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METHODS OF DETERMINATION OF INITIAL DATA FOR EVALUATION OF EFFICIENCY OF SEA DEFENSE OF THE SEA COAST

The article presents a method for determining and substantiating the options of the initial data system for assessing the effectiveness against the ship's defense of the sea coast, taking into account the differences of opinion of experts.
Keywords: *anti-ship defense, grouping of ships, naval forces.*

Introduction

The main task of the reform of the Naval forces is to rebuild Ukraine's naval capabilities, reliable defense of the Motherland and the ability to defeat a stronger enemy. This will require new thinking, some time and significant resources.

Ukraine, together with its strategic partners, is making a great effort to restore its naval potential. Reform is based on NATO standards, principles and values [1]-[3].

Today, the decision on the further development of the Ukrainian Navy must be made at the state level, because the development of the Navy totally depends on the development of high-tech and science-intensive industries. The construction of the fleet is a long process and requires long-term planning, which is possible only at the strategic, country level. In addition, the implementation of the shipbuilding program requires significant amounts of financial resources, which requires not just to consider them in total defense spending, but as a separate program. Also, Ukraine today must decide how to protect and defend the sea coast and protect the interests of the country in the maritime economic zone, and what to have, and how to develop forces and means for this? [1]-[5].

Analysis of recent achievements and publications

Evaluation of the effectiveness of the use of forces and means of troops (forces) is carried out according to the appropriate methods according to the developed scenario.

Over all, approaches to the development of combat scenarios are quite openly discussed in the literature. Thus, in particular, in [4] it is emphasized that the scenario of hostilities is based on assumptions about the possible development of the process of armed struggle and should provide for several options for its course. These options are determined by the level of intensity of a possible armed conflict, the composition of the troops (forces) of the opposing parties, the forms and methods of use of troops (forces).

And first of all the basic scenario of military operations on the basis of which other scenarios can be developed is developed, but the initial operational situation should not undergo essential changes [4].

The scenario of possible hostilities must meet the following basic requirements [4]: the use of projected information on the composition of the troops (forces) of the opposing parties; completeness of the description and reflection of the operational situation; a clear sequence of forms and methods of using forces and means of troops (forces) of the parties at different stages of hostilities; sufficiency of information for conducting operational and tactical calculations and modeling of bilateral hostilities.

The content of the combat scenario should contain [4], [5]: analysis of the military-political and military-strategic situation; composition of forces and means of troops (forces) of the parties before the start of hostilities, determination of opportunities for their strengthening; the plan of hostilities, the definition of the purpose and tasks of troops (forces); description of hostilities.

However, these general recommendations need to be meaningful for the specific operation (combat) to be studied.

Regarding the anti-ship defense of the sea coast under consideration, a detailed analysis of the military-political and military-strategic situation is given in [4], a description of the stages of hostilities is given in [5], but the question of initial data for assessing the effectiveness of air defense remains open. the composition of the opposing parties and the criterion by which the decision is made to achieve (or not achieve) the enemy's goal of hostilities. The degree of validity of such data significantly affects the reliability of the calculation results, and therefore there is a need to develop a methodology for determining reasonable baseline data to assess the effectiveness of the PKO of the sea coast.

Thus, the purpose of the article is to develop a methodology for determining such initial data for evaluating the effectiveness of ICO of the sea coast, which ensure the validity of the results of calculations for several options for hostilities.

Main Questions

In Ukrainian society, attention towards issues of safety at sea and, accordingly, to the state and development of the Naval Forces of the Armed Forces of Ukraine is growing. But in the conditions of the information war waged against us by Russia, it is not surprising that these issues have become another platform for manipulation [1] – [3]. In 2014, the Russian Federation, in violation of international agreements and norms, established control over Crimea through «hybrid» aggression. Ukraine has lost most of its Navy, including 75% of its personnel, 70% of its ships and key infrastructure. The aggressor has seized and is actively using the population and territory of the peninsula, a significant part of the sovereign waters and objects of the Ukrainian economy. Ukraine's national security system must respond to these challenges, clearly organize cooperation between Ukraine's defense and security forces to protect national interests at sea. Today, Ukrainian sailors take an active part in hostilities to protect our country in the East, do tasks in the Black and Azov Seas. New challenges and experience gained require the development and implementation of the Strategy of the Naval Forces of the Armed Forces of Ukraine 2035.

In the current military-political situation, some countries (Russia, USA, Turkey) pay more attention to the creation and improvement of anti-ship defense systems (AFS) in various areas [5]. Anti-ship defense is an important subsystem of the coastal defense system. This type of defense is organized and carried out in order to ensure the safety of objects on the coast and in the coastal sea area, the safety of ships at sea and in combat areas from strikes by various weapons of surface ships and enemy combat boats. To achieve the maximum effect, the air defense system should include not only the forces and means of the Navy, but also other types of aircraft (planes and aircraft): missile ships (boats), submarines, bombers and assault aircraft, attack helicopters, prepared for action over the sea, coastal missile and artillery units, mine barriers, underwater sabotage forces and means. In order to strengthen the air defense system, it is possible to use non-traditional methods of combating the surface forces of the aggressor.

When assessing the effectiveness of combat operations, one of the stages of the calculations is the operational and tactical description of the situation studied, such as a description of combat operations, taking into account the use of forces and means of air defense. That is, the definition of those elements of the situation that relate to the forces of the enemy, their forces, the conditions on which the course of hostilities depends, and so on.

To ensure the reliability of the assessment of the effectiveness of the use of troops (forces) requires both the appropriate methodological apparatus and the projected scenario of hostilities. The quality of assessing

the reliability of forecasting the effectiveness of the use of troops (forces), largely depends not only on the methodology used for calculations, but also on the quality of the selected source data needed to calculate the effectiveness of the use of troops (forces) in certain conditions environment.

Therefore, increasing the reliability of the assessment of the effectiveness of hostilities through the use of sound source data for calculations is, in our opinion, an urgent task.

Presentation of the main material of the study with a full justification of the obtained scientific results

It is proposed to determine the initial data for evaluating the effectiveness of ADM of the sea coast on the basis of an expert survey for a formalized presentation of knowledge of highly qualified specialists.

The methodology for determining the initial data for evaluating the effectiveness of ADM of the sea coast consists of two stages: direct expert survey and processing of its results.

First of all, a survey table is created, which contains a list of initial data required for calculations. The total amount of initial data J depends on the model ideas about the course of hostilities. In particular, for the model of combat operations during air defense, the following components of air defense management are proposed (see Table 1), which contains 14 indicators.

In this case, each source data corresponds to two rows of the table. The first of them gives the possible numerical values of the source data x_{ij} ($j = 1 \dots J$, $i = 1 \dots I_j$, where I_j is the number of options for the j-th source data), and the second line is filled by an expert during the survey (a_{ij}) [4] - [7].

When filling in the table, the expert is asked to assign scores to the variants of numerical values of the original data in each j-th line so that the sum of points in it was constant and equal to A_j (in our case, $A_j =$ 10 points):

$$A_j = \sum_{i=1}^{I_j} a_{ij} = 10 \; , \; a_{ij} \in \{0,...,10\} \, , \; j = 1...J \, , \; i = 1...I_j \tag{1}$$

In this case, the highest score is given to the option of the value of the original data, which the expert considers the most likely to be possible. If several options are possible, then the points between them are distributed by the expert in proportion to the probability of their practical implementation.

Such tables are filled in by each of N experts that provides reception of N numerical values of points for each initial data.

The task of the next stage of the methodology is to determine reasonable options for the source data for the study of several scenarios of hostilities. To do this, the data from all survey tables are reduced to a single table. Based on the fact that the total number of points in each row, which was filled by an expert, is equal A_j, the values of the elements of the summary table are calculated by the formula:

$$a_{ij}^* = \frac{\sum_{n=1}^{N} a_{ijn}}{A_j N} \, , \; j = 1...J \, , \; i = 1...I_j \, , \tag{2}$$

a_{ijn} – assessment provided by the nth expert for each x_{ij} .

Questionnaire to determine the initial data for evaluating the effectiveness of ADM of the sea coast (option)

	Output data	Variants of numerous values of initial data				
		1	2	3	4	5
	ENEMY					
1	Number of ships (boats) of guided missile weapons (units)	2-4	4-8	8-12	12-15	15-17
		1	1	4	3	1
2	Number of ships (boats) of protection (units)	1-2	2-4	4-6		
		2	5	3		
3	Number of fighter cover aircraft (units)	2-6	6-12	12-18	18-24	
		2	3	4	1	
4	Speed of the ship's strike group (nodes)	2-4	4-6	6-8	8-10	10-14
		1	2	2	4	1
5	Boundary of detection of ship strike group (km)	50-100	100-200	200-300		
		1	5	4		
6	Boundary of combat mission (km)	20-40	40-60	60-80	80-120	
		1	3	4	2	
7	The degree of defeat at which the enemy refuses to continue the combat mission	0,3-0,5	0,5-0,6	0,6-0,7	0,7-0,8	0,8-0,9
		1	4	3	1	1
	OUR FORCES					
8	Number of strike aircraft (units)	8-12	12-24	24-38		
		2	5	3		
9	Number of fighter jets (units)	2-6	6-12	12-18	18-24	
		1	4	3	2	
10	Possibility of re-use of strike aircraft	Так	Ні			
		6	4			
11	Number of ships (boats) of guided missile weapons (units)	1-2	2-4			
		4	6			
12	Number of ships (boats) of protection (units)	1-2	2-5	5-7		
		4	3	3		
13	Number of PU BRV (units)	2-4	4-6	6-8	8-12	
		1	2	3	4	
14	Number of parts MT&A (units)	1-2	2-4	4-6	6-8	
		4	3	2	1	

Given that, $A_j = const$, elements of the summary table can be considered as an expert assessment of the probability that the scenario of hostilities will be determined by such a set of source data.

To make calculations to assess the effectiveness of hostilities during the ADM of the sea coast, it is advisable to form three options for sets of source data.

The most probable is a set that corresponds to the variants of the source data that have the greatest value of expert assessment of the probability of implementation. These are the elements of the PivotTable for which the condition is met $a_{ij}^* = \max \{a_{1j}^*, a_{2j}^*, ..., a_{I_jj}^*\}$, $j = 1 ... J$

The most intense part is a set of initial data, which according to experts can be implemented as the most unfavorable for our side (for the enemy - the largest number of means, the highest transition speed, the

smallest distance to the detection limit of a naval strike group, etc., for their own forces - the least number of means involved for ADM). These are the limit values of the indicators for which the condition is met $a_{ij}^* \neq 0$, $j = 1 \dots J$, $i = 1 \dots I_j$.

The average is a set that contains the average values of the original data according to experts. Average value $\overline{x}_j$ calculated acording to the formula

$$\overline{x}_j = \sum_{i=1}^{I_j} a_{ij}^* x_{ij}' \,, \quad j = 1 \dots J \,,$$
(3)

x_{ij}' – the average value of the indicator for the i-th variant of the numerical value of the original data. The only indicator of the initial data in the table that has a verbal meaning is the indicator № 10 (the possibility of re-application of strike aircraft), to which formula (1) cannot be applied. Therefore, its value for the average version of the original data is chosen as the most probable. In the case where experts have given the same assessments of both options, we believe that the re-use of strike aircraft is impractical.

Unlike existing methods, which are based on expert surveys (for example, [4, 5]), and require the consistency of experts' views in order to obtain a single reasonable option, the proposed method does not require such consistency. On the contrary, the presence of differences in expert assessments allows to form several sets of source data, which allows to reasonably take into account the uncertainty of a possible scenario of hostilities and to consider several options for the composition of groups of parties.

The following cases may occur:

– if the experts have fully agreed views on the course of hostilities, then all three options for the above sets of source data coincide;

– if the experts do not have agreed views, then their assessments (in the extreme case) will be evenly distributed, which will lead to the presence of two sets of source data: the most intense and average;

– if the experts' estimates are partially inconsistent, then we have all three sets of source data.

This approach to the choice of baseline data for assessing the effectiveness of hostilities during ADM offshore gives the decision-maker the opportunity to analyze several options for the course of hostilities, taking into account the initial uncertainty about the possibility of their practical implementation.

Conclusions

The analysis of the conducted researches allows to conclude that the developed technique allows to define some substantiated variants of initial data for an estimation of efficiency of military operations during ADM of sea coast taking into account a difference of views of experts.

Their practical use expands the methodological apparatus that can be used in headquarters during the planning of the ADM of the sea coast.

We see the prospect of further research in the creation of a software product to summarize the knowledge of highly qualified specialists in the expert system in order to increase the efficiency of assessing the effectiveness of hostilities.

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МЕТОДИКА ОПРЕДЕЛЕНИЯ ИСХОДНЫХ ДАННЫХ ДЛЯ ОЦЕНКИ ЭФФЕКТИВНОСТИ ПРОТИВОКОРАБЕЛЬНОЙ ОБОРОНЫ МОРСКОГО ПОБЕРЕЖЬЯ

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Главной задачей реформы Военно-Морских Сил является восстановление военно-морских возможностей Украины, надежную защиту Родины и способность побеждать сильного противника. Это потребует нового мышления, определенного времени и значительных ресурсов. Украина вместе со стратегическими партнерами прилагают много усилий для восстановления военно-морского потенциала. Реформирование происходит по стандартам, принципам и ценностям НАТО.

При оценке эффективности ведения боевых действий одним из этапов проведения расчетов является оперативно-тактический описание ситуации, исследуется, например, описание ведения боевых действий с учетом применения сил и средств ВКО. То есть определение тех элементов обстановки, касающиеся сил противника, своих сил, условий, от которых зависит ход боевых действий, и тому подобное.

Для обеспечения достоверности оценки эффективности применения войск (сил) необходим как соответствующий методический аппарат, так и прогнозируемый сценарий боевых действий. Качество оценки достоверности прогнозирования эффективности применения войск (сил), в значительной степени, зависит не только от методики, применяемой для расчетов, но и от качества выбранных исходных данных необходимых для проведения расчетов по оценке эффективности применения войск (сил) в тех или иных условиях обстановки.

Итак, цель статьи заключается в разработке методики определения таких исходных данных для оценки эффективности ПКО морского побережья, которые обеспечивают обоснованность полученных результатов расчетов по нескольким вариантам боевых действий.

Ключевые слова: *противокорабельная оборона, группировка кораблей, военно-морские силы.*

МЕТОДИКА ВИЗНАЧЕННЯ ВИХІДНИХ ДАНИХ ДЛЯ ОЦІНЮВАННЯ ЕФЕКТИВНОСТІ ПРОТИКОРАБЕЛЬНОЇ ОБОРОНИ МОРСЬКОГО УЗБЕРЕЖЖЯ

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Головним завданням реформи Військово-Морських Сил є відбудова військово-морських спроможностей України, надійний захист Батьківщини і здатність перемагати сильнішого супротивника. Це вимагатиме нового мислення, певного часу і значних ресурсів. Україна разом із стратегічними партнерами докладають багато зусиль для відновлення військово-морського потенціалу. Реформування відбувається за стандартами, принципами та цінностями НАТО

Під час оцінювання ефективності ведення бойових дій одним з етапів проведення розрахунків є оперативно-тактичний опис ситуації, що досліджується, наприклад опис ведення бойових дій з урахуванням застосування сил і засобів ПКО. Тобто визначення тих елементів обстановки, що стосуються сил противника, своїх сил, умов, від яких залежить перебіг бойових дій, тощо.

Для забезпечення достовірності оцінювання ефективності застосування військ (сил) необхідний як відповідний методичний апарат, так і прогнозований сценарій бойових дій. Якість оцінювання достовірності прогнозування ефективності застосування військ (сил), у значній мірі, залежить не тільки від методики, що застосовується для розрахунків, а й від якості обраних вихідних даних необхідних для проведення розрахунків щодо оцінювання ефективності застосування військ (сил) в тих чи інших умовах обстановки.

Тому підвищення достовірності оцінки ефективності бойових дій шляхом використання обґрунтованих вихідних даних для розрахунків є, на наш погляд, актуальним завданням .

Оцінювання ефективності застосування сил та засобів військ (сил) проводиться за відповідними методиками згідно розробленого сценарію.

Загальні підходи до розробки сценаріїв бойових дій досить повно розглянуті в спеціальній літературі. Так, зокрема, в наголошено, що сценарій бойових дій базується на припущеннях стосовно можливого розвитку процесу збройної боротьби і повинен передбачати декілька варіантів його перебігу. Ці варіанти визначаються рівнем інтенсивності можливого збройного конфлікту, складом військ (сил) сторін, які протистоять, формами й способами застосування військ (сил).

Стосовно протикорабельної оборони морського узбережжя, яка розглядається, докладний аналіз воєнно-політичної і воєнно-стратегічної обстановки наведений в, опис етапів бойових дій наведений в, однак залишається відкритим питання про вихідні дані для оцінювання ефективності ПКО, тобто підлягає визначенню склад протиборчих сторін та критерій, за яким приймається рішення про досягнення (або недосягнення) противником мети бойових дій. Ступінь обґрунтованості таких даних суттєво впливає на достовірність результатів розрахунків, а тому виникає потреба в розробці методики визначення обґрунтованих вихідних даних для оцінки ефективності ПКО морського узбережжя.

Отже, мета статті полягає в розробці методики визначення таких вихідних даних для оцінювання ефективності ПКО морського узбережжя, які забезпечують обґрунтованість отриманих результатів розрахунків за декількома варіантами бойових дій.

Ключові слова: *протикорабельна оборона, угрупування кораблів, військово-морські сили.*