| \begin{matrix} 0{,}62\ 0{,}95\ 0{,}77\ 0{,}59\ 0{,}20 \\ 0{,}10\ 0{,}70\ 0{,}54\ 0{,}14\ 0{,}37 \\ 1{,}14\ 0{,}20\ 0{,}31\ 1{,}33\ 0{,}03 \\ 0{,}41\ 0{,}30\ 0{,}09\ 1{,}25\ 1{,}65 \\ 1{,}45\ 1{,}56\ 1{,}72\ 0{,}51\ 1{,}04 \end{matrix} \right\|. \quad (6)$$

Further, at this stage, the importance coefficients of the respective TTC each OFG CBR reconnaissance vehicle (assets) by using the method of expert survey were determined . The set of these importance coefficients could be reflected by a matrix of the such form:

$$B = \left\| \begin{matrix} B_1 0..0..0..0 \\ 0..B_2 0..0..0 \\ 0..0..B_3 0..0 \\ 0..0..0..B_4 0 \\ 0..0..0..0..B_5 \end{matrix} \right\| = \left\| \begin{matrix} 0,1..0..0..0..0 \\ 0..0,3..0..0..0 \\ 0..0..0,2..0..0 \\ 0..0..0..0,1..0 \\ 0..0..0..0..0,3 \end{matrix} \right\|, \quad (7)$$

where B_j – "weight " *j*-их TTC of analysed CBRN reconnaissance vehicle, in this case:

$$\sum_{j=1}^{5} B_j = 1. \tag{8}$$

Further, the task is reduced to multiplying the normalised A^* (6) and diagonal B (7) matrices, while the matrix colums' number A^* should be equal to the matrix rows' number B. After multiplying the normalised A^* and diagonal B matrices, the "weighted" matrix A^z is obtained:

$$A^z = \begin{Vmatrix} \alpha^z_{11} \alpha^z_{12} \alpha^z_{13} \alpha^z_{14} \alpha^z_{15} \\ \alpha^z_{21} \alpha^z_{22} \alpha^z_{23} \alpha^z_{24} \alpha^z_{25} \\ \alpha^z_{31} \alpha^z_{32} \alpha^z_{33} \alpha^z_{34} \alpha^z_{35} \\ \alpha^z_{41} \alpha^z_{42} \alpha^z_{43} \alpha^z_{44} \alpha^z_{45} \\ \alpha^z_{51} \alpha^z_{52} \alpha^z_{53} \alpha^z_{54} \alpha^z_{55} \end{Vmatrix}, \tag{9}$$

where the element of the "weighted" matrix $\alpha^z_{ij} = \alpha^*_{ij} \cdot B_j$ is equal to the scalar product of matrix A^* (6) *i*-vector-row by *j*-vector-column of diagonal matrix B (7).

The results of multiplying the normalised A^* and diagonal matrix B are summarised in Table 4.

Table 4. CBR reconnaissance vehicle (assets) coefficients α^z_{ij}

CBR reconnaissance vehicle's type, *i*, $(i = \overline{1,5})$	*j*- vehicle's TTC, $(j = \overline{1,5})$				
	1	*2*	*3*	*4*	*5*
RKhM-4-01	*0,062*	*0,285*	*0,154*	*0,059*	*0,06*
RKhM-4	*0,01*	*0,21*	*0,108*	*0,014*	*0,042*
RKhM-1K	*0,114*	*0,06*	*0,062*	*0,133*	*0,396*
BRDM-2cbr	*0,041*	*0,09*	*0,018*	*0,125*	*0,495*
Kozak-2M1	*0,145*	*0,468*	*0,344*	*0,051*	*0,312*

After "rolling up" the TTC importance coefficients α^z_{ij}, the complex indicators A^z_i of *i*- type CBRN reconnaissance vehicle (assets) are obtained:

$$A^z{}_{i\ розвід} = \sqrt{\left(\alpha^z{}_{11}\right)^2 + \left(\alpha^z{}_{12}\right)^2 + \ldots + \left(\alpha^z{}_{ij}\right)^2 + \ldots + \left(\alpha^z{}_{i5}\right)^2}. \tag{10}$$

Further, for each type of the above-mentioned CBR reconnaissance vehicle (assets), their importance coefficients are determined $K_{i\ розвід} = \frac{A^z_{i\ розвід}}{\sum_i^5 A^z_{i\ розвід}}$.

At the 4th stage, "Nomenclature and movable vehicles' number determination of OFG CBR reconnaissance" is performed by solving the optimisation problem of integer linear programming through the use of importance coefficients K_i of these vehicles (assets). Taking into account that there are five *i*-types of vehicles (assets) to conduct a certain CBR reconnaissance task, each of them has capabilities v_i and required time T . It is necessary to determine the nomenclature and the number X_i of these vehicles (assets), which will allow to perform the necessary scope of tasks in condition minimising the cost of all vehicles (assets).

Obviously, the total cost of the vehicles (assets) should be equal:

$$min\sum_{i=1}^{5} c_i \cdot X_i \qquad (11)$$

on condition that the required scope of CBR intelligence tasks are completed::

$$\sum_{i=1}^{5} v_{i\ розвід} \cdot K_{i\ розвід} \cdot X_{i\ розвід} \cdot T_{розвід} \geq \sum_{i=1}^{5} S^{потр}_{розвід\ i}, \qquad (12)$$

where $S^{потр}_{розвід\ i}$ determined according to (2).

Based on the results of solving the optimisation task, non-negative values variables X_i, are selected for which the objective function reaches a minimum.

The calculation results are shown in Table 5.

Table 5. Nomenclature of nuclear threat detection and assessment assets (on CBR reconnaissance assets example) of the OFG CBRN battalion

Indicators name		CBR reconnaissance vehicles names			
		RKhM-4-01	RKhM-4	Kozak-2M1	BRDM-2CBR
CBR vehicle capabilities for area reconnaissance, km²/hours, $v_{i\ reccon}$		*80*	*70*	*90*	*60*
Time for CBR reconnaissance, hours, $T^{опер}_{розвід}$		*10*	*10*	*10*	*10*
Vehicle importance ratio, $K_{i\ reccon}$		*0,15*	*0,11*	*0,19*	*0,23*
Scope of activities required, km², $S^{потр}_{розвід}$		*8640*			
CBR reconnaissance assets' nomenclature available, units $x_{i\ reccon}$		-	-	-	*18*
Variants of the CBR reconnaissance assets' nomenclature, units. $x_{i\ reccon}$	1	*4*	*6*	*4*	*9*
	2	*5*	*5*	*6*	*8*
	3	*4*	*6*	*7*	*7*
	4	*5*	*6*	*5*	*8*
A rational variant of the CBR intelligence assets nomenclature is determined, од., $x_{i\ reccon}$	5	*6*	*4*	*6*	*7*

Based on the analysis of the obtained results, it was determined that 20 to 24 CBR reconnaissance vehicles (assets) as components of OFG CBRN brigade's are necessary to perform the required scope of CBR reconnaissance tasks $S^{потр}_{розвід} = 8640\ км^2$, taking into account losses (see Table 4, Fig. 1).

Thus, the nomenclature and number of mobile assets for detecting and assessing nuclear threats (on the example of *i*-type CBR reconnaissance assets) are determineding.

At this point, the task of determining the nomenclature of mobile assets to conduct the scope of nuclear threat detection and assessment tasks is considered to be completed.

Prospects for further research are the development of software to reduce the time of headquarters and services' work.

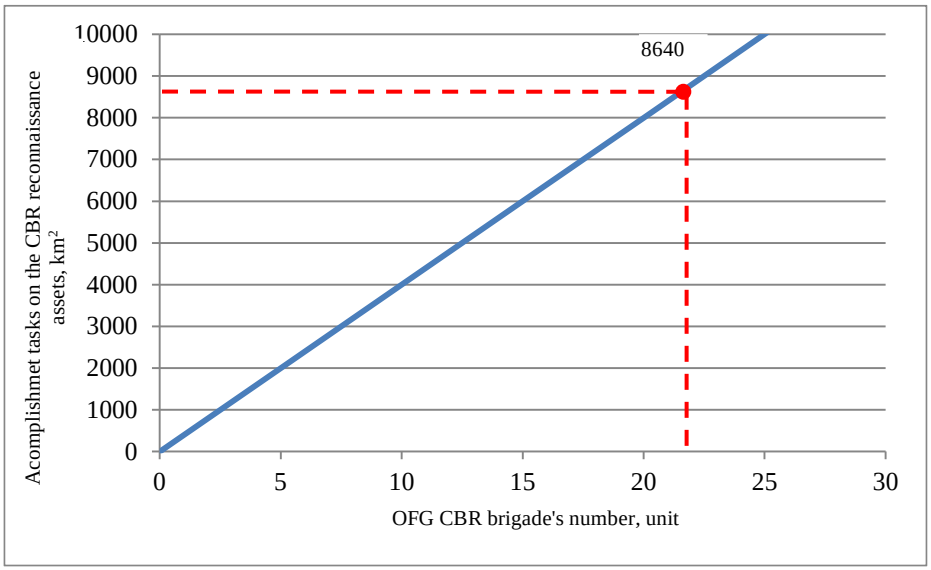


Figure 1. Scope dependence of nuclear threat detection and assessment (CBR reconnaissance) acomplishmet tasks on the CBR reconnaissance assets in OFG CBR brigade's number

Results and Discussions

Thus, by expanding the list of indicators for assessing the functioning of nuclear threat detection and assessment capabilities by introduction of additional time indicators and task completeness for detection and assessment of the situation (CBR reconnaissance), improving the means for determining the capabilities of these assets by using the importance coefficients of assets' individual samples, their nomenclature for performing the scope of tasks under conditions of a high level of threat of nuclear weapons use by the enemy was determined.

This definition means that the results of the assessment of the functioning of nuclear threat detection and assessment assets depend on the level of assets losses that affect their ability to conduct the scope of tasks during combat actions in conditions of the use of nuclear weapons by the enemy, the nomenclature and number of detection and assessment assets (CBR) and their tactical and TTC.

The results of the research and publications analysis showed that a number of studies paid attention to matters related to the troops' protection against nuclear threats organisation and conduct, in particular, detection and assessment of the CBR situation. These are, for example, general questions regarding the CBR reconnaissance organisation and conduct operations (Units' Chemical, Biological, Radiation Protection, 2007), radiation, chemical, biological protection troops' tactics in relation to the conduct CBR reconnaissance activities, tactical calculations substantiation for the conduct of CBR protection tasks and activities, including CBR reconnaissance activities (Hutchenko, Hyshko, Prokofiev, 2017). However, the nomenclature of movable assets for performing the scope of tasks of detecting and assessing nuclear threats, taking into account the loss of these assets and their importance, was not considered in these researches and publications.

The russian-Ukrainian war experience convinces that during the conduct of combat actions in the conditions of threat level escalation, the scope of tasks for detecting and assessing nuclear threats will increase, and the capabilities for their accomplishment will change. In consideration of the above, it is necessary to determine the nuclear threat detection and assessment assets nomenclature by assessing their characteristics, which will allow to evaluate their capabilities and importance in a complex radiological situation, which was done in the article using the proposed methodological approach.

Conclusion

Thus, the presented extended list of indicators for assessing the nuclear threat detection and assessment assets functioning by introducing additional time indicators and tasks completeness of situation detection and assessment (CBR intelligence), improving the method of determining these assets' capabilities through the use of individual assets samples' importance coefficients made it possible to determine the nomenclature of these assets to perform tasks' scope in a high level of nuclear weapons use threats by the enemy conditions .

The research has shown that the results of the assessment of nuclear threat detection and assessment assets functioning depend on the level of assets losses that affect their ability to accomplish the scope of tasks during combat actions in the enemy use of nuclear weapons' conditions, the nomenclature and number of detection and assessment assets of situation (CBR intelligence) and their tactical and technical characteristics.

Prospects for further research in this area are research on the tasks of defence against CBR and nuclear threats, as well as software development to reduce the time of military command and control bodies with this purpose.

Recommendations

The materials in this publication may be useful for military command and control officials involved in CBRN planning for troop protection during combat actions. The results of these calculations will allow determining the nomenclature of assets to perform the scope of nuclear threat detection and assessment tasks.

References

1. Hutchenko, A., Hyshko, V., Prokofiev, V. Tactical calculations on the CBRN protection service's tasks: methodological manual. (2017). Kharkiv. Kharkiv National University of Air Force named after I. Kozhedub. P. 48.
2. Doctrine on Chemical, Biological, Radiological and Nuclear Protection of Troops (Forces). Support Forces Command of the Armed Forces of Ukraine: (2020). VKP 5(3)-00(03).01 of 26.10.2020. Kyiv. P. 35.
3. Zahorka, O. Comparative assessment of weapons samples (complexes and systems) using the taxonomic method. (2004). Scientific Proceedings of the Central Research Institute of the Armed Forces of Ukraine. Kyiv. № 3 (28). P. 96-102.
4. Instruction "Chemical, Biological, Radiological and Nuclear Protection in NATO Operations". Support Forces Command of the Armed Forces of Ukraine: (2023). PTKP 10-25(263). Kyiv. P. 433.
5. Fact Sheet of the US Department of State. (2009). https://2001-2009.state.gov/t/vci/rls/prsrl/2008/ 102844. htm (accessed 15.10.2022).
6. Information sheet. (2022). https://www.washingtonpost.com/world/2022/10/05/russia-nuclear-weapons-military-arsenal/ (accessed 08.10.2022).
7. Koval, V. Methodical approach to assessing the effectiveness of the automatisation assets' integration into the work of radiation, chemical and biological defence in troops' (forces') command and control bodies. (2008). Modern information technologies in the field of security and defence. Kyiv. № 3 (3). P. 28-30.
8. Blekot, O., Romaniuk, V., Nikitin, A., Kotsiuruba, V. Methodology for assessing the situation in emergency situations of technogenic and natural character: a study guide. (2018). Kyiv. National Defence University of Ukraine. P. 12.
9. Meshcheriakov, I., Kurtseitov, T. CBR defence units' action modes formation based on the experience of russian military aggression against Ukraine. (2023). Problematic issues of

organising support activities of the troops (forces) of the Armed Forces of Ukraine in the counteracting course the large-scale armed aggression of the russian federation against Ukraine (taking into account the experience of the joint forces operation). *Scientific and practical seminars materials' collection* (Kyiv, 27 April). Kyiv. National Defence University of Ukraine. P. 38-42.

10. Nikitin, A., Vysotskyi, P. CBRN planning experience analysis for the protection of military facilities and the use of CBRN defence units in the counteracting course of russian federation against Ukraine armed aggression. (2023). Problematic issues of organising support activities of the troops (forces) of the Armed Forces of Ukraine in the counteracting course the large-scale armed aggression of the russian federation against Ukraine (taking into account the experience of the joint forces operation). *Scientific and practical seminars materials' collection* (Kyiv. 27 April). Kyiv. National Defence University of Ukraine. P. 23-24.
11. Regarding the Instruction on the Functioning of the System of Prevention and Warning of Chemical, Biological, Radiological and Nuclear Threats (Incidents) in the System of the Ministry of Defence of Ukraine's Approval. (2023). Decree of the Ministry of Defence of Ukraine of 22.03.2023 No. 152/nm. Kyiv. P. 43.
12. Strategic Missile Forces of the russian federation. (2022). https://uk.wikipedia.org/wiki (accessed 08.10.2022).
13. Slobodianyk, V., Sevostianov, I., Shvets, O. & Dolhalenko, O. (2023). Methodology for Assessing the Military-Technical Level and Prospects for the Development of Radiation, Chemical, and Biological Reconnaissance Devices. *Scientific Proceedings of the Central Research Institute of Armaments and Military Equipment of the Armed Forces of Ukraine*. Kyiv. № 1 (75). P. 152-158.
14. Teploukhov, B. Weapons of mass destruction and protection against them: methodological guide. (2008). Kyiv. Military Institute of Taras Shevchenko National University of Kyiv. P. 100.
15. Lessons of the russian-Ukrainian War of 2022: Military Aspects (2022). (Information and Analytical Report No. 19). Experience of using the units and subdivisions of the Support Forces of the Armed Forces of Ukraine in the context of the russian federation's large-scale aggression against Ukraine. Kyiv. Central Research Institute of the Armed Forces of Ukraine. Inv. no. 18339. P. 132.
16. Completeness of radiation survey is a criterion for the quality of actual radiation situation in modern conditions' detection. (2015). Actual problems of modelling risks and threats of emergencies at critical infrastructure facilities. Proceedings of the International Scientific and Practical Conference (Kyiv, 20-21 April). Kyiv. Ukrainian Research Institute of Civil Defence. P. 35-36.