MINISTRY Of DEFENCE Of UKRAINE MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE

Central Research Institute of Arms of the Armed Forces of Ukraine

COORDINATION PROBLEMS OF MILITARY TECHNICAL AND DEVENSIVE INDUSTRIAL POLICY IN UKRAINE. WEAPONS AND MILITARY EQUIPMENT DEVELOPMENT PERSPECTIVES

VII International Scientific and Practical Conference

Abstracts of reports

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PLENARY SESSION

First Deputy Minister of Defence of Ukraine,
Doctor of military sciences, profesor Rusnak Ivan Stepanovich
Introductory statement at the VII international scientific-practical conference "PROBLEMS OF COORDINATION OF MILITARY-TECHNICAL AND DEFENSE-INDUSTRY POLICIES IN UKRAINE. PROSPECTS THE DEVELOPMENT OF ARMAMENTS AND MILITARY EQUIPMENT"

Dear participants of the conference!

Within the framework of the XVI International specialized exhibition "Arms and Security - 2019" the Ministry of Defense of Ukraine is holding the next (seventh) international conference, which, as in previous years, has a thematic title **"Problems of coordination of military-technical and defense-industrial policy in Ukraine. Prospects the development of armaments and military equipment"**. Every year this conference attracts more and more attention of both the military-political leadership of the country and a wide range of specialists in the military-technical and defense-industrial policy of Ukraine and other countries of the world. The importance of this conference is the fact that this year the Ministry of Defense (MoD) again holds it together with the Ministry of education and science of Ukraine, which has become a good tradition, who's educational and scientific institutions also, make a significant contribution to the development of technical equipment of the Armed Forces (AF) of Ukraine. In this regard, I believe that the scientific level and practical orientation of the conference is constantly increasing.

Opening the conference, I would like to express my gratitude to all its participants for the presence at this event and not indifferent to the problems of technical equipment of the AF of Ukraine, which are being solved at the moment in the MoD of Ukraine.

At this event, we plan, as always, to summarize the main results of the year after the last conference, to analyze our achievements in strengthening the defense capability of Ukraine, the military might of the AF of Ukraine, in resolving the issues of military-technical and defense-industrial policy of Ukraine, etc. At the same time, the issues in this area must be covered, that have not been resolved or have not been fully resolved, the reasons for their condition, and ways to remedy them and prevent them in the future, should be highlighted.

It should be noted that the past year was quite difficult for Ukraine and its AF of Ukraine.

The current stage of development of the situation in the world is characterized by the presence of military tension in certain regions of the globe, including - around and in the middle of Ukraine. The armed conflict in Eastern Ukraine is ongoing for five years and has led to a huge loss of economic and human potential of Ukraine. For the prevention and elimination of military conflicts, an important role belongs to the AF of Ukraine, which must be staffed with trained personnel and equipped with modern armaments and military equipment. The past years have become, to some extent, positive for the development of the technical equipment of the AF of Ukraine by supplying a large number of upgraded armaments and military equipment to them, and by adopting some new ones.

Considering that the AF of Ukraine are now equipped with samples of weapons, created mainly during the Soviet Union's existence, which are obsolete both physically and morally, ***Ukrainian military experts believe that their further development should be based on the results of fundamental search and applied research across all scientific and technical areas.***

At the same time, **the main directions of the development of weapons at the present stage, taking into account the global tendencies and achievements and achievements of Ukrainian science**, should be the intellectualization of the means of conducting armed struggle (creation and mass use of robotic, autonomous and remotely controlled models and systems of armaments and military equipment) the use of weapons based on unconventional (including non-lethal) principles of action.

Simultaneously with the refinement of existing ones and the development of new weapons intended for warfare in the near future, **one should prepare for the wars of a more distant future.** In many cases, military researchers predict that so-called sixth-generation wars, so far, they will be of the character of the war built on **the technology of the Fifth Technology generation wars.** But ***it is a weapon that has already reached (or reached) the peak (more properly, the limits) of its possible effectiveness within the underlying technologies contained in it, from which practically "squeeze" everything possible.*** According to the philosophical law of "denial of denial" such weapons should be replaced in the near future with a new one, created on the basis of technologies of **the sixth technological generation**, ***the key factor of which scientists see nanotechnology, cellular technologies and methods of genetic engineering, the emergence of alternative energy (hydrogen energy, use of wind, sun, etc.).***

The nature of the wars and the accounting of the armies that will characterize the sixth technological generation have not yet been fully determined. This cannot be done until new basic technologies have been created, their properties studied, weapons developed and tested, and their place and role in the structure of the armed forces and on the battlefield determined.

This is what the military science should do in its close and fruitful cooperation with science, which is carried out in the institutions and institutions of the Ministry of education and science of Ukraine, the National academy of sciences of Ukraine, etc.

Of course, the development and implementation in practice of the latest achievements of science and technology **are hindered by the numerous shortcomings and difficulties that hinder the implementation of the plans that**

have been put in place and the identification of effective ways to prevent or eliminate them. We have always been reminded of them at previous conferences, so we will not dwell on them. The MoD of Ukraine, the General Staff of the AF of Ukraine are aware of all available and possible shortcomings and, to the best of their ability, try to avoid them or to identify and eliminate them in a timely manner. However, we ourselves cannot solve all the complex issues that are or are emerging.

Therefore, the leadership of the AF of Ukraine expects from you, scientists, scientists and industrialists of the maximum return, new ideas, new constructive and technological solutions, improved characteristics of armaments, military and special equipment that will allow the personnel using them perform all their combat tasks with the highest efficiency.

Concluding my speech, I would like to express confidence that, as always, this conference will be held in a constructive way, and the presence of representatives of the Ministry of education and science of Ukraine, foreign specialists in the military and military-technical sphere will increase her scientific level. At the plenary meeting, which is taking place now, as well as tomorrow at the meetings of sections on armaments and military equipment**, it is planned to consider:**

the basic aspects of the military-technical and defense-industrial policy of Ukraine at the present stage, improvement of the algorithm of their synchronization;

the roles and tasks of military-technical cooperation in the implementation of military-technical and defense-industrial policy of Ukraine;

current tendencies and problems of development of the defense-industrial sphere of Ukraine;

prospects for the development of armaments, military and special equipment of the AF of Ukraine, etc.

The result of the discussion of these issues should in scientifically substantiated proposals for further improvement of the military-technical and defense-industrial policy of Ukraine in the near future in order to equip the AF and other components of the security and defense sector of Ukraine with modern and promising armaments equipment, military and special equipment, taking into account the economic realities and opportunities of Ukraine.

I wish all of us fruitful work!

Thank you!

First Deputy Minister of Education and Science of Ukraine,
Candidate of Historical Sciences POLYUKHOVYCH Yuriy Yuriyovych
at opening of the VII International Scientific and Practical Conference

“PROBLEMS OF COORDINATION OF MILITARY-TECHNICAL AND DEFENSE-INDUSTRY POLICIES IN UKRAINE. PROSPECTS THE DEVELOPMENT OF ARMAMENTS AND MILITARY EQUIPMENT”

Dear participants, organizers and guests International scientific-practical conference!

Please accept my sincere congratulations on the occasion of the opening of the VII International Conference “Problems of coordination of military-technical and defense-industrial policy in Ukraine. Prospects for the development of weapons and military equipment »!

Today's event takes place on the eve of the Defender of Ukraine Day and is of great practical and social importance. After all, the exhibition "Weapons and Security" is a unique tool both to strengthen the domestic economic potential, and to unite all citizens of Ukraine around the idea of building a new strong and prosperous Ukraine.

Time proves that every year this conference attracts considerable attention of a wide range of specialists in the military-technical and defense-industrial spheres of Ukraine's economy. The event promotes a combination of theoretical and practical developments in the field of defense and security, exchange of experience and establishing contacts for further cooperation between higher education institutions and scientific institutions, which make a significant contribution to the development of technical equipment of the Armed Forces of Ukraine.

In order to create conditions for successful cooperation in the scientific and innovation spheres, the Ministry of Education and Science of Ukraine considers, first of all, the formation of a qualitative legislative field and legal framework for the introduction of mechanisms for promoting the development of innovative activities.

That is why the Ministry developed the Strategy for Innovative Development of Ukraine until 2030, which was approved by the Government (CMU Order No. 526-r of July 10, 2019), which laid new approaches to the development of innovation, technology transfer, support for start-ups and communication between all participants the innovation process, as well as the removal of legislative obstacles that occur in the innovation field.

In order to provide state support for the development of critical technologies in the field of arms and military equipment production, the Ministry is taking measures to update the list of critical technologies in order to determine the directions of development of the military-technical and technological potential of the state for the long-term perspective to ensure the proper equipping of all components of the security and defense sector with the needed weapons and military equipment.

Today, Ukraine faces the urgent task of entering the trajectory of rapid and sustainable economic growth, as well as improving the country's defense capability.

Ukraine has a strong scientific and innovative potential, which can and has, in accordance with current global trends, become a driver of economic growth.

Hope that the professional dialogue and the results of today's conference will give a new impetus to the creation of favorable conditions for the implementation of scientific, scientific and technological, innovative activities and commercialization of innovations, as well as the creation of high-tech industries by domestic industrial enterprises in higher educational establishments and institutions of higher education.

Together, we must increase the efficiency of the country's intellectual potential and ensure the development of science and innovation at all levels.

So I wish the participants of the conference fruitful work and creative inspiration for joint decisions to improve the defense capability of our country!

Thank you for your attention!

Chepkov I.B., *Doctor of Technical Sciences, Professor*
Central RI AME AF of Ukraine

STATE MILITARY AND TECHNICAL POLICY IN THE LIGHT OF MODERN TRENDS OF WORLD'S SCIENTIFIC AND TECHNICAL PROGRESS

One of the most important factors in the formation of the state military and technical policy (hereinafter - MTP) is its orientation on the latest achievements of world science and technology, industrial production.

If we critically analyze the current state of the state MTP in this perspective, a number of alarming circumstances are being revealed. Underestimation of these circumstances is able to create significant, hidden up to a point, threats to national security of the state.

Despite the complexity of this issue, we should pay attention to the following specific trends.

Firstly, it is widely recognized that humankind has entered the Fourth Industrial Revolution.

It is known that the First Industrial Revolution began when the steam engine was invented by James Watt. That allowed carrying out the primary industrialization of Europe during the XVIII-XIX centuries.

The Second Industrial Revolution occurred in the early XX century due to electricity and the Henry Ford's conveyor, which led to the organization of mass production and its mechanization.

The Third Industrial Revolution dates back to the 60s of the XX century, when digital technologies began to develop rapidly: computer, microprocessor, numerical control was invented, and later - industrial robots and rapid development of chemistry.

Thus, the first three industrial revolutions were based on three components:

raw materials, sources and methods of energy transfer;

technology;

production and management organization.

The Fourth Industrial Revolution, which logically follows the Third, is characterized by the widespread penetration of digital technologies into virtually every sphere of life through the introduction of cyber-physical systems[1] (hereinafter - CPS). The CPSs, being united in a single network (eg, the Internet), are able to connect with each other in real time, self-configure and learn new behavior patterns, appropriately build production or other process, interact with products and, if necessary, permanently adapt to the new consumers' demands without human involvement. The situation where the product itself, through all stages of the technological process, determines the equipment for its own production, is classic of the Fourth Industrial Revolution.

Unlike the first three, the Fourth Industrial Revolution is based on completely different principles, namely:

functional compatibility of the person and the machine, possibility of direct contacts between them via the Internet;

the ability to create a virtual picture of the physical world through the accessibility, transparency and completeness of the information required, as well as the capabilities of computer technology;

transferring to machines a wide range of tasks, which cannot be solved by the human mind or poses a threat to humans, by creating large databases, accumulating information, processing and analyzing it;

the ability of the machines to make the necessary decisions independently and autonomously.

More than three years have passed since the famous Klaus Martin Schwab[2] speech at the World Economic Forum[3] in Davos (January 20, 2016), in which he outlined the basic principles of the Fourth Industrial Revolution. Professor K.M. Schwab reveals three reasons why today's digital developments are to be considered not just continuation of the Third Industrial Revolution, but the beginning of the Fourth:

the speed of changes;

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[1] The cyber-physical system (CPS) is a peculiar mechanism, which is controlled by computer algorithms and connected to the Internet. In the CPS the software is closely tied up with physical objects. The CPS components can interact on various time and space levels and can have different behavior patterns. They can interact in different ways which can change depending on the context.

[2] Klaus Martin Schwab is a renowned German-Swiss economist, born March 30, 1938, founder and permanent president (since 1971) of the World Economic Forum.

[3] World Economic Forum is a reputable non-governmental private international foundation, founded in 1971, with headquarters in Geneva, with members and partners of more than a thousand leading companies and organizations in the world. It organizes its annual meetings in Davos, Switzerland, where renowned business executives, political figures, eminent thinkers and journalists are invited to discuss the world's most pressing issues.

their scope;

the systemic nature of the consequences.

Two books by K.M. The Swab "Fourth Industrial Revolution"[4] and "Technology of the Fourth Industrial Revolution"[5] have been translated into many languages and have become real best-sellers.

At the same time, the implementation of the Fourth Industrial Revolution in the armed forces and defense industries in the United States, Germany, France, the United Kingdom, China, India and a number of other countries, including what is dangerous enough for us, Russia, is already well underway.

And nobody is going to share these achievements with Ukraine.

Obviously, the world is about to make a grand quality jump.

Unfortunately, our country, with significant backlogs in this area, cannot boast of great success.

As early as 2007, the Verkhovna Rada of Ukraine adopted the Law of Ukraine “On Basic Principles of Information Society Development in Ukraine”[6], and in 2013 the Cabinet of Ministers of Ukraine approved the Strategy for the Development of the Information Society in Ukraine[7]. However, these regulations are already hopelessly outdated, at least because no changes have been made over the years since the proclamation of the Fourth Industrial Revolution in 2016.

It cannot be said that nothing has been done in the direction of digital development in the country. Implementation of ProZorro e-Procurement and Electronic Declaration systems, 3G and 4G standards in mobile communications, transfer of some administrative services to computer basis, separate pilot projects of the Ministry of Health and the Ministry of Education and Science of Ukraine, other specific activities have definitely brought revival in the digital market.

To this can be added:

approval in 2017-2018 of the Concept of Development of the Digital Economy and Society of Ukraine[8] and the Concept of Development of e-Governance in Ukraine[9] by the Government;

development of the conceptual document "Digital Agenda -2020" within the framework of the Digital Agenda Ukraine project;

[4] Schwab, Klaus. The Fourth Industrial Revolution/ Klaus Schwab. - M: Exmo Publishing House, 2016. - 208 p.

[5] Schwab, Klaus. Technology of the Fourth Industrial Revolution: Translated from English / Klaus Schwab, Davis Nicholas. - M: Exmo Publishing House, 2018. - 320 p.

[6] On Basic Principles of Information Society Development in Ukraine: Law of Ukraine of January 9, 2007 No. 537-V // Official Bulletin of Ukraine, 2007. - No. 8. - P. 9.

[7] On Approval of the Strategy for the Development of the Information Society in Ukraine: Order of the Cabinet of Ministers of Ukraine of May 15, 2013 No. 386-r // Official Bulletin of Ukraine, 2013. - №44. - P. 79.

[8] On Approval of the Concept of Development of the Digital Economy and Society of Ukraine for 2018-2020 and Approval of the Action Plan for its Implementation: Order of the Cabinet of Ministers of Ukraine of January 17, 2018 No. 67-r // Official Bulletin of Ukraine, 2018. - No. 16. - P. 70.

[9] On Approval of the Concept of Development of e-Governance in Ukraine: Order of the Cabinet of Ministers of Ukraine of September 20, 2017 No. 649-r // Official Bulletin of Ukraine, 2017. - №78. - P. 109.

the creation of the Ministry of Digital Transformation of Ukraine in 2019 and the introduction of the post of Deputy Prime Minister.

But all these actions resemble not a rapid leap into the future, but rather a slow crawl from one local goal to another, being a modest imitation of those grand revolutionary transformations taking place in the technological world.

A further delay with an objective response to the achievements of the Fourth Industrial Revolution will mean that Ukraine is lagging behind the civilized world not for ten or even fifty years, but forever.

Professor K.M. Schwab mentions this, predicting the rapid widening of the technological gap between world leaders and the rest of the world as a result of the laws of the Fourth Industrial Revolution.

Thus the problem of inadequate treatment of the technologies of the Fourth Industrial Revolution becomes a problem of national security.

Therefore, strategic, mid-term and current plans and programs in the military and technical, defense and industrial spheres need to be fundamentally reviewed in order to radically enhance their technological items, especially those related to digital technologies. These works must be given undeniable priority.

In this important matter, the military hope for the full support and active participation of the National Academy of Sciences of Ukraine.

Secondly, the Fourth Industrial Revolution, in addition to all its technological achievements, caused another prominent social phenomenon, which has not yet been publicly assessed. That is an unprecedented breakthrough of private capital in high-tech field which until recently was considered a monopoly of the state.

What Elon Musk[10], an American entrepreneur, creates in the fields of electronic payment systems, electric automotive, energy, unconventional vehicles, rocket and space technology, etc., not only will become the brightest pages in the history of mankind, but also marks the beginning of a new technological era.

It is necessary to pay attention to a fundamentally new trend in the relations between the state and private capital, which arose due to the successes of E.R.. Musk.

On the one hand, by addressing and continuing to solve global technological problems at his own expense, he is enormously raising the role of social responsibility of private capital to the society.

On the other hand, a state that has not been able to solve the same problems with significantly greater resources has to think seriously about the effectiveness of the entire public administration system.

If the model is extended to the Ukrainian defense industrial complex, which is still referred to high-tech spheres, then with the development of the ideas of the

[10] Elon Reeve Musk is an American engineer, entrepreneur, inventor and investor, born June 28, 1971.
The founder of PayPal, SpaceX, Chief Product Architect, Tesla, SolarCity and many more, he is a billionaire. In Forbes magazine's 2018 ranking, his fortunes are valued at more than $ 22.5 billion. He is known for his outstanding revolutionary achievements in many fields of modern science and technology. In 2018, he was honored with membership in the Royal Society of London for outstanding service.

Fourth Industrial Revolution, the public sector of the defense industry is obliged to significantly strengthen the financial and economic component of its activity. Private defense enterprises inevitably will be forced to take on some of the social responsibility to society.

In this sense, one should worry about a number of issues related to the unequal ownership.

Unfortunately, formally proclaiming equality of all forms of ownership in legislation, the state clearly does not consistently act according to this fundamental principle of market economy.

In reality, groundless priority, from the standpoint of economic logic, is given to state ownership. And, paradoxically, very often this priority is legitimized.

All these legal metamorphoses are remnants of planned economy when there was only one form of ownership - a state one. However, 28 years have passed since Ukraine gained independence, and the main aspects of domestic legislation concerning the relationship between state and private ownership are dated back to the 1990s and are hopelessly outdated.

And as long as such a regulatory situation persists, its own Elon Musks will not appear in Ukraine.

Thus, the situation regarding Ukraine's response to the prospects of the Fourth Industrial Revolution is very alarming and requires both broad public discussion and decisive actions by the legislative and executive authorities, academia and industry.

Only in this way can we bring the state military and technical, defense and industrial policy into line with the current trends of scientific and technological progress in the world in a limited time.

Pavlovskii I., PhD
Central RI WME AF of Ukraine

AREAS OF IMPLEMENTATION OF THE UKRAINIAN MILITARY AND TECHNICAL POLICY AT PRESENT AND IN THE NEAREST FUTURE

The armaments available must be in line with existing technologies, taking into account the **nature of today’s wars**, which have changed significantly, even in comparison with the recent past. Until recently, the main purpose of war was to destroy the enemies and seize their territories in order to use their raw materials, industrial and labor resources, though the modern war can achieve its goals without armed struggle. Economic, political, informational, ideological, psychological and other methods of warfare are becoming increasingly important. However, such methods can only be effective if the country at war relies on its economic and military capabilities. We can confidently conclude that the main goal of most wars at present and in the nearest future is to ruin (weaken) the economic capacity of any "hostile" state in a "contactless" way at any distance at any point on the globe.

The world's leading nations are constantly working to improve their existing weapons and to create new ones for use in future wars. However, general trends in the armaments development do not depend on the country of service. Simply, individual countries may or may not have the ability to support certain general trends, or they may not need to support these trends due to geopolitical factors. Therefore, it is reasonable to consider trends in the means of warfare development at the global level or at the level of the militarily leading countries, while highlighting the new trends that will be used extensively for armaments development in the nearest future.

The first of these trends **is the intellectualization of means of warfare: development and widespread use of robotic, autonomous, and remotely controlled armaments**.

Experts believe that the development, production and use of such systems can be very wide ranging from the underwater environment to the outer space.

Another trend **is the development and application of armaments based on unconventional (including non-lethal) principles of action.**

According to most of the leading military analysts, in the wars of the next generation munitions based on the use of various forms of energy will be widely used. Elements of such weapons are beginning to be used nowadays. Such weapons include: electromagnetic, laser, beam, plasma, acoustic, radiological, biological, chemical and geophysical weapons etc.

It is in this direction that we should move in Ukraine while implementing its military and technical policy at the present stage, taking into account the scientific, production, technological and financial capabilities of the country.

At the same time, while improving existing and developing new armaments for the nearest future, **we should prepare for wars of the more distant future**. To forecast their nature, possible directions of new armaments development and ways to use them is quite difficult and, perhaps, impossible.

The transition to other principles of defeating the enemy is possible only if the technologies to implement such principles are available. But it is impossible to require the "birth" of technology. They appear only on the basis of a fundamental study of matter, knowledge of its properties and determination of applicability of these properties in complicated technical devices, which are the modern weapons.

To some extent, to forecast the direction of development of specific new weapons and ways for their application in the wars of the distant future is possible if a retrospective analysis is conducted and a correlation between the development of technologies, weapons created with their use and ways for their application in the past is revealed.

This correlation is reflected in the **theory of long-term technical and economic development**. In this theory, the concept of "**technological generation**", which is now used by scientists in many countries of the world, was introduced.

This concept is also of particular interest in the study of the armaments development patterns, including - to forecast the change of their generations. The technological generation is characterized by a common technical level of production related to the vertical and horizontal flows of homogeneous resources, based on joint labor resources and common scientific and technological capacity.

From 1770-1785 to 2020-2035, scientists distinguish five technological generations (the fifth is conditionally from 1980 to 2020-2035).

Now the advanced countries of the world are entering the next - ***the sixth technological generation*, *the key factor of which scientists consider nanotechnology, cell technologies and methods of genetic engineering, alternative energy (hydrogen energy, energy of wind and sun, etc.).*** The nature of the wars and the outlook of the armies that will characterize the sixth technological generation have not yet been fully determined. However, the outline of armaments using the latest technologies has already begun to be formed.

This fact should be taken into account. Studies show that in times of global technological shifts, advanced countries find it difficult to retain leadership, as **developing countries, which have accomplishment for better preparation, advance in the growth wave of a new technological generation**. In contrast to the advanced countries facing the crisis of capital accumulation in obsolete industries, they have the opportunity to prevent massive capital depreciation and concentrate it on breakthrough directions. On this basis, we must consider that Ukraine has a chance. It should be taken.

Hultiaiev A.A., PhD, Senior Research Fellow
Central RI AME AF of Ukraine

SOME ISSUES OF COORDINATION OF MILITARY-TECHNICAL AND DEFENSE-INDUSTRIAL POLICY IN UKRAINE

The experience of the advanced countries of the world shows that military-technical and defense-industrial policy are considered as the main mechanism of the state's military policy strategy, which is based on a system of scientifically-based views on the development of armaments and defense-industrial complex (DIC). It is the basis for the implementation of scientific ideas and development of armaments and provides initial data for planning the development of the defense and industrial sphere and planning the financial resource for the creation of armaments and military equipment (AME).

The formation of military-technical and defense-industrial policy is carried out taking into account the state of military security, factors of economic, scientific-technical, industrial-technological and other content using complex and systematic approaches. It is used as the main tool for practical implementation achievements of scientific and technological progress in the military field and in industry. Based on it, the choice of priorities, specific directions and sequence of actions of the state in this field is made.

It is quite clear that the level of technical equipment of the Armed Forces, other components of the security and defense sector of Ukraine, the development and capabilities of the Ukraine's defense-industrial complex, the effectiveness of international military-technical cooperation depend on the state of formation and implementation of military-technical and defense-industrial policy in Ukraine.

Consider the question vital activity of the DIC of Ukraine, as one of the components of the security and defense sector of Ukraine, which depends directly on the effectiveness of the implementation of military-technical and defense-industrial policy as a whole.

Unfortunately, the non-systematic measures undertaken in recent years to reform Ukraine's DIC have led to the gradual destruction of its specific features as an industry in the defense sphere. The DIC of Ukraine, by its many components, has lost the ability on creation and batch production newest samples of AME. Enterprises of Ukraine on capital repairs of arms were somewhat in better shape, but they also experienced significant difficulties in restoration of the armaments and military equipment, mainly due to the lack of spare parts.

The main problems in the current situation are:

low level of formation and implementation of the state defense-industrial policy;

uncertainty of the basic model of organizational construction and management system of the domestic defense-industrial sphere;

absence of a system-forming factor capable of integrating, in market conditions, economic entities engaged in the creation and production of weapons and military equipment into a single functional integrity;

lowered the role and place of the Institute of General Designers for the creation of equipment for the needs of the defense and security of the state is neglected;

reduced role of scientific potential of the National Academy of Sciences, other scientific institutions of the Ministry of Education and Science of Ukraine;

insufficient support for innovative development of the strategic and scientific institutions and industrial enterprises of importance for the defense, security and economy of the country;

the absence of technologically closed production cycles of most species armaments and military equipment, destruction of traditional scientific and technical and industrial cooperation, low rates of diversification of military and dual-use purchases;

critical physical and moral deterioration of fixed assets, low efficiency of use of the scientific and industrial base, considerable energy intensity of production, technological backwardness of the leading countries of the world, critical financial and economic condition of most enterprises, low profitability of production, lack of working capital and lack of investment resources;

inconsistency of the existing system of construction and management of the DIC of Ukraine with the general-economic market conditions of life in the country and the world;

critical condition of providing the enterprises of the DIC with highly skilled workers, technical and engineering personnel, etc.

The following are the first priority measures to improve the situation in the defense and industrial sector at an early stage:

1. Acceleration of holding the review of the DIC in accordance with the Law of Ukraine "On National Security" with the obligatory assessment of the status of implementation of other measures provided by this law;

2. Urgent adoption by the Verkhovna Rada of Ukraine of the following most relevant draft laws:

“on creation and production of armaments, military and special equipment”;

“on military-technical cooperation of Ukraine with foreign countries”, and development and adoption of draft laws:

“on the defense-industrial complex of Ukraine”;

“on amendments to the economic code of Ukraine and other legislative acts to ensure sustainable development of the national defense-industrial complex”;

“on amendments to the law of Ukraine “on state defense order”;

“on some amendments to the law of Ukraine “on peculiarities of management of state property objects in the defense-industrial complex”;

“on making some amendments to the law of Ukraine “on public-private partnership” and “on making some amendments to the law of Ukraine “on investment activity” to regulate the issues of improving the investment climate in the DIC of Ukraine by publicizing it and its subordinate state-owned enterprises and involvement of shareholders;

“on the list of objects of state property that are not privatized”;

“on amendments to the law of Ukraine" copyright and related rights”, other legislative acts in the field of intellectual property,

and other.

3. Development and adoption by the Cabinet of Ministers of Ukraine and interested central executive bodies of relevant normative legal acts to ensure the implementation of the above-mentioned laws of Ukraine and regulatory legal acts on enhancing the role and place of the Institute of General Designers for the creation of equipment for defense and security of the state.

4. Immediate implementation of a set of measures aimed at:

replacement in other regions of the country of experimental and production facilities lost as a result of annexation of Crimea and seizure by illegal armed groups of certain regions of Donetsk and Luhansk regions;

restoration of missing technical documentation and equipment;

rapid adjustment in the new points of deployment of full-fledged work of enterprises that ceased their activity in the occupied territories;

5. As part conducting a review of the DIC, analyze the state of implementation of the current Strategy for the development of the DIC of Ukraine for the period up to 2028, the current State program for the reform and development of the DIC by 2021, the State target program for the creation and development of ammunition and special chemistry products by 2021, development and implementation of measures for their implementation.

6. The results of the review of the DIC, development and adoption of a new Strategy for reform and development of the DIC of Ukraine for the period up to 2040. Ensuring its mandatory coherence with the military security strategy of Ukraine for the period up to 2040, the Strategies for development of other components of the security and defense sector of Ukraine for the period up to 2040, the relevant state target programs to be developed or specified on the basis of the reviews of the components of the security and defense sector of Ukraine, as well as plans for the development of the National academy of sciences of Ukraine, other national scientific, design and technological institutions, organizations of Ukraine.

The result of the implementation of the proposed measures is the basis for eliminating systemic contradictions in the functioning of the DIC of Ukraine and improving the effectiveness of interaction with the components of the security and defense sector of Ukraine with a view to their technical equipment.

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INFORMATION AND ANALYTICAL SUPPORT OF EQUIPMENT, WEAPONS DEVELOPMENT AND MILITARY ENGINERY OF UKRAINIAN MILITARY FORCES PROCESS

Information resources are the basis of military experts and many others analytical activity. Narratives of which characterize properties and functioning of all nomenclature weapons and military equipment means. Scientific and technical production description narratives must be included too. It could be used to modernize the existing or to create new means of weapons and military equipment which meet the modern world challenges in the armament sphere. Means which could support constructive solution of these problems are of cognitive character. They are determined on the solution of such series of cognitive meta-tasks: structuring; problem analysis; synthesis; choice. Based on this on each stage of life circle and weapons and armament equipment development are provided functioning levels evaluation and compliance with modern challenges.

This approach implements the constructive use of all information resources that describe and reflect the current state of the military technology and the one used in the Armed Forces of Ukraine. Moreover, the organization of interaction and automated network-centric data exchange between all participants involved in the process of creation of military technology, production of military-industrial complex and equipping of the Armed Forces of Ukraine is ensured. For this purpose, cognitive services of integrated analytical processing of the whole narrative of weapons and equipment means descriptions are implemented. These services provide processes for semantic content analysis of this narrative and structural reflection of its results across all the system components that characterize the state and development of the military technologies, namely: their properties, functional characteristics, and interconnections, including references to technological processes of production taking into account national and international standards and more. For this purpose, appropriate information and analytical services, especially at the stage of decision-making, ensure that a large number of interdisciplinary relationships are taken into account, which characterize descriptions of various samples of military-industrial equipment and military technologies adopted and planned for adoption in the Armed Forces of Ukraine. An appropriate cognitive information-analytical system (CIAS) is created on the basis of the use of ontological foundations and technologies of semantic processing of heterogeneous spatially distributed information, which characterizes the different stages of the creation and use of the military weapons and equipment means. The technological basis of CIAS is made up of intelligent network-centric cognitive services, capable of providing analysis, evaluation and selection of technological and scientific-technical products and supporting decision-making regarding the use, maintenance, repair, modernization, creation, operation and development of military-armed forces, as well as technologies and products of military forces.

These services allow you to:

- analyze and monitor the condition of samples of military weapons and equipment at each stage of the life cycle;
- identify compliance levels tasks that are solved with the modern requirements for their implementation;
- form technical specifications and requirements for the creation of an IAU sample on the basis of semantic analysis of the available prototypes and formulation of the tactical and technical characteristics that it must meet;- form a knowledge base of thematic tasks of structural units of the Ministry of Defense of Ukraine on the development of military-industrial complex with tracking of the levels of conformity to quality and relevance.

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USPP President

COMPREHENSIVE REFORMING AND DEVELOPMENT OF THE DEFENSE-INDUSTRIAL COMPLEX OF UKRAINE

The formation of the European vector of Ukraine's international policy, the emergence of new external and internal challenges to its national security, the insufficient pace of ongoing economic reforms, the scientific and technical and technological updating of the real sector of the economy have greatly exacerbated the known contradictions related to the choice of the main path for the further development of the country, the life force of its Armed Forces, other military formations, the defense-industrial complex (DIC), namely:

between the desire to integrate into the European community on the basis of universal democratic values and the continuation of the foreign policy orientation towards the CIS countries characterized by artificial seclusion;

between military necessity (the presence of its own Armed Forces, other military formations designed to ensure the security of the country) and defense sufficiency (maintaining the security structures in a state that allows to preserve the sovereignty and territorial integrity of the state);

between the defense adequacy and the actual scientific and technical and production potential of the domestic defense industry (the ability of defense industries to provide an acceptable level of technical equipment of the Armed Forces, other military formations);

between its potential and existing resource constraints.

The intense rapprochement with the European Union leads to the introduction of new standards of living, which is connected with the transition from the traditional normative base of Soviet times to a universal, but at the same time, more rigid, international system of standards.

However, for a variety of objective and subjective reasons, the defense-industrial complex has shown its inability to respond adequately to such significant changes in the political, economic and military environment by creating the latest models and deploying modern armaments and military equipment in the required quantity at the required quality level and consumer properties of the products.

That is, the current state of defense does not meet the requirements that flow from the main directions of foreign and domestic policy of the state, Ukraine's aspirations for membership in the European Union and NATO, scientific and technical trends prevailing in the world.

Thus, today there is a problem in the reproduction of a new kind of domestic defense industry, which is responsible for its capabilities the actual task of developing the country for the future.

This problem, which is inherent in almost all countries of the post-Soviet space, arose in Ukraine at the end of XX century as a result of the collapse of the military-industrial complex of the former Union, which led to the destruction of traditional system-forming relationships and brought a whole new set of principles to the young independent state. areas of state construction:

formation of the system of state management of the defense-industrial sphere, its organizational structure;

creation of the legal framework of the defense industry;

development and practical implementation of the state military-technical and defense-industrial policy;

ensuring the presence of domestic defense industry in the global arms market as a mandatory attribute of international state policy, and more.

However, the lack of necessary management experience in such a complex industrial complex, which combines several high-tech industries, underestimation of its systemic nature have led to certain managerial failures, the consequences of which are felt to this day. The most characteristic in this sense is the desire to build the control of the defense industry in the image and likeness of the civil industries, thereby eliminating the specific features of the defense-industrial sphere.

The optimal solution to the problem of forming a new form of defense industry depends crucially on the choice of the model of organizational construction of the defense-industrial sphere and the corresponding system of public administration.

In this regard, based on foreign experience and management traditions that have developed in the domestic industry, three models can represent practical expediency:

in the form of a set of separate disparate parts of different industries, each of which specializes in the development and manufacture of certain types of weapons and military equipment, without being the subject of macroeconomic relations (option 1);

a secluded industry that is the subject of macroeconomic relations and unites enterprises specializing in the development and production of the entire country of the nomenclature of arms and military equipment (option 2);

industrial complex, as the subject of macroeconomic relations, in the form of a systematic set of separate industries, the main system-forming factor of which is the development and production of weapons and military equipment, if there is a parallel production of other civilian products (option 3).

Given the content of tasks arising from the main directions of domestic and foreign policy of the state at the present stage, the most optimal should be considered option 3. The main emphasis in its implementation should be made:

complete the market transformation of the defense and industrial sector in order to achieve an acceptable level of economic efficiency;

scrupulous implementation of the relevant system-forming factors in the process of its functioning as a guarantee of achieving the scientific, technical and financial and economic self-sufficiency of the defense industry and its high rates of self-development;

revive the innovative nature of defense and industrial activity as a prerequisite and a sound basis for further progress.

However, it should be noted that the defense industry, being the most high-tech and high-tech sector of the Ukrainian economy, along with the development and production of weapons and military equipment, should solve the problem of creating and expanding the production of competitive high-tech and high-tech civilian products. Accordingly, the solution of this problem is another ultimate goal of technological development of this sector of economy.

Given that most of the high technology in our country is focused on defense industry, we need to build a dual-use defense technology. It is the defense technologies that can be the basis for new industrial technologies in the civilian sector.

As the Armed Forces of Ukraine are tasked with protecting the economic and political interests of the state, it is the Ministry of Defense of Ukraine, as the procuring entity of arms and research, and the DIC, as the executor, that can become the epicenter of the country's new re-industrialization and scientific and technological development.

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REALIZATION OF DOUBLE TECHNOLOGIES IN UNMANNED AIRCRAFT SYSTEMS

Dual technology in aviation involves the use of technology for both civilian and military purposes. This well-known thesis is fully applicable to the new direction of aviation - unmanned aircraft.

The relationship between the areas of aviation, in this context, is in terms of reducing the likely risks for manufacturers from falling sales in the market: in the event of a decrease in the volume of the military market, the manufacturer relies more on the civilian component and vice versa.

For this, a deep unification of the main components of dual-purpose unmanned aerial vehicles is carried out, the target load is brought to almost one type, their tactical and flight characteristics are made identical; the similarity of operational documents also contributes to this.

Another important component of the implementation of dual technologies is the actual substantive and formal similarity of tasks in the operation of the fleet of unmanned aircraft (UAV).

A critical number of improvements (changes) are concentrated not on the carriers themselves, but mainly on-board systems, target equipment and ground control stations, which in the end is the main reason for the wide spread of dual technologies in unmanned aerial systems.

Over the past 10years, the National Aviation University has been implementing this technology in the development of the *Scientific and Production Center of Unmanned Aviation ‘Virazh’. In particular, the complex of unmanned aerial vehicle M-10-2"Око" for civilian use, received a second* military "profession" - a scout of the battlefield, and under the name "UA-beta" was transferred to controlled operation in the Armed Forces of Ukraine.

It differs from civilian UAVs with high-resolution cameras, maximum flight time, ejection launch and the like.

The M-56 "Module" complex with an electric drive is designed as an intelligent munition; he can also conduct species reconnaissance, determine the necessary targets and deliver warning (non-main) strikes.

This UAV is in the stage of factory testing. By replacing the combat load with an additional onboard battery, it can be used in civil aviation to monitor territories for up to 4 hours and up to 130km away. The maximum flight altitude of this UAV sample is 3000 m.

The heavier UAV complexes at NAU are, in particular, the M-6-3 «Zhayvir» complex and the M-6-5 «Sheriff» complex.

Their civilian use is actually based on two modifications. The first modification is intended for long-term monitoring.

For this, the fuel tank volume is increased to 10 liters, which ensures a flight duration of up to 14hours. The second civilian modification is designed to transport valuable goods weighing up to 4 kg to a distance of 700 km in reserved airspace. This modification performs automatic takeoffs/landings and cruise flights without human intervention.

Instead, the military modifications of the M-6-3/M-6-5 are equipped with payloads in the form of day and infrared cameras and aerial cameras. At the same time, the duration of the flight is maintained within the limits necessary for the armed forces of five hours, and launch is carried out using a catapult device. It should be noted that these civilian and military modifications are obtained within the same standard airframe and virtually typical powerplant with minimal changes

UAVs with a launch weight of more than 150 kg are located in a much more complex segment of civilian UAVs: these aircraft must have an aircraft type certificate.

This requirement imposes significant restrictions on the use of the UAV of this class, which at NAU is represented by the UAV complex M-7-B5 «Nebesniy patrul». The complex has been in the type certification procedure since 2018, and its main goal is to conduct aviation work in the interests of economic sectors. Types of approved works and methods of their execution should be included in the flight manual of the UAV complex. However, the basic documents of civilian modification indicate the inapplicability of military regimes.

Given this circumstance, as well as the acceptability of military-tactical and technical characteristics of the civilian version (carrying capacity of 70 kg, flight duration of 8-10 hours, etc.), the possibility of using a certified civilian complex of the M-7-B5 type in the interests of the armed forces should be identified by conducting additional research work in conjunction with the relevant units of the Armed Forces of Ukraine in order to establish the suitability of the aircraft for military use. In case of positive results of additional research works, it may be decided to develop a military modification of this UAV with the introduction of appropriate changes to the standard design to change its main purpose.

Particular attention is paid to the technologies implemented in UAV complexes, which are related to the use of artificial intelligence methods to determine the necessary goals and to identify different objects.

The developed unmanned aeronautical systems are ready for testing in the Armed Forces of Ukraine after following the appropriate procedures.

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APPROACH TO CHANGE CRITERIA FOR DETERMINING SUSTAIN WAY PRIORITY OFARMAMENT & MILITARY EQUIPMENT

Ukraine's integration into the European political, economic and security space and aspirations to become a member of the North Atlantic Treaty Organization prompts to implement experience of those countries. Even United States recognizes necessity in expensive material means taking to consideration practices of plan approach to management by living cycle (LC) of armament and military equipment (AME) and Plan of LC support. That approach leads to relevant reaction from side of Congress and to increasing of effectiveness of purchasing system due to it change. Ukraine is not exception in desire to improve its own defense planning system and, in recent years, it did attempts to improve such mechanisms. The exchange of experience between US defense planning professionals and representatives of the Defense ministry of Ukraine structural units and studies conducted in other countries indicate the need to determine the cost of AME LC in process of all stages of defense planning process. An analysis of defense planning in the Ministry of Defense and the Armed Forces of Ukraine, which is implemented on the basis of capabilities, focused on such LC component as operation and it support cost. From the experience of the leading countries There in Ukraine is a need to develop a scientific and methodological support to reflect the cost of this LC stage on base of the leading countries experience. First of all, this is necessary to minimize the most burdensome expenses for the Defense Office in the future, completing the defense planning activities and selecting the necessary AME. There has been little research by scientific institutions in this area and insufficient attention has been paid to the operational phase of the LC, which in turn dominates in total cost of the LC. In the defense planning system of Ukraine, there is little knowledge about determining the cost of a set of elements of a specified LC stage. The first attempt to improve the accuracy of the determination of many of its elements has already been proposd in recent publications using methodological approaches that are grouped on statistics, which in practice are complicated by the collection and retrieval of their order. But using dependencies, the author sees the loss of relevance of the cost of the initial LC stages at the corresponding amounts of such AME sustain.

The ratio of operating costs to development of such an AME varies by times and ranges from 8 to 22. Not reflecting of difference between such costs for the defense planning adjustments, if the AME significantly needs it, leads to greater operational costs. The ratio of the costs associated with the operation to the cost of purchasing such AME varies slightly less, but is in the range from 2 to 3. Focusing on the cost of the "operation" LC depending on the number of these samples, which are planned to provide military units and taking into account even the aggregated values in the conditional units and summing them up, it is possible to calculate the loss of relevance of the cost of development and purchase of AME sample. The proposed approach changes the criteria for priority of alternative same-types of samples when included in the armament program.

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THE APPLICABILITY OF THE SYSTEM METHODOLOGY FOR PREDICTION DURING THE PROVIDING THE ARMED FORCES WITH ARMAMENTS AND MILITARY EQUIPMENT

During the beginning of implementation R&D, a legitimate question arose about scientific methods and techniques that can be used as working tools. to identify, analyze, calculate and work out directions for eliminating the effects of negative circumstances and phenomena that will occur at all stages of the newly created (upgraded) or purchased overseas sample of Armaments and Military Equipment (AME).

The scientific study of the problems addressed in the implementation of the R&D requires the use of various scientific methods. In this case, the problem is that the issues under consideration are in most cases accidental and probabilistic in nature and are practically impossible to implement using one or more separate methods.

An analysis of the existing methodological framework for scientific research has shown that the so-called relatively young, systematic prediction methodology, modified and refined to take account of specific, can be used to achieve the results it pursues and the qualitative solution to its questions. issues of equipping the Armed Forces of Ukraine with the latest (modernized) samples of military-industrial complex, which are being solved in the R&D.

The possibility and feasibility of applying a systematic prediction methodology to resolve issues related to the development, batch production, modernization or purchase of new AME samples for the technical equipment of the Armed Forces of Ukraine in the context of uncertainty, account being taken of the possible risks and their management is explained by the considerations the brief content of which is.

Separate indicators of the AME samples that will be supplied to the Armed Forces of Ukraine and their probable accounting can be established by analyzing current trends and forecasting known methods for the future development of AME in the leading countries of the world and in Ukraine. At the same time, it is extremely difficult, and sometimes impossible, to accurately predict, on the basis of a retrospective analysis, all possible processes that will occur in the future, as well as possible obstacles that may arise in the way of solving complex problems of technical equipment of the Armed Forces of Ukraine. However, it should be noted that throughout the history of mankind, many thinkers and seers have sought to look into the future in order to have an idea of its possible further development. They used a variety of methods - from palmistry and sorcery to astrological and sci-fi predictions. They were purely subjective and did not withstand any criticism from the natural sciences.

Therefore, in today's context, a new task is becoming more relevant - to represent the future, which cannot be interpreted as a mere continuation of the past, since that future can take fundamentally different forms and structures in comparison with what was known in the past.

This problem was called prediction. This term was used by Gaston Berger (in the well-known journal “Two Worlds”) in the late 1950s, but the formation of foresight as an independent scientific and practical methodology occurred only in the early 1990s.

Familiarity with this methodology leads to the conclusion that it, in its organic combination with the current methods of forecasting, system analysis, etc., and can be used to solve such a complex issue as forming the outline of the Armed Forces of Ukraine of the future and equipping them with the latest samples conditions of possible impact of various negative circumstances and phenomena that will arise during the development, batch production and acquisition of the latest samples of AME, which are both objective and subjective nature, and compelling while when making critical decisions, go to certain risks that could lead to both negative and positive results. On this basis, it is advisable to study this methodology in more detail and to modify it taking into account the topics and focus of the research being carried out at the Institute of the Armaments, including on risk analysis and management. In this particular case, the authors of the ongoing work propose to give it a conditional name - a systematic methodology for forecasting (forecasting) and risk management.

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METHOD OF ASSESSMENT OF RELATIVE VALUE OF SAMPLES

WEAPONS AND MILITARY EQUIPMENT

In the practice of research institutions, the tasks of assessing the potential combat effectiveness of similar types of arming and military equipment (AME), the actual indicators of their military-technical (technical and economic) level occur quite often.

For the optimal solution of this task and development of relevant scientifically-based recommendations in the Central research institute of arming and military equipment of the armed forces of Ukraine, a method of comprehensive comparative evaluation of military technical and economic level of AME samples, in which the evaluation method of relative evaluation, is an integral part.

In accordance with this methodology, the potential technical and economic efficiency of the examined AME samples is proposed to be evaluated by means of a comprehensive generalized indicator, the relative value factor.

The coefficient of relative value characterizes, as the name implies, the value of the evaluated samples of the AME relative to the selected standard. It is clear that the price (catalog price) should be in the same currency and, if necessary, brought to the course of the year of research, that is, inflation processes are taken into account. It is possible to use selected AME samples if relevant life cycle cost data is available.

Determining the costs for the entire life cycle of a sample of AME is not always possible, first and foremost, because of the lack of necessary input data. This is especially the case for AME samples produced in other countries, when conducting a comparative analysis of AME samples of this class and in carrying out a comprehensive comparative assessment (military technical and economic level) of new WME samples at the stage of their creation.

A way out of this situation can be to estimate the cost of not only the entire life cycle of an AME sample, but only its first two components: the catalog value (price) of the reference sample and the catalog value (price) of the samples under study, which is one of the reference currency sample and its exchange rate. This approach can be applied to both new and used samples.

The catalog or commercial price of a AME sample is one of the most affordable metrics. Its main disadvantage is the high likelihood of additional commercial and even political components in its structure.

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MAIN TASKS OF CREATION IN UKRAINE SYSTEMS OF MANAGEMENT BY LIFE CYCLE OF WEAPONS AND MILITARY EQUIPMENT

To date, an effective way of solving tasks of managing activities for the creation of complex weapons systems, military and special equipment, and other defense products is the use of technology to manage the complete life cycle of such systems, that is, the set of interrelated processes of successive changes in the state of the system from the original conceptual design through a full scale realization to full write-off and safe disposal.

Effective management of the life cycle of defense products allows for such planning and spending of various kinds of resources that will ensure the achievement of maximum indicators of combat and operational efficiency of certain types (types) of defense products and the implementation of state targeted weapons development programs, military-technical cooperation programs, defense and industrial development programs complex, other target programs that provide Ukraine's national security and defense capability within the established financial limits financial and financial resources of the state with maximum consideration of the profitability of defense enterprises and their commercial interests.

(ALCCP), якістю (AQAP, AEP, AFAP), придбанням (AAP-20, AACP, AEDP-1), ризиком (ARAMP), стандарти з конфігураційного менеджменту (ACMP), інтегрованої логістичної підтримки (ALP-10, AUIDP-1, ADMP), управління оперативним середовищем (AECTP, AEP), утилізаційного менеджменту (STANAG 4597))

Of greatest interest is the study of the whole system of standards that comprise the NATO Life Cycle Management Document Framework (including cost management standards (ALCCP), quality (AQAP, AEP, AFAP), acquisition (AAP-20, AACP, AEDP-1), risk (ARAMP), Configuration Management Standards (ACMP), Integrated Logistics Support (ALP-10, AUIDP-1, ADMP), Operational Environment Management (AECTP, AEP), Utilization Management (STANAG 4597)) and their adaptation for national needs taking into account the established practice of enterprises of the defense industrial complex of Ukraine and the normative elaboration standardization of weapon systems.

This is a new topic for Ukraine, and practical research on elements of the life cycle security management system in member states of NATO has not been carried out at this time.

At the first stage, it is necessary to carry out in-depth analysis of the national legislative and regulatory framework in the field of weapons and equipment, to develop possible options for creating a system for managing the life cycle of defense products in Ukraine, to develop methods and algorithms for the effectiveness of the application of such a system in accordance with the existing political and economic conditions in Ukraine, and also work out the best ways to adapt it to NATO standards.

The final result of this work should be the development of a Roadmap for the development of a life-cycle management system for defense products in Ukraine.

All this involves conducting a large amount of research in different directions, and the expected results should be suggestions on:

- structures (models) of the management system for the life cycle of defense products in Ukraine, adapted to the normative documents of NATO member states;
- the main directions of the creation of a system of life cycle management of defense products in Ukraine;
- Roadmap for the development of a life cycle security management system project.

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NATO AS A GLOBAL TOOL FOR SUPPORTING PEACE

Russia's hybrid war against Ukraine continues, the adversary tries to impose its terms and deprive Ukraine of its right to choose a foreign policy course. However, the desire to consolidate efforts in the field of military and military-technical cooperation with Euro-Atlantic and European collective security systems is an integral part of Ukraine's state policy.

The package of basic strategic and defense planning documents implemented a unified approach to the implementation of defense reform. The purpose of the reform is to create effective defense forces based on NATO principles and standards. This is one of the main conditions for guarantee of defense of the state and adequate response to the military threats to Ukraine's national security.

The Law of Ukraine "On National Security of Ukraine" regulates the basics and principles of state policy in the field of national security and defense, taking into account the accession to the EU and NATO.

The transformation of NATO from a Euro-Atlantic defense structure into a global peacekeeping tool enhances the Alliance's ability to counteract threats to the security of countries through the development of joint anti-crisis capabilities. This task is solved within a complex system of coalition military construction, which is cyclical. Each complete cycle of military construction consists of three phases: the formation of the conceptual framework of NATO's military policy; military alliance planning; implementation of specific programs of development of the armed forces and means of the unit. The cycle is approximately a decade.

The planning of the key areas of military construction of the North Atlantic Alliance is based on the general principles of the collective security system: the political solidarity of the member states of the organization; development of mutually beneficial international cooperation; proportional distribution of tasks and costs between allies, recognition of mutual obligations; collective retention of forces sufficient to ensure the security of the Alliance.

The planning of military construction activities takes into account the impact of the existing objective factors of global development, including changing military and political situation in the world and crisis regions, demographic and environmental processes, the opportunities of the Allied Armed Forces for ensuring coalition security, general trends in defense technology development, and the economic capabilities of individual Allies. This approach allows the optimal use of the collective and national resources provided for defense purposes.

The process of conceptually substantiating the North Atlantic Treaty Organization's military construction plans begins with the publication of the NATO Comprehensive Political Directive, which defines the organization's objectives for the future and outlines key areas for improving the bloc's defense capabilities. The baseline of this programmatic document is taken into account in the preparation of an updated version of the NATO Strategic Concept, the decision to develop the Concept is usually taken concurrently with the approval of this Directive.

As part of the current cycle of military construction, the new NATO Comprehensive Political Directive was endorsed by the Heads of State and Government at the Riga Summit (2006).

According to the requirements of this document, the development of the North Atlantic Treaty Organization's force structures should be directed towards improving the capabilities for rapid deployment of troops (forces), increasing the stability of command and communication, achieving the required level of interoperability of the armed forces formations of all participating countries, ensuring the ability to autonomously conduct hostilities in remote areas.

These requirements and guidelines are further substantiated in the "Strategic Concept for Defense and Security of the North Atlantic Treaty Organization Member States". It was adopted at the November 2010 Lisbon meeting. In the new strategic concept, major efforts are planned to focus on the following areas of military construction: optimization of the existing structure of governing bodies of Allied Armed Forces; increasing the level of combat readiness and staffing of national and coalition troops (forces); increasing their expeditionary capabilities; consolidation of the leading positions of the block countries in the field of high technologies and information support.

The second phase of the Alliance's military construction, known as the NATO Defense Planning Process, involves a set of consistent and coordinated working procedures for aligning national defense programs with coalition security objectives to meet the bloc's defense needs. The main purpose of this process is to determine the quantitative and qualitative parameters of the military potential needed to conduct all possible crisis response operations, also to ensure timely and complete allocation of resources to participating countries to formulate the Alliance's defense capabilities.

In determining the size and nature of national contributions to the collective defense of NATO countries, they declare that their sovereignty and independence are maintained. However, the current security system of the Alliance requires that its members take into account the common interests of the North Atlantic Alliance when making individual decisions. Therefore, they adhere to approved military planning procedures that provide a unified methodology for determining the type of forces required to ensure the military and political course of the North Atlantic Alliance and clarify planning tasks for the construction of the Allied Armed Forces.

The NATO military planning process forms the basis for the building of the North Atlantic Treaty Organization and is viewed by the Organization's leadership as one of the most effective mechanisms for implementing a comprehensive crisis management approach. In addition, the current system of working methods and mechanisms of the military planning process contributes to the effective use of defense resources to ensure collective security and reduces duplication of efforts in the area of joint defense capabilities.

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ON THE IMPLEMENTATION OF THE VALUABLE CONCEPT OF PRICING INTO THE PRODUCTION OF MILITARY PURPOSE

The problem of pricing for military purpose products (MPP) is one of the keyissue in the process of ensuring the financial security of defense industry enterprises and the state as a whole, since during the recent years the volume of financial resources for the development and purchase of modern defence weapon and equipment (DWE) has significantly increased, and the nomenclature of products ordered from enterprises within the Government Purchases contains thousands of names.

The analysis of regulatory documents on regulation in the public procurement system aimed at increasing the objectivity and validity of pricing for MPP shows that the existing pricing system for such products in Ukraine is based on the application of the traditional costing method, which is essentially cost-effective. which is based on the summation of total costs and profits. Even the methods of calculating (forecasting) the cost of DWE based on a sample – analogue basis are also approximate to the cost-effective methods, since they are based on data on the labour-output and cost estimatшщт for previously completed works.

The dominance of traditional cost effective methods in the area of MPP procurement has been created largely due to the high level of administration of the allocation of public financial resources and the procurement of public goods. Despite the positive properties of cost methods (their high objectivity, ease of use and control over the availability of all raw data), they also generate certain negatives.

First of all, lack of interest of the customer and the contractor in reducing the cost of production. In addition, cost methods provide defense enterprise management with the possibility to misuse the budget funds, when expenditures may include expenditures that are not related to the execution of a government contract for MPP.

Therefore, the existing cost system of pricing in Ukraine does not stimulate the implementation of organizational, technological, scientific and other innovations in the defense industry, which help to reduce the cost of production and increase the level of financial security of enterprises.

The analysis of publications on MPP pricing problems shows that for a long time the scientific and practical environment searches for new approaches to overcome the disadvantages of cost methods and to develop a new pricing system which should be based on a value concept. It implies the dependence of the product price on the efficiency of use and the cost over its life cycle (LC).

The value concept of pricing for defense industry products implies that the value of the product to the customer is determined by its tactical and technical characteristics (incl, quality, effect from use in both war and piece, as well as the effect from possible use in other non-military fields of activity) on one hand, and on the other hand, a significant financial effect (the ability to reduce costs, increase the price of more innovative products, etc.)for the company -.

The essence of the value concept of pricing lies in the combination of two aspects:

- the first reflects the interests of the customer (usually a state) in the effective use of budget funds (according to the criteria of technological and financial performance of products);

- the second reflects the interests of the contractor (enterprise) in the financial and economic attractiveness of the order.

The technological efficiency of the order's execution involves its execution in the required time and in the required volume. The cost-effectiveness (rationality) of order fulfillment includes such choice of a prototype design option that, when compared to alternative ones, ensures that the desired effect is achieved with minimal financial resources over the entire life cycle of the product.

The paralell fulfillment of these conditions provides the maximum effect of embodying the value concept of pricing. Fundamentally the new approach in the value concept is the full life cycle determination at designing DWE prototype, taking into account the value of the product for the customer. The cost of each stage of the life cycle is defined as part (component) of the total cost.

In this approach, it is virtually impossible to develop and purchase a less efficient sample, which is achieved in comparison to alternative MPP products at the same cost or efficiency but at a higher cost.

It is fundamentally important that the purpose of implementing this pricing method is not to minimize the budgetary costs of individual orders (stages of the life cycle of MPP products), but to minimize the total costs during its life cycle, including development, production, operation, repair, overhaul and the construction of infrastructure to support these stages.

The detour from the traditional firm fixed price and its variants and the use of flexible pricing models adopted in foreign practice in the contracts for the creation of MPP prototypes form the conditions for finding the balance of interests of the customer and the contractor.

Thus, an important feature and advantage of the value approach to pricing is the relationship of MPP value indicators with its costs, for the customer, which, firstly, stimulates contractors to improve the MPP and increase its competitiveness, and, secondly, eliminates price increases , not related to improving the quality of the product.

It should be noted that the transition from a cost-based to a value-based pricing system requires a review of a significant amount of the relevant regulatory framework and, most importantly, the creation of a methodological (instructional-methodical) base that will provide the opportunity to obtain the dependence of MPP on the quality (effect) and the possible risks of its creation. It is necessary to develop clear techniques for the practical application of different pricing models and the order of revising the price structure.

Thus, the introduction of a value approach to pricing will encourage Government Purchases contractors to improve MPP and increase its competitiveness, and will ensure a fair price depending on the quality of the final product.

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TASKS LIST FORMATION FOR ARMING OF ARMED FORCES OF UKRAINE, WHICH CAN USE THE MEANS OF STATE-PRIVATE PARTNERSHIP

The basic list of tasks on technical arming for projects of state-private partnership (SPP) should be considered within operational life (OL) of armament and military equipment (AME) samples. Decomposition of AME OL is representing as list of the stages (1 level), works kinds (2 level) and stages (3 level) in accordance with interstate standard GOST V15.004-84 accepted for implementation in Ukraine.

Consideration of the attributes, advantages, particularities and other characteristics of SPP permits to draw the criteria for assessment of possibility to use that means in defense area. A task may be implemented with usage of SPP projects, when the conditions or possibilities to meet the mentioned criteria are in availability.

List of tasks is drawn with application of criterial analysis of the AME OL levels.

Content, tasks and terms for implementation of different works stages (3 level) do not meet the criteria of SPP. The works kinds (level) are implementing as rule by means of public procurements. SPP provides a complex and long-term projects; the 3 level of decomposition (different works stages) is not proposed for consideration.

For most cases, analysis of “different works” level has shown impossibility to use SPP projects. Works kinds deal with designing of samples, commissioning, creation of provisioning infrastructure, it using and maintenance, repair, support of military equipment may be considered as exception. Other works kinds do not meet all assessment criteria and can’t be implemented with using of SPP.

AME OL stages meet all mentioned criteria.

Process of formation and implementation of SPP projects on every stage of AME OL has some particularities. Unification of the stages, works kinds permits to increase a project duration and complexity, to increase the party’s interest.

The military equipment and dual use products are most actual for SPP.

Tasks for SPP projects can’t be considered for weapon, armament and other types of military equipment, where the international or inner limitations (usage, trade, development of banned AME types, etc.).

AME nomenclature includes big list of equipment, which demands the different works scope and resources, experience and capabilities to be under management. Therefore, the form, SPP conditions, algorithm of project implementation depends on characteristics of AME sample.

List of tasks for SPP projects is not final, and it should be specified on the results of gain of experience and development of it usage practices.

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THE APPLICABILITY OF USING MODERN TECHNOLOGIES IN THE MODERNIZATION OF SAMPLES OF ARMS AND MILITARY EQUIPMENT IN THE FRAMEWORK OF THE MILITARY TECHNICAL SYSTEM

The most important activities in the field of military-technical sphere are services in repair and modernization of samples of arms and military equipment (WME) in the framework of military-technical cooperation with foreign countries. This type of service can have a significant economic effect on the provider state of such services. At the same time, the modernization of these or other WME samples is often carried out at the same time both for the benefit of the foreign customer of this type of services, and in order to solve the problems of technical equipment of one's own armed forces with more advanced samples of the WME.

Management of the life cycles of complex upgraded WME samples is possible only in a single information space using modern information technologies. The information and methodological elements in this process of governance related to the military and economic aspects should facilitate the formation and implementation of more informed decisions on the rational use of recruited resources in the modernization of WME samples.

One of the ways to reduce the total costs (and as a consequence of the price of the upgraded WME sample) in carrying out the modernization work of the WME samples may be to introduce elements of modern information technologies, such as CALS-technologies. The essence of the CALS concept lies in the continuous provision of information to participants in the life cycle of the sample of the WME product data, and is to create a single integrated model of the product. This model accompanies the product throughout its lifecycle, from the moment the needs of a particular sample of WME are identified to meet the product's disposal needs. The model must include all product information, namely design, production and operational information, as well as upgrading information.

The basic principles of CALS-technologies are: all data about the product, processes and resources are stored and circulated in the chain of partner companies electronically; data from partner companies are not duplicated and used many times, which creates a single information environment; data is available to all partners in the chain.

The implementation of CALS-technologies by Western experts leads to: reduction of design costs; reduction of time of product development (modernization); reducing the proportion of defects and the volume of structural changes; reduction of technical documentation preparation costs; reducing the cost of developing operational documentation.

Unfortunately, in Ukraine there are no fundamental economic studies to date on the effectiveness of CALS technologies and the cost-of-life evaluation of WME samples.

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PROBLEMATIC ISSUES IN THE MILITARY TECHNOLOGY OF FOREIGN AND DOMESTIC ELECTRONICS

The current task in modern conditions is to simplify and legalize procurement procedures and legitimize the use of the domestic and foreign electronic component base (hereinafter - ECB) during the development, manufacture or modernization of armaments and military equipment (hereinafter referred to as "weapons"), which must be observed by the manufacturer and the consumer. for use in weapons.

The task of ensuring complete independence (or decrease of dependence) on imported electronic components in the near future can not be solved due to the lack of own production of the vast majority of electronic components (components), electronic modules, etc.

In order to minimize the cost of creating military systems by using the achievements available on the commercial market, it is necessary to switch to the use of so-called COTS (Commercial Off-The-Shelf) products, which will allow, apart from saving financial resources, shorten the timing of the creation of weapons systems and increase their reliability.

Technical solutions, architecture, software, information processing algorithms are advisable to create in the country of manufacture of the final product. And a specific chip should be ordered where it is better and cheaper to make.

In military equipment, the Armed Forces of Ukraine is using electronics manufactured in Ukraine, collected almost entirely on foreign components or upgraded with the use of these components. An electronic unit or device containing foreign components designed and manufactured by Ukrainian enterprises should have permission to use without a permissive procedure, as it is a Ukrainian product.

In order to ensure centralized coordination and control over the use of imported components in the defense industry, a clear and transparent mechanism is required that will require the adoption of a certain permitting procedure and verification of the justification of the impossibility of using domestic ECBs to meet the requirements of a standardized weapons as specified by the customer, as well as quality control, special inspections, etc. In order to solve this problem, it is advisable to use intermediaries who will have the legitimate grounds for their respective activities, after passing the certification, for the right to purchase and supply as a supplier of imported products for the needs of enterprises and organizations that are developing, manufacturing, modernizing and repairing weapons of the Armed Forces of Ukraine .

At the current stage, it is necessary to adopt at the state-level the ideology of the use of COTS products in the creation or modernization of weapons samples and to consolidate it with the relevant regulations, the main provisions of which should be: the permission for the use of modern COTS products in the military apparatus; a ban on the development (at the expense of budgetary funds) for the use of materials, products, technologies and solutions available in the general market on the weapons; when using the COTS-products, it is preferable to give domestic products, up to price preferences in relation to foreign analogues; creation of interagency restrictive (recommended) list of electronic component base and products of domestic and imported production allowed for application in the development, modernization, production and operation of weapons, with the condition of its periodic updating; development of a program for reviewing (or creating) military standards and normative and technical documentation for weapons, with a view to regulating them in the order and rules of use of domestic and imported COTS products in weapons; creation of normative base of contract production within the framework of State Defense Order with the participation of civil enterprises.

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METHODICAL APPROACH TO SELECTING DIRECTORATE DEVELOPMENT OF ARMED FORCES ARRANGEMENTS

The paper describes the provisions on the justification and selection of directions for the development and the of the perspective weapon system of a type of armed forces of a state. The main focus is on the air defense weapons system. The developmental sequence of air defense weapons systems as a species system is considered.

The necessity of developing a complex methodology with other partial methods is proved. The scientific and methodical apparatus that is used should provide assessment and forecasting the development of the weapon system during the program period. It is determined that the justification of the development of the weapon system should be based on shaping the outline of a perspective weapon system using a systematic approach and defining a promising nomenclature of samples.

A study of the development of the weapon system should be conducted consistently, phased, with the aim of:

clarify the tasks to be solved with the use of weapon systems;

more complete definition of the weapons system perspective outline;

clarification and justification of the type of armament and military equipment weapon system;

assessment of numerical and value indicators of creation and supply of armament and military equipment to the weapon system in perspective groups;

assessment of the levels of their technical equipment with combat vehicles and assistance means;

assessment of the dynamics of changes in the structure of weapons system.

On the basis of the conducted researches the procedure of assessment of scenarios of application of perspective groups with the use of the proposed promising weapon system is offered.

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NATO LIFE CYCLE MANAGEMENT LEGISLATIVE BASEMENT

Ukraine's military doctrine identifies major allies and partners of Ukraine in the US, NATO and EU, and the priority task of cooperation with NATO is to achieve the technical interoperability of the Armed Forces of Ukraine with the Armed Forces of NATO member countries.

In the countries of the Alliance, achieving the compatibility and interchangeability of armaments is one of the main tasks of the Conference of National Armaments Directors (CNAD), and is being addressed at all stages of the armament's life cycle. The key to this is the development of unified operational-tactical requirements (OTR) for the armaments of different countries, providing the ability to solve tasks in common typical scenarios of combat, integration in such scenarios for different branches and types of troops.

The methods and tools of managing the military-technical system are usually chosen by NATO member countries on their own but taking into account the NATO's strategy for the life cycle management (LCM), as well as their own and best practices in implementing such processes. As a rule, the results of this work in each country or in the corporations of the defense industry of these countries, which have the ability to effectively manage the LC, adopted a set of regulatory guidance documents (RGD), which set the methodological, regulatory and technical basis for the armament's LCM.

Usually, such a complex of RGDs is a hierarchical system of documents, at the top of which are the LCM strategies (policies) and a description of ways to implement them; below are general guidance on the implementation of LC processes, such as: project management, quality management, risk management, requirements management, configuration management, information management, etc . Further below are implementation plans that are based on the guidance, which determine the conditions for the implementation of individual projects or units.

NATO Strategy for Life Cycle Management - CM- (2005) 0108 (NATO Policy for System Life Cycle Management (SLCM)) in NATO countries, aimed at optimizing the capabilities of NATO in accordance with the LC of armaments, taking into account their operational capabilities, cost , terms of development and delivery to the troops, quality, etc. This ensures that all requirements throughout the LC of a system will be formulated and taken into account at the beginning of their LC, and as a result, most of unwanted surprises will be avoided later.

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SCIENTIFIC AND TECHNOLOGICAL INFORMATION IN THE FIELD OF DEFENSE AS A MATTER OF CRIMINAL-LEGAL PROTECTION

Scientific and technological activity plays an important role in the field of defense of the country, because it depends on its achievements on the modernization of the technical composition of the armed forces of Ukraine, which in turn influences the effectiveness of conducting military operations. This is confirmed by the doctrine of the state policy on national security issues. Thus, the National Security Strategy of Ukraine, approved by the decree of the President of Ukraine "On the decision of the National Security and Defense Council of Ukraine dated May 6, 2015," On the Strategy of National Security of Ukraine "states that one of the main tasks of improving the state defense is to support promising, practically directed scientific research in the field of national security and defense; modernization and forward-looking development of the defense-industrial complex, increase of its production capacities, development of world-class weapons and military equipment competitive on the world market, import substitution and increase of own production of critical components and materials.

Along with this, information on the latest scientific and technical developments in the field of defense may be the subject of criminal influence, primarily by foreign states or their representatives. The current Criminal Code of Ukraine (hereinafter - the Criminal Code of Ukraine) provides for four categories of crimes, the subject of which may be scientific and technical information in the field of defense, which, depending on the degree of its importance to the interests of the state and, accordingly, the degree of state protection may become a state secret, or official information. Thus, in the Special Part of the Criminal Code of Ukraine stipulated art. 111 (state betrayal in the form of espionage), art. 114 (espionage), art. 330 (transfer or collection of information constituting official information gathered in the process of operational-search, counter-intelligence activities, in the field of defense of the country) and Art. 422 (disclosure of information of a military character, constituting a state secret, or loss of documents or materials containing such information). Separation by the legislator of these syllables of crimes is carried out in different constituents: an object, an objective party, a subject and an object. Let's dwell on the subject of these syllables of crimes, which includes scientific and technical information in the field of defense.

In analyzing the legislative description of the crimes provided art. art. 111, 114, and 422 of the Criminal Code of Ukraine, the legislator has clearly indicated that it has information that relates to state secrets. According to the Law of Ukraine "On State Secret", the latest is a kind of secret information that includes information in the field of defense, economy, science and technology, external relations, state security and law enforcement, the disclosure of which may harm the national security of Ukraine and recognized in the procedure established by this Law shall be state secrets and shall be protected by the state. The same legislative act, part 3 of Art. 10 states that Information is considered to be a state secret from the time of the publication of the Statement of Information constituting the state secret to which this information is included or changes to it in accordance with the procedure established by this Law.

In turn, the Statement of Information containing State secrets approved by the Order of the Security Service of Ukraine of August 12, 2005 No. 440 "On the approval of a set of information constituting state secrets" provides an exhaustive list of types of classified information that is recognized as state secrets, including in the field country defense. In particular, it includes the following scientific and technical information about:

- the purpose, directions, scientific and technical ideas, results, the possibility of application (realization) of fundamental, search applied scientific research, aimed at improving the state's defense capability (paragraph 1.9.1);

- discoveries, inventions, scientific and technical decisions that can be used for the needs of state defense and are of fundamental importance for the development of new types of weapons or military equipment (paragraph 1.9.2);

- the achievements of science and technology, the research direction, the results of research or development work that enables the improvement of weapons or military equipment for defense purposes (paragraph 1.9.3) et seq.

In the category of official scientific and technical information in the field of defense, which falls under the criminal law of Art. 330 of the Criminal Code of Ukraine in accordance with the order of the Ministry of Defense of Ukraine dated 27.12.2016 No. 720 "On Approval of the List of Information of the Ministry of Defense of Ukraine containing Service Information (PSI-2016)" to this category include information about:

- Plans, directions and results of research and development work of the scientific subdivision (clause 13.1);

- scientific developments on dual-use technologies. (paragraph 13.10);

- Innovative proposals, revisions and other constructive changes to non-invasive weapons and military equipment that enhance their tactical and technical characteristics. (paragraph 13.11) and so on.

Summarizing the above, it is possible to note that scientific and technical information is important for Ukraine's sustainable defense, and its protection against a criminal offense is a priority task of the state in the sphere of national security of Ukraine.

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KEY ELEMENTS OF THE INNOVATION PROJECT

The main elements of the innovation project include:

- formulated goals and objectives that reflect the main purpose of the project;
- a set of project measures to solve the innovation problem and achieve the set goals;

- organization of the implementation of project activities, ie linking them by resources and contractors to achieve the project objectives within a limited period of time and within the set cost and quality;
- the main indicators of the project (from the target - the project as a whole, to the particles - by individual values), including indicators that characterize its effectiveness.

Innovative projects can be formed as part of scientific and technical programs, realizing the tasks of particular directions of the program, and independently, solving a specific problem in the priority directions of the development of science and technology.

Formation of innovative projects for solving the most important scientific and technical problems (tasks) provides:
- a comprehensive, systematic approach to solving a specific task (goal) of scientific and technological development;
- quantitative specification of the goals of scientific and technological development and strict reflection of the ultimate goals of scientific and technological development and strict reflection of the final goals and results of the project in innovation management;
- continuous cross-cutting management of processes of creation, development, production and consumption of innovations;
- reasonable choice of ways of the most effective realization of project goals;
- balance of resources for the implementation of an innovative project;
- interagency coordination and effective management of complex project work.

Project appraisal is the most important procedure in the initial stage of the project, but it is also a continuous process that allows the project to be stopped at any time due to additional information that appears. Thus, this is one of the procedures for the operational management of research and development. It should be based on a clear formal basis and include the following components:
- identification of the main factors characterizing the purpose of the project;
- evaluation of project proposals on these factors using quantitative information or expert judgment;
- acceptance or rejection of project proposals based on estimates made;
- identifying areas where additional information is needed and allocating resources to obtain it;
-comparison of new information with that used in the initial assessment;
- assessment of the impact on the project of selected new variables;
- making a decision to continue or terminate work on the project.

When implementing innovative projects, priority and support from the state should be those projects that are focused on the final socio-economic results.

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ANALYSIS OF LIFE CYCLE COSTING METHODS FOR COMPLEX TECHNICAL SYSTEMS

Different methods and models can be used to predict the life cycle cost of complex technical systems. The most commonly used methods belong to the category of computing. It is an engineering method, an estimation method by analogy, and a parametric method.

If necessary, several methods or a combination of these may be used at the same time.

The engineering method of cost estimation is based on the detailed description of cost items and is the most resource consuming in application. The procedure for its implementation begins with the evaluation of the lowest cost items and in the subsequent cost estimation at the higher levels of the structure by summing up the costs at the previous levels.

The advantages of the engineering method include:

Intuitiveness, reasoning, reliability (due to the factual information for each cost element), separability (not a significant dependence of the overall result on the individual cost element), clarity (provides a deep insight into the main cost elements), reusability (easily portable to other projects for later use).

The main disadvantages of the engineering method include:

inflexibility (slow response to change, "what if" assumptions), need for new estimates for each alternative scenario, lack of "statistical" confidence level, lack of in-depth analysis of factors that directly affect cost.

The method of valuation by analogy is based on the use of the cost data of similar cost items for similar products or technologies. In doing so, they use statistics that are adjusted for price increases, technology improvements and more. This method is the least complicated and time consuming. It is recommended to be used for components of products for which there is real data from previous experience of their manufacture and use.

The advantages of the analogy method include:

use of real statistics, speed, accuracy at small deviations from the analogue, clarity.

The main disadvantages of the method of analogy include:

relying on data at one point, the difficulty of finding an appropriate counterpart, the need for "normalization" to ensure accuracy, relying on extrapolation and / or expert judgment on "correction factors".

The parametric method of cost estimation is used when there are certain dependencies between the costs and the product parameters (characteristics or attributes of the sample of armaments, if they can be measured). Of course, the existence of such dependencies is associated with the existence of a cause and effect relationship between cost and product parameters. These relationships are revealed by analyzing data that has been accumulated over a period of time using mathematical statistics.

The advantages of the parametric method include:

the speed of estimates on the list of assumptions (answering "what if" questions), the availability of statistically valid predictors that provide information about the estimator's confidence in their predictive ability, the reliability of the results based on the logic of correlation, thoroughness and consistency of the studies, the validity of the data, as well as the scientific method.

The main disadvantages of the parametric method include:

complexity of understanding the obtained CER (Cost estimating relationship), the need to carefully document the process of selecting the source data, adjusting data, developing equations, statistical conclusions and conclusions about their validity, the complexity of the process of gathering relevant data and generating statistically correct CER, reliability in a narrow CER data (loses predictive ability / confidence beyond the relevant data range).

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FEATURES OF PROJECT COSTING AT NASA

Today, NASA has a state-of-the-art methodological tools that allows it to estimate the costs of engineering projects, both for the needs of the Agency and for the benefit of US government agencies.

The cost estimate provides a sound basis for budget planning, which in turn undergoes a complex approval process in Congress and in presidential structures. It is also used for internal needs – for examining programs and making investment management decisions.

One way in which NASA informs Congress and the Office of Management & Budget regarding reaching its goals is to integrate cost and timing data into the budgetary and external activity reports, ensuring transparency of the Agency's activities.

The process of estimating costs for engineering projects at NASA consists of 3 phases.

Phase 1 is to identify the project. At this stage, the evaluation expert finds out the reason for the evaluation, identifies the prospects and begins to understand the essence of the project to be evaluated. When the assessment has been conducted and data have been collected, the work breakdown structure (WBS) and the technical description of the project are determining. All this helps to define the project itself, as well as to make the basis for its evaluation. At each step at this stage, the evaluating expert may return again when new information is received.

Phase 2 involves defining the cost methodology and includes four tasks that define the assessment approach and the structure of the assessment. These tasks are carried out consistently and iteratively. They return to the task of developing basic rules and assumptions several times after completing the steps of methodology selection, cost model development, and data collection, if it is necessary.

Phase 3 involves a direct cost assessment and consists of five tasks, which include the evaluation itself, presenting its results and updating them on a regular basis.

This approach allows NASA to make cost estimates and undertake a comparative analysis of budgeting data with external reports, which improves the quality of budget plans and costs estimates. NASA is constantly focused on to achieve maximum results with a constrained budget, for which the US Government uses an external NASA evaluation community of experts to provide accurate, reliable and reasonable estimates of the life cycle costs of NASA entities.

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FORECASTING THE COST OF RESEARCH AND DEVELOPMENT FOR THE CREATION OF A NEW SAMPLE OF ARMAMENTS AND ITS MASS PRODUCTION

Using the created economic and mathematical models, the orient cost of a new sample of armaments is estimated during the two initial stages of its life cycle: 1) the cost of R&D; 2) the cost of mass production. For this purpose, regression analysis and next types of equations are used:

$$Cfori = A * Ktpi + B, \text{ where}$$

Cfori - the forecasted cost of the required i-th sample of the armaments, adjusted to the estimated year;

A - the coefficient of regression equation;

B – the coefficient of regression equation;

Ktpi - the calculated coefficient of technical perfection of the required i-th sample of armaments.

The estimated cost of R&D and mass production is estimated using statistical data on the cost of similar works for creating of the same types of armaments. The cost of R&D is forecasting, without detailing the costs of individual components. Similarly, a preliminary estimation of the orient cost of mass production of new samples of armaments is being made, the results of which will be used in the selection of the contractor of the mass production of the samples of armaments as a whole and its subcontractors.

In the absence of statistical data regarding the cost of R&D and the mass production of the same types of armaments in Ukraine, which are necessary to build a complete economic and mathematical model for estimating the cost of a new samples, the data usually is taken from foreign sources and the cost information of the precursor samples, which were created during the former Soviet Union time, interpreted to the financial and economic conditions of Ukraine.

Obtained at those stages, the orient cost of a new sample of armaments is used to predict the full life cycle cost, and on that basis - to decide on the feasibility of its development and mass production.

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THE ROLE OF THE STATE IN THE INNOVATION PROCESS

The development of Ukraine's defense-industrial complex is inextricably linked to the need to develop an innovative environment in Ukraine.

The need for state regulation of innovation processes is due not only to their national importance, but also to their economic content. On the one hand, in a market economy, innovation is the main means of increasing the profits of business entities through better satisfaction of market demand, reducing production costs compared to competitors. On the other hand, in the conditions of classical market mechanisms of obtaining scientific and technical results and their introduction into economic practice will be significantly complicated.

The experience of foreign countries with a market economy proves that in the issues of innovative development one cannot fully rely on the automatism of the market. The use of innovations can not only be a private problem of a particular enterprise or region, it is increasingly becoming social in nature, since the socio-economic prospects of a country's development are increasingly dependent on how innovative processes flow there. Therefore, the priority of centralized methods of managing innovation processes is proven by world practice.

Thus, the state should fully support the development of the economy on the market principles, while taking the main responsibility for comprehensive overall regulation and strategic planning of economic development and direct support for the innovation process. Particularly decisive role of the state should be at the pre-commercial stages of the innovation process, in the field of high-tech defense productions, in the system of stimulating the innovative activity of fundamental science, economy and society, as well as in addressing the allocation of productive forces, efficient use of national natural resources and human resources.

The following factors contribute to the successful development of the national innovation system:

consistent and long-term innovation policy of the state with clearly defined goals and objectives;

rational use of existing innovation potential as a foundation for building an innovative economy and implementing innovation policy;

systematic efforts to establish and strengthen collaboration between the stakeholder, research and education sectors;

reaching out to as many potentially innovative firms as possible through government support;

sensible attraction of foreign investments of multinational corporations;

availability of developed legislation in the field of intellectual property.

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ANALYTICAL METHODS OF ANALYSIS AND EVALUATION OF STATE PROGRAMS

Attempts of using modern analytical methods are seen in the United States as one means of overcoming subjectivism in decision-making when evaluating the various types of government programs so characteristic of the "agreements and concessions" process that it is to replace objective criteria by seeking compromises between the interests of influential political groups in the federal government and the forces behind them.

One of the most important new phenomena in the direction, that is considered, connected with the formation and development of the approach known as policy analysis.

Policy analysis is not related to any narrowly defined class of methods for studying problems (mathematical, simulation, game, etc.). It is designed specifically to substantiate public administration decisions and is intended to supplement (and in some cases replace) less flexible and more formalized methods of system analysis and operations research based on the use of mathematical apparatus and computers.

When conducting a policy analysis, the following are explored:

legislative acts and the deployment of political forces in the field of planned state events;

proposed and existing programs of government departments and private sector actions;

potential conflicts of the proposed option with other goals and programs;

the political implications of the analyzed decision and its impact on society, the economy and the environment;

organizational aspects, information-gathering, implementation problems, etc.

This approach does not involve the development of any fundamentally new advances in management science, it makes extensive use of the analytical apparatus of operations research, systems analysis and other theories and has a pronounced pragmatic orientation. Its supporters are trying to structure the workings out of government decisions in areas where there is not sufficient basis to build accurate quantitative estimates and applying scientifically valid criteria for selecting courses of action, where subjective judgments are dominated, that take into account the interests of influential political groups and other "interest groups".

The significant increase in the size of federal programs and the strengthening of their complex nature make the consequences of the activities of state agencies not limited to the specific results to which the program is aimed. However, indirect economic, social, technological, international and other influences (both foreseen and unexpected), taken as a whole, often outweigh the value of specific program results. In this case, there is the problem of identifying and accounting for possible influences on early stages of program development. On this basis, the researchers were tasked with conducting impact analysis, the essence of which is to study both quantitative and qualitative characteristics of those changes that will occur in all areas that are directly and indirectly affected by the programs being analyzed. Along with this, methods of impact management, which were designed to be developed, were tested that would prevent the unwanted effects of the programs and at the same time maximize the benefits of all aspects of their implementation. One of the most methodologically and organizationally completed areas of use of impact analysis in the practical work of the federal government is the so-called "technology assessment" - a method of comprehensive identification of the consequences (social, economic, political, etc.) of the implementation of programs in the field of new equipment and technology. The necessity of considering these effects in decision-making at the state level led to the establishment of the special staff in the US Congress- Office of Technology Assessment. The complexity of the economic, social, political conditions in which government agencies operate, driven by the increasing number and scope of problem solving, the multipurpose nature of government programs and measures, the need to take into account risk factors and uncertainties - all these could not affect the nature of the models used, which all more often they are used not to develop the best version of a program, but only to identify the consequences of the proposed alternatives, to analyze the observed phenomena and to predict.

Thus, the extension of the use of analytical methods is of great importance, but not always necessarily due to the use of complex mathematical apparatus and computers.

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IMPLEMENTATION OF MODERN TECHNOLOGIES TO THE MANAGEMENT SYSTEM OF THE LIFE CYCLE OF PROTECTED PURPOSE

Companies of the world leading countries Defense industrial complex always seek to shorten the development period of the new products and to introduce innovative technologies during this process, while maintaining high standards of quality. For this purpose, powerful information technologies are used, but this does not always allow companies enterprises to optimize their R&D processes and gain returns in the form of lower costs and shorter terms of development of defense products.

The transformation of the R&D process of these products begins with the simulation, which defines the entire life cycle of the sample - from engineering analysis of constructive and dynamic properties to the development of tools, production and assembly processes, maintenance and repair.

For the first time, work on the creation of integrated systems supporting the life cycle of products was started in the 80's in the US Defense Complex. The new concept was used as a tool to improve the logistics management of the US Army. It was anticipated that the implementation of the new concept, known as CALS (Continuous Acquisition and Life Cycle Support), would reduce the costs of organizing the information interaction of government agencies with private companies in the formalization of requirements, delivery, supplies and operation of military equipment. There was a real need to organize a process that provides for the exchange of data between the customer, manufacturers and consumers of products, as well as increased manageability, reduction of paper workflow and related costs.

Under present conditions, in Ukraine the vast majority of technically complex weapon complexes have already exhausted their resources or they are coming to an end in the coming years, with every 10-14 years the cost of modern weapons is doubled, and the cost of modernizing armaments and military equipment (AME) increases annually by 10%.

The cost to provide a lifecycle of a AME is roughly distributed as follows: 35% - creation; 20% - adoption testing of weapons; 40% - operator cycle intended use; 5% - recycling. The each period of time depends on fin type of weapons. Depending on the technological novelty of the AME, the terms of its serial production and intended use may vary within several decades.

One of the ways to improve the effectiveness of the AME restoration is to improve the legal base of the National Arms Life Cycle Management System, which involves the adaptation of the requirements of NATO standards in the field of system engineering, a modest approach to abolishing of existing outdated standards, and the introduction of CALS and technologies for the use of special information systems supporting the life cycle on all stages.

Thus, an improved defense planning system, in particular the implementation of CALS-technologies at all stages of the AME life cycle, will contribute to the effective management of the development of armaments, as well as the concentration of attention on improving the combat capability of the Armed Forces of Ukraine and the development of the main means of armed struggle.

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ITALIAN EXPERIENCE ON MEASURES OF AME DEVELOPMENT PLANNING

Today Italy is one of biggest manufacturer of weapon in Europe and it leads the purposeful policy deals with creation of united European military and industrial complex. Such policy permits Italy to get access to new technologies from other countries, to upgrade level of technological infrastructure, to increase a competitive ability produced armament and finally to win a rightful place on world market of armament.

Management system of defense orders in frames of Italian national policy in armament area consists from two stages: the 1-st stage – determination and agreement; the 2-nd stage – administrative and technical implementation.

The 1-st stage provides the following measures:

- identification of the need and determination of operative demands (that measure is implementing in General Staffs of Italian armed forces (AF) branches);
- determination of operative demands (system of armament and military equipment (AME) should meet these demands);
- determination of military demands with detailed description of armament system characteristics, including requirements to technical service (technical support and training);
- accept of solution deals with financing by Committee of chiefs of staffs chaired by chief of General Staff of Italia;
- getting of recommendations from Committees on defense problems of Italian parliament (recommendations are not obligatory);
- approval by Italia defense ministry (if budgeting is planning from Defense ministry budget) or approval by Parliament (if budgeting demands the special law).

After the first stage execution, Program production of AME system together with Decree of Defense ministry is directing to General secretary of Defense ministry. GSDM begins to execute administrative and technical implementation stage.

GSDM elaborates Technical agreement project, elects the main Contractor on competition base, prepares Contract and controlling it execution in process of the second stage.

A usual purchasing procedure provides following actions:

- elaboration of Technical agreement;
- bid issue;
- choice of the best proposal and declaring winner;
- contracting (procedure of approval of contract draft by Council committee on purchase chaired by GSDM, if contract exceeds 5 million Euros);
- signing of Contract;
- registration of Contract in National Audit Office;

- full execution of Contract.

During choosing of Contractor, GSDM can act on base of available armament system on world market or he can begin the scientific and research works, if available system does not meet to made demands.

If the scientific and research works are necessary for production of new AME system in cooperation with other countries, then procedure provides the following:

- execution assessment, technical and economical grounding of project (determination of technological possibilities of defense industry deal with military demands to project under consideration; choice of most optimal variant taking into account effectiveness of execution, expected expenditures and period of project duration);
- consideration of final product configuration;
- development (production of experimental sample of new AME system, material, transport means meet to military demands to project, approval of sample);
- design and production;
- serial production and maintenance.

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SUMMARY, FORMS AND FUNCTIONS OF OPERATING AND STRATEGIC REQUIREMENTS TO THE PERSPECTIVE SYSTEM AME AD

The concept of perspective system of arms and military equipment (AEM) of air defense (AD) of the Air Forces (AF) of the Armed Forces of Ukraine (AFU) is defined. It is shown that the WME AD system contains the defeat subsystem, the control and communication subsystem, the intelligence and information subsystem, the subsystem subsystem and the staffing and training subsystem. The essence, content and functions of the Operational Strategic Requirements (OSR) for the prospective WME AD system are given. It has been shown that OSR should ensure the creation of a promising WME AD system as a coherent, balanced system and be able to apply it at any level of armed conflict escalation. They should reflect the objectives of the construction of the weapons system and military equipment AD AF AFU, the projected tasks and necessary levels of their solutions, the principles of construction of the WME AD system, the principles of military art and the application of the WME AD system, composition, status and prospects of air strikes of likely adversaries and allies; the required level of redundancy in the composition and characteristics of the WME AD system, the transformational properties of the WME AD system, the requirements generated by the need to interact with the forces and means of AD of other AFU troops and types, the required characteristics and properties of the WME AD subsystems, all types of restrictions, regulations, prohibitions, acting against the promising WME AD system of the Armed Forces of the Armed Forces. Thus, OSR to the promising WME AD AF AFU system must reflect the properties and quantitative and qualitative characteristics of the relevant (operational-strategic) scale.

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ASSESSMENT OF CAPABILITIES AT AME CREATION BY INDUSTRY ENTERPRISES

Necessary for determination of production capability level is arising at comparative analysis of the new (modernized) armament and military equipment (AME), including stages of its creation (designing) or accept of solution on its purchasing from row of native alternative samples. Assessment of capability level at production is proposed to do by means of determination of numerical values of production level coefficient K_{CP} for specified AME type. Method for determination of K_{CP} coefficient on it essence and tasks is directed to determination not capabilities of specified enterprise to develop or produce serially AME nomenclature in general, but on it capabilities deal with production of specific concrete AME type. This is done with purpose of comparative assessment of determined row of alternative AME samples.

For determination of coefficient K_{CP} there is necessary to form List of basic indexes of financial and production activity (FPA) of enterprise for assessment of it capabilities deal with development and serial production of determined AME types separately. Further, there is necessary to decompose the determined indexes, as minimum, in accordance with following groups of influence factors on enterprise capabilities:

- administrative - financial and political factors;
- production and technological possibilities at AME production (development);
- scientific and staff potential at AME production (development).

Next stage includes determination of influence level (with application of expert methods, i.e. importance, basic indexes of FPA and its decomposition groups) on capabilities of typical enterprise of defense-industrial complex deal with concrete activity kind. At comparison, the gotten assessments will fulfill a role of etalon values for assessment of specific enterprise

Assessment by enterprises own capabilities deal with determination of FPA indexes at development or/and serial production of specified AME types. Comparative analysis (with application of separate FPA indexes for every enterprise) with etalon and its compilation in generalized indexes as in decomposition groups well as whatever for enterprise. In this case, coefficient $\boldsymbol{K_{CP}}$ is determining as sum of relative values of FPA indexes. Coefficient $\boldsymbol{K_{CP}} = 1{,}0$ for etalon values of FPA indexes, but for specific enterprises, which are assessing on subject of production (development) of specific AME kind, that index will be less. Values of coefficient $\boldsymbol{K_{CP}}$, which are gotten with this method application, permit to determine the complex index of military technical-economical level of AME samples for its comparative analysis with using of known methods.

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NATO POLICY ON THE APPLICATION OF CIVIL STANDARDS IN THE ARMAMENT STANDARDIZATION

NATO's standardization policy is to maximize the use of civilian standards in the military field, in particular system and software engineering standards.

International systems engineering standards are a mandatory element in the process of a development of various regulatory guidance documents (RGD) and handbooks. For example, ISO/IEC/IEEE 15288 is the basic standard that describes the model of the Life cycle (LC) of any technical system. Its previous editions were taken as the basis for the development of the US Department of Defense Procurement Guidelines, the NATO Phased Armaments Programming System, the INCOSE Systems Engineering Handbook, NASA systems engineering Handbook and etc.

This standard has also been used as a basis for the implementation of NATO's Life Cycle Management Strategy-CM-(2005) 0108 (NATO Policy for System Life Cycle Management (SLCM). The implementation of the SLCM strategy was realized through the direct adoption of ISO/IEC/IEEE 15288 through Allied Publication AAP-48.

The publication of AAP-48 is fully adapted to ISO/IEC/IEEE 15288 as part of a description of all typical LC processes, with the addition of specific processes used in NATO. The AAP-48 defines a system of perspectives on the stages and processes of LC of systems in NATO, and provides guidance on the implementation of the LC management strategy for these systems, as well as providing a common understanding of the principles and terminology of system life cycle management (SLCM). The AAP-48, as ISO/IEC 15288, uses a process approach to manage of LC of the military-technical systems. AAP-48 defines the minimum sufficient set of typical processes of the LC, by which the LC of any system can be modeled.

Over time, the AAP-48 document has been strengthened by the introduction of the AAP-20 allied publication, which defines the requirements for management of the armaments program throughout LC of system, including accelerated fielding and the implementation of new technologies. The AAP-20 offers a single common framework for planning, implementing and controlling NATO armaments programs, with a focus on mitigating potential risks. The peculiarity of the publication is that in addition to the typical stages described in AAP-48, preconcept stage is introduced, which is connection between NATO Defense planning process and the armaments program.

Publications AAP-20 and AAP-48 can be considered as the main RGDs that regulate the process of development of armaments in NATO member countries based on international standards in systems and software engineering, in particular, ISO/IEC/IEEE 15288.

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COMPETITION ISSUES BETWEEN DICS OF THE USA AND EU, POSSIBILITY OF UKRAINE'S PARTICIPATION IN THE EUROPEAN ALLOCATION OF JOBS IN WME PRODUCTION

Companies of the Ukrainian DIC interact with the global defense industry that rapidly changes in the context of globalization. That is why it is a topical issue to analyze experience and trends of interaction and competition of defense industry complexes (DIC) of developed countries, particularly the USA and EU DICs and define directions of cooperation of Ukrainian and European defense industry companies in the global environment.

The main point of the transatlantic defense industry partnership (DIP) is constantly changing in line with political goals. In the 1950s and 1960s the cooperation of DIC of the USA and Western European countries was on the level of the licensed production of the US weapon systems in Western Europe; in 1970s, it was on the level of agreements on joint production of weapons and military equipment (WME); in 1980s and 1990s, it was on the level of joint interstate programs on WME development and production.

In the XXI century, processes of interaction and competition between the USA and EU DICs have become more actively influenced by global political, economic and scientific and technological changes in the conditions of DICs operation. Within the framework of interaction and competition between the USA and EU DIC, the following are formed today:

- a separate WME market and defense industry cooperation between the USA and Great Britain;
- EU-USA market (*except Great Britain*);
- continental and European market within the EU.

Global political, economic and scientific and technological changes in the conditions of DIC operation in the beginning of the XXI century have resulted in the reduction of defense orders on the political and economic levels and alteration of these orders structure for DIC companies. It has increased the competition between DIC of the USA and EU both in the context of weapon markets of the EU and global markets. Mergers and acquisitions in the defense industry have also fostered the competition between transnational corporations (TNC) of the USA and EU.

The rapid expansion based on scientific and technological progress of new knowledge has significantly changed the orientation and organization of the development of high-tech WMEs, including the interaction with scientific institutions of different countries. This has enhanced the engagement of high-tech companies. The change of industrial technologies in the conditions of small-scale production (*robotic industrial complexes, information technologies of designing and preparation of production*) has significantly changed the structure of DIC companies, especially of TNCs. They become interstate and highly diversified; this fact also enhances their interaction.

Characteristics of the US policy. Terrorist attacks in the USA in 2001 and change in focus of the US national security strategy had a significant impact on the interaction and competition policies of DICs of the USA and EU. Despite the abundance of declarations for the expansion of the transatlantic DIP and numerous initiatives to achieve this goal (*interoperability, enhancement of NATO capabilities, effective use of NATO resources, etc.*), the real outcome of the integration of the US and EU DICs is rather mediocre today. This has been predetermined by the following circumstances.

Access of military purpose products (MPP) to the US national market for foreign companies is as complicated as before, it is well protected from foreign supplies. The Department of Defense (DD) purchases products mainly from companies that manufacture MPPs in the USA. In addition, complex rules and procedures governing arms imports and exports are a major obstacle to the company-level cooperation.

The US political leadership and their armed forces are extremely negative about any dependency on foreign suppliers. In view of these sentiments, it is also difficult to create a political climate favorable to the defense-industrial cooperation between the USA and EU.

At the same time, the DD declares uniting of the US allied defense-industrial base with the aim of enhancing the compatibility of coalition forces during hostilities and reducing the DD spending on MPP procurement.

From the perspective of the Americans, the potential benefits of the transatlantic defense-industrial cooperation are, at best, strengthening of NATO unity and interoperability. Therefore, it is believed in the United States that the best way to achieve such goals within NATO is the purchase of the US arms by the EU countries.

Characteristics of the EU policy. Currently, EU countries do not have means to implement a strategy of the defense industry consolidated development. As a result, the Europeans are experiencing difficulties in forming general positions towards the USA and have critical views on the dependence on arms supplies from the USA, especially high-tech ones. At the same time, the access to the US market and to US technology as a whole in considered in the EU as attractive enough. In addition, EU countries are interested in interoperability as a prerequisite for strengthening the coalition within NATO. However, limited financial resources, national producers' own interests, and the difficulties associated with the organization of transatlantic productions significantly diminish the EU's interest in cooperation with the USA.

In the EU, even the major armaments countries cannot afford to have their own defense and industrial base for the production of the whole range of WME. With the exception of some technological niches, they need international cooperation for the development and production of high-tech weapons. Therefore, the EU leadership is taking more and more initiative regarding the development of the European defense industry and creation of a single MPP market. On the one hand, EU central bodies insist on opening up national defense markets of the EU member states to all European DIC companies with the elimination of the national protectionism in this area and introducing unified purchasing procedures. On the other hand, there are attempts to step up joint development and procurement of WME under the aegis of the EU.

The possibility of participation of defense industry companies of DIC of Ukraine in the European allocation of jobs in WME production.

Attraction of EU companies to the defense industry sector of economy should ensure solving issues of increasing competitiveness of the Ukrainian economy.

According to this task, the strategy of interaction of DIC companies of Ukraine with the EU companies should take into account the following rules:

- introduction of mechanisms of the strategic management planning in DIC companies of Ukroboronprom concern in line with the relevant measures of optimizing functions and structure of state power bodies, regulatory basis of their operation on DIC management;
- ensuring an acceptable investment climate on the basis of the Ukrainian legislation (*on intellectual property, on military and technical cooperation, on foreign investments in DIC company*) adaptation to the EU level for the attraction and operation of foreign EU companies in Ukraine;
- neutralization of threats of the activity of foreign companies within the frameworks of adherence to the economic safety of the state;
- ensuring competition on the world markets by means of creating our own highly diversified TNCs in the defense industry, as the US and EU countries have done, and develop co-operation on the basis of compensation agreements.

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ANALYSIS OF THE IMPACT OF THE DEVELOPMENT OF ARMS AND MILITARY EQUIPMENT ON THE LEVEL OF MILITARY SECURITY OF THE STATE, WAYS OF DETERMINATION OF IMPACT

The main task of the state's military security is to protect state sovereignty, territorial integrity, democratic constitutional order and other national interests of Ukraine from real and potential threats.

In the current conditions of hostilities, as well as in the development of the Armed Forces (hereinafter referred to as the AF), arms and military equipment (hereinafter referred to as the AME) play a major role. One of the prerequisites for the effective development of the AME is the formation and implementation of the state program for the development (hereinafter - the SPD) of the AME. The effectiveness of planning and implementation of the program can be evaluated by criteria, which in turn has an impact on the military security of the state (hereinafter - MSS). The methodology for evaluation of SPD AME is a different topic and in this publication it is not addressed.

In order to determine the impact of the development of AME, on the level of MSS was conducted the analysis of works and normative-legal acts, in which there was determined direct or indirect influence of scientifically-methodological devices on the level of military security of the state.

In the work “Military systems of remote monitoring of the surrounding space regarding moving objects: methodological aspects of substantiation of requirements” the author defined the general functional for the level of ensuring the military security of the state, consisting of five levels:

Realization of tasks to monitor threatening situations to national security in the military sphere;

Predicting the development of threats to national security in the military sphere;

Administrative decisions to protect the sovereignty of the state on the basis of current legislation and international law, including through the use of military force;

The fighting power (capability) of the security and defense sector of the state to deter and repel aggression;

The level of resources for military security of the state.

2. In the work “Methodological bases of the formation and implementation of the SPD AME on the basis of risk-oriented approaches” identifies the direct impact of scientific and methodological apparatus and organizational and technical measures on the overall level of military security of the state.

3. In the work “Methodological bases of substantiation of measures of development of the Armed Forces of Ukraine for maintenance of the given level for their fighting capacity” the author shows the need for resources for development of the Armed Forces of Ukraine, consisting of the following types of expenses:

- the development of AME;
- the creation of stocks;
- military infrastructure;
- training of personnel;
- training of the Armed Forces.

This work work shows that "the development of AME" is a component of the resource provision, which is one of the functionals of the level of ensuring the military security of the state.

4. The Law of Ukraine "About the National Security of Ukraine" sets out the main terms, composition and structure of all components that are related to related to the MSS.

The above mentioned analysis indicates that the impact of the development of AME on the level of MSS has a hierarchical structure. Accordingly, it is proposed to determine this impact as follows:

1) To form a hierarchical structure, where the lower level will be the development of AME (SPD AME), and the upper one - MSS.

2) At each level, identify the components that affect the level of MSS.

3) Choose a method for determining the quantitative assessment of the impact of the development of AME (SPD AME) on the level of MSS (it is advisable to apply the method of analysis of hierarchies).

4) Determine the indicator of the impact of the development of AME (SPD AME) on the level of MSS without applying the methodology of SPD AME and with its application.

Thus, this approach regarding determining the impact of the development of AME (SPD AME) on the level of MSS is new and has the following properties:

- taking into account a large number of components in determining the impact of the development of AME (SPD AME) on the level of MSS;
- quantitative end result;
- the reliability of the results obtained through the use of a formalized method of expert evaluation.

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THE ESSENCE OF A SYSTEM METHODOLOGY FOR THE PREDICTION (FORECASTING) AND RISK MANAGEMENT TO RESOLVE THE ISSUES OF THE ARMED FORCES OF UKRAINE

Revealing the essence of the systematic methodology of prediction (forecasting) and risk management (SMPRM), which is proposed for use in research at the Central Research Institute of Armaments and Military Equipment of the Armed Forces of Ukraine (Institute) it should be noted. Foresight, first of all technological, assumes the role of the most important methodology for innovative and socio-economic development of modern society, both at national or regional level, as well as at the level of individual industries or large organizations and companies. Preliminary analysis of the content and essence of SMPRM shows that it can be applied as a whole or in the form of individual elements in solving certain questions raised in research, as well as in practical activity in solving specific issues regarding the equipment of the Armed Forces of Ukraine. the model of Armaments and Military Equipment (AME) (development, mass production, modernization and acquisition, etc.), especially since this methodology uses many known methods of mathematical analysis.

This is encouraged by the practice of starting to use a prediction methodology in many countries, based primarily on the application of intuition, experience, knowledge, skills of experts in various subject areas to solve strategic planning and decision-making tasks. They apply a variety of practical techniques, but because of the novelty of this area, they are still characterized by underutilization of cybernetics, mathematics and modern information technology.

Prediction can be considered as a decision-making process for complex systems with human factors regarding their possible behavior in the future. Such a process involves the application of particular methods in a specific sequence with the establishment of clearly defined relationships between them. It is formed using a more universal methodology known as scenario analysis.

In the scenario analysis, as a methodological basis of prediction, the object of prediction is formally understood to be some complex system with a human factor, which can be a company, enterprise, industry or the country as a whole, uniting any social (human or any social) groups) with technological, environmental, economic and other components specific to such systems. Such a complex system is the Armed Forces of Ukraine, to predict the structure, composition, directions of their development and application, samples of AME, etc. in the distant future is required to solve the main directions of military-technical policy at the present stage.

However, some problems should be solved on the basis of systematic analysis methodology using known methods of quantitative analysis, combinatorial mathematics and simulation modeling, which allows to take into account the whole set of properties and characteristics of the studied objects.

It is important to note that the impact of the human factor on prediction results determines the significant subjectivity of this procedure. This is due to the combination of the prediction of both objective knowledge and subjective attitude of the person to the subject of study. Every expert involved in prediction expresses his or her opinion as a subjective assessment, but he / she should rely as much as possible on objective knowledge. At the same time, looking to the future implies the need to make certain assumptions, to be creative. The convergence of objective knowledge and creative assumptions of experts in the interactive human-machine procedure allows to increase the reliability and practical benefit of scenarios of development of the studied processes, phenomena and events.

The construction of such scenarios can be ensured through a universal set of tools and approaches, called the scenario analysis methodology, which is a set of mathematical, programmatic, logical and organizational tools and tools to determine the sequence of application of individual methods, the relationships between them and the formation of the prediction process itself.

In this methodology, eight methods of qualitative and quantitative analysis have been selected and adapted to solve prediction problems:

- scanning method;
- method of brainstorming;
- Delphi method;
- cross-impact method;
- Saati method (hierarchy analysis method);
- method of morphological analysis;
- scripting method;
- Bayesian model method.

These methods are used in four stages of prediction (forecasting):

1) preliminary study of the problem;
2) qualitative analysis of the problem;
3) writing scripts;
4) analysis and selection of scenarios.

In the first stage, they study the problem and the object of prediction (forecasting) using qualitative and quantitative analysis methods, after which qualitative and quantitative information is reduced to a single platform. Then determine the sequence of use of individual methods and establish relationships between them. This will further shape the holistic prediction process and develop a group of scenarios for the future behavior of the prediction object (a complex human-factor system).

Analyzing the characteristics and features of each scenario developed, a group of strategic decision makers selects the scenarios that are interesting to them, develops a plan of action for the object of prediction (forecasting) and ensures the implementation of this plan.

It should be added that, in solving the problems of prediction (approximation) close to reality, different methods of qualitative analysis are used at different stages in a single human-machine procedure. This should be done taking into account: the disadvantages and advantages of each method; the features of the system under study regarding the topology of the relationships between its internal elements; the nature of the information circulating in the system (quantitative or qualitative); the contradictions of the criteria on which many solve the problem; the degree of uncertainty of information and other aspects. Solving such problems is possible only by applying a systematic approach, taking into account the totality of properties and characteristics of the systems under study, as well as the peculiarities of methods and procedures used to create them.

The creative application of the proposed SMPRM as a working tool will, in our opinion, allow us to solve the complex problems of providing the Armed Forces of Ukraine with this or another model of AME.

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NEW PROTECTIVE COATINGS FOR PROTECTION OF STRUCTURES AND OBJECTS EXPLOITED UNDER SPECIFIC CONDITIONS

In order to obtain new technologies for the protection of various types' structures from destruction under the influence of biotic, abiotic, technogenic, as well as dynamic destructive factors of the environment, a method for obtaining polymer composite materials (PCM) based on polyurethanes (PU) of different composition and structure and epoxy polyurethanes (EpPU) for use them as multi-functional protective coatings has been developed.

PU based PCM with the ratio of BPU: LPU = (70-50): (30-50); PU based PCM with the content of organometallic modifiers (MeOM): NiOM, CuOM and ZnOM; PCM based on EpPU, modified PU, EpPU LPU_{100}, $EpPU/SPU_{70:30}$ with the content of modifiers NiOM, CuOM and ZnOM of (0,06-0,20%) and PCM with the use of renewable raw materials - castor oil (CO) based PU: PU_{CO} and EpPU/ PU_{CO}, PU_{CO}/MeOM (MeOM: NiOM, ZnOM and CuOM (0.6-3.0%)) have been created.

PU based PCM have high adhesion/cohesion indices of 29.0-36.5/40.0-43.6 MPa, respectively, and are characterized by high elasticity. The introduction into the PCM structure of the MeOM leads to the increase of their adhesion/cohesion properties up to 35.7-37.0 42.8-43.9 MPa.

The modification of EpPU with $BPU_{70:30}$ and LPU_{100} polyurethanes leads to the increase of adhesion/cohesion strength in 1.23/1.43 and 1.20/1.25 times, respectively, as compared to the original epoxy composition.

By adjusting the composition of the PCM, the EpPU compositions with a given hardening rate have been created; hardening rate is about: 2-5 hours.

PCMs based on LPU/BPU and EpPU and PCM with NiOM, CuOM, ZnOM modifiers are salt fog and saline solutions resistant, they are stable to the action of special reagents at low temperatures, as well as chemical, bio-, light and wear-resistant .

The index of waterproofness of concrete, w, is increased with application of protective coating on the basis of PCM from 4 to 12-15.

Protective non-slip coatings of two types - rigid and elastic for metal and concrete structures have been created on the basis of PCM (LPU/BPU). The coefficient of friction of sliding of such protective coatings is adjustable within the range of 0,5-0,9 (dry, moist, or oiled surface).

All samples of PU and EpPU based PCM comprising CuOM and ZnOM possess fungicidal properties in relation to the most active biodestructors, and their fungicidity is estimated with the highest score of 0 points.

The results of the study of the effect of complex atmospheric factor (UV and IR radiation, hight temperature and humidity) on the MAC have shown that all PCM samples are resistant to destructive factors.

The results of the salt mist and seawater effect study on the PCM stability have shown that all samples (metal and concrete) covered with PCM based on $BPU_{70/\ 30}$, PCM based on $BPU_{70/30}$/NiOM and PCM based on $BPU_{70/30}$/PNS (non-slip coating) after being kept in seawater for 60 days have no damage - there are no changes on the surface of the samples and coating.

Concrete elements protected by PCM based on $BPU_{70/30}$ and PCM based on $BPU_{70/30}$/NiOM, after 50 cycles of "freezing/defrosting" in seawater, have no damage, no changes on the surface of the samples and on the surface of the coating At the same time, unprotected concrete samples after 30 cycles of "freezing-defrosting" in seawater have collapsed.

The long-term (summer-autumn-winter-spring) stability tests under the atmospheric conditions of experimental protective PU-coatings and protective/ non-slip coatings on concrete (LDS-2, DP-410, Kiev civil aviation factory), as well as experimental PU and EpPU based protective coatings on the ferroconcrete pontoon dock (DKZ "Palada", Kherson, external beam fender) confirmed their high protective efficiency against destructive factors.

Long-term field trials of PCM as protective/non-slip coatings of concrete structures and protective (including fireproof) coatings of wooden constructions on the objects of the Ukrainian armed forces; rigid and elastic protective/non-slip coatings of metal constructions on the objects of the Ukrainian Navy Armed Forces have begun (July).

On the basis of EpPU, together with the scientists of the ISC NASU, a corrosion-resistant nanocomposite radio-absorbing coating was created, which provides effective protection of objects from electromagnetic radiation. The absorption of radiation in the range of 25-38 GHz is 8-16 dB.

The use of the PCMs as: 1) multifunctional protective coatings of surfaces and different types' objects and configurations: decks and superstructures of ships and / or ferroconcrete pontoons and metal towers of floating docks, which have high adhesion, operating parameters and non-slip properties;

2) special protective coatings for metal, ferroconcrete and others surfaces guarantees: a) reliable prolonged operation of metal, ferroconcrete and wooden constructions, buildings and structures in the conditions of dynamic, abiotic, biotic and technogenic loads; б) safe operation of the objects under specific operating conditions; b) the practical exclusion of the destruction of protected concrete surfaces from the changing effect of positive and negative temperatures and the

duration of their operation, and d) in general, increasing the safety and operation life of structures and objects.

The organization of PCM is possible on active (or reconstructed) chemical production using standard chemical equipment.

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ARTIFICIAL INTELLIGENCE AS THE BASIS OF FUTURE CONTROL NETWORKS

The implementation of Artificial Intelligence (AI) is an important trend in the development of battlefield and weapons control systems. NATO experts use two alternative definitions of artificial intelligence (NIAG StudyGroup SG-238 "GBAD Operations against the 21st Century Peer Nation Cruise Missile and Unmanned Aerial Systems (UAS)"):

"AI is the capability provided by algorithms of selecting optimal or sub-optimal choices from a wide possibility space, in order to achieve goals by applying strategies which can include learning or adapting to the environment";

"Artificial intelligence (AI) refers to systems designed by humans that, given a complex goal, act in the physical or digital world by perceiving their environment, interpreting the collected structured or unstructured data, reasoning on the knowledge derived from this data and deciding the best action(s) to take (according to pre-defined parameters) to achieve the given goal. AI systems can also be designed to learn to adapt their behavior by analyzing how the environment is affected by their previous actions".

As a scientific discipline AI includes several approaches and techniques, such as:

machine learning (deep learning and reinforcement learning),

machine reasoning (planning, scheduling, knowledge representation and reasoning, search, and optimization),

robotics (control, perception, sensors and actuators, as well as the integration of all other techniques into cyber-physical systems).

AI is useful in particular with respect to Human resources & manning requirements: making (heterogeneous) systems work together; data exchange; command coordination; target allocation (also between nations); working with fewer resources; taking the man on/over the loop; coordination of sensors and effectors; threat detection and identification; semi-autonomous weapon allocation; improving timeliness (fast threat, pop up, numerous threat); derivation of intent, situational awareness and evaluation.

The main applications of Artificial Intelligence and Machine Learning are to enhance C2, Communications, Sensors, Integration and Interoperability.

On the basis of Artificial Intelligence (AI) and Machine Learning (ML) with Microsoft Common Objects in Context (MS-COCO) or Limpid Armor Inc.

(Ukraine) technologies the Synthesis of Augmented Reality Symbols can be provided. It enables target acquisition, targeting of moving targets (single or swarm), coordination and deconfliction of distributed Join Fires between networked combat vehicles, tanks, ships etc. also inside Manned and Unmanned Teams (MUM-T).

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ACTUALIZATION OF THE TASK OF CREATING A LIFECYCLE MANAGEMENT SYSTEM FOR ARMAMENTS AND MILITARY EQUIPMENT IN UKRAINE

The need to create a lifecycle management system for armaments and military equipment (LCMS AME) in Ukraine is due to several factors, and, first of all, the imperfection of the existing lifecycle management system for AME. There are several aspects here. Admitting to the troops in the process of rearmament of the army and navy modern high-tech equipment should be maintained in constant readiness for its intended purpose. This is especially true when performing time-consuming, medium, major and major overhaul with modernization. These types of repair are capable of performing only organizations - manufacturers of defense-industrial complex (DIC).

Another, equally important aspect is the lifetime of the equipment. For a large part of the AME it is ten years. They may undergo several upgrades during this period. This will save considerable money on the purchase of new samples. And without serious logistical support from DIC organizations, this task is impossible.

The main disadvantages of the current LCMS AME are the following:

the main contractors for the creation, production, repair of products are responsible for the quality of work only within a separate stage of the life cycle. At the same time, the work performed at different stages of the lifecycle products remains weakly interdependent, and the overall goal of control for the entire lifecycle is not fully achieved;

there is no effective mechanism for engaging industry to perform maintenance and repair work;

the participants of the lifecycle products are not provided with complete and up-to-date information about the lifecycle, first of all, information about the actual indicators of reliability, readiness, consumption of resources, costs of the lifecycle;

continuous monitoring of the values of the tactical and technical characteristics of the products, the value costs of the lifecycle, from designing the product to its decommissioning, is not provided;

insufficiently used methods of assessing the impact of technical decisions made on the stage of development on cost of full lifecycle products, their readiness and quality;

imperfection of normative, methodological and informational support of lifecycle for AME. Informational and methodological inconsistency and discontinuity of processes and works of different stages of the lifecycle of samples of AME arises due to the large number of participants in the life cycle, the diversity of their work, the decisions made and the methods and information used. As a result, decision-makers are unable to fully evaluate and take into account the impact of the decisions made on the results of work carried out at other stages of the life cycle of the created AME samples while managing their quality and effectiveness. All this with weak through-through life cycle of coordination of works on creation and operation of samples of AME with variety and heterogeneity of systems of management of these processes and works of different participants of lifecycle leads to imbalance, and most often to inconsistency of the made decisions on choice of technical decisions. and technological solutions for the construction of samples, etc.

As a result, these drawbacks of the lifecycle management system lead to a decrease in the quality of all works of the full lifecycle of AME samples, which are manifested as an increase in the duration of the work at the stages of the lifecycle, an increase in the cost of their creation and operation, as well as a decrease in the efficiency of their use.

An important incentive for the creation of LCMS AME is the positive foreign experience of implementing such systems (built using information technology, commonly known as CALS or PLM technology). First of all, this concerns the application of a mixed approach to the division of responsibilities between industrial enterprises and staffing units of the Ministry of Defense to maintain the proper condition of new samples of AME and those in service. Overseas experience in the distribution of responsibilities between AME operators and industry organizations shows that the goal of improving the lifecycle management system is to reduce the cost of servicing the AME and to increase its combat capability.

CALS technologies have been widely developed in the defense industry and the military and technical infrastructure of the US Department of Defense. According to the available data, this allowed to accelerate the implementation of research and development by 30-40%, reduce the cost of purchasing military products by 30%, reduce the time of purchase of the maintenance facilities by 22%, as well as reduce the time for project adjustments by 9 times.

In addition, the US Department of Defense is actively implementing an end-to-end service support mechanism. The contractor serves AME throughout the lifecycle. And the object of the contract with the operator is not deliveries and work, but the end result of service support is to ensure the combat capability of the systems in service. That is, the subject of such agreements were not the specific spare parts, materials or services, but the normalized indicators of the end result of service support - serviceability, reliability, economy in operation, downtime of military equipment in the troops. The calculations of military analysts at the US Department of Defense show that the widespread use of such a concept is potentially capable of delivering $ 10 billion to $ 20 billion in budget savings per year.

Finally, the need to provide after-sales service for exported military-grade products (MGP) is another important impetus for the creation of a lifecycle management system. Foreign customers make the same requirements for Ukrainian products as for similar products of foreign companies. One of these requirements is the provision of integrated logistical support (ILS) of the supplied MGP (the ILS is aimed at reducing costs at the post-production stages of the lifecycle and ensuring the specified operational and technical characteristics of the product). For this reason, export-oriented enterprises of the defense industry, when delivering military products to foreign customers, must develop plans for ILS and make appropriate proposals. ILS is one of the most important technologies in the life cycle management system, which provides MGP support at the post-production stages of the lifecycle down to disposal, including the fulfillment of warranty obligations, routine repairs and maintenance. This allows, in a competitive environment, to establish closer and more trusting relationships with suppliers and customers, to increase the level of its own operational efficiency and, as a consequence, to ensure the competitiveness of its products.

Creating a full life cycle management system should address the issues that exist first and foremost during the operation phase of the AME. In turn, this will allow you to reach the specified levels of technical readiness for armaments. After all, faulty state-of-the-art equipment cannot ensure the readiness of troops (forces) to use. The system will also ensure the rational use of budgetary resources allocated for the development, procurement, operation and utilization of AME by accounting and coordinating the interests of all participants in the full lifecycle.

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CHANGES IN UKRAINE'S POSITION ON THE WORLD ARMS MARKET

Military-technical cooperation (MTC) is one of the components of our country's foreign economic policy and is designed to maintain at the required level the export potential of the defense-industrial complex (DIC) of Ukraine, to promote the development of its scientific, technical and experimental base, to ensure the flow of foreign currency needed for state funds needs and development of defense industries.

The supply of arms and military equipment to foreign markets over the past two decades has contributed not only to the inflow of foreign exchange earnings into Ukraine, but also to the preservation and technological development of the DIC sector. Important for Ukraine is the provision of services and the implementation of the repair and modernization of armaments and military equipment (AME).

Following the launch of the Donbas Anti-Terrorist Operation in April 2014, the implementation of international arms sales contracts has come to the fore. The main task for her was to ensure the fighting ability of the Ukrainian army. However, arms contracts are an important part of income for the country's defense industry and the state budget, as the portfolio of international contracts provides the national economy with millions of dollars of much needed foreign exchange earnings.

An analysis of data from the Stockholm Institute for the Study of the Problems of the World (SIPRI) shows that Ukraine is one of the major suppliers of military products to the global arms market. For the period from 2012 to 2016, Ukraine ranked 9th among the arms exporting countries, and for the period 2008-2012 - 4th. In 2013-2017, Ukraine ranked 11th among arms suppliers, providing 1.7% of the global arms market. In the period from 2013 to 2017, arms deliveries from Ukraine decreased by 26% compared to the previous five-year period. It should be noted that the country's share in world arms exports in 2010-2014 was at the level of 3% and 2.6% in 2011-2015 and 2012-2016 respectively.

Ukraine supplies military and dual-use goods to 80 countries in all regions of the world. In general, the main countries to which Ukraine exports arms are those in Africa, the Middle East, the CIS and Asia. The main potential buyers of Ukrainian weapons are China, India, Saudi Arabia, Kazakhstan, Azerbaijan, Pakistan and several African countries - Algeria, Egypt, Angola, Nigeria, Zambia, Ethiopia.

In most cases, the main items of Ukrainian arms exports were the sale of weapons (developed in the USSR), withdrawn from the Armed Forces of Ukraine, repair of Soviet-made equipment for countries-buyers of this equipment, and the sale of components to Russian factories, although there were new samples (tanks "Oplot", armored personnel carriers BTR-3 and BTR-4 in various modifications).

It should be noted that, although Ukraine remains one of the largest exporters of SIPRI weapons, the country has in recent years begun to lose ground in foreign markets. This is evident from the decline in annual revenue from $ 1.344 billion in 2012 to $ 589 million in 2013, $ 664 million in 2014, $ 323 million in 2015 and $ 528 million in 2016. Ukrainian manufacturers of PVP also lost their position in the global arms market: in 2014, compared to 2013, Ukroboronprom dropped from 58th to 92nd position in the list of the 100 largest world companies in terms of AME sales in the world (in 2015 compared to the previous year rose to 81st position - its share in total arms sales of the 100 largest companies in the world is only 0.2%), and the engine manufacturer for military aircraft "Motor Sich" and completely dropped out of this list.

In addition, the narrowing of the geography of arms supply becomes noticeable. Thus, in 2014, Ukraine virtually ceased to supply military equipment to the ancient partner countries: Azerbaijan, Iraq, Sudan and Russia, etc.

Due to the significant deterioration of Ukraine-Russia interstate relations following the 2014 accession of the Crimea to the Russian Federation and the launch of an anti-terrorist operation in eastern Ukraine, the participating companies of the Ukroboronprom concern have suspended the shipment of military supplies to the Russian Federation since March 2014. According to Presidential Decree No 691/2014 of 27.08.2014 on the Enforcement of the National Security and Defense Council of Ukraine Decision on Measures to Improve the State Emergency Service, the export to the Russian Federation of military goods and dual-use goods for the purpose of their military end-use with the exception of space technology has been stopped , which is used for the exploration and use of space for peaceful purposes in the framework of international space projects. On May 20, 2015, the Cabinet of Ministers of Ukraine approved a resolution terminating the agreement between the governments of the Russian Federation and Ukraine on military-technical cooperation (the intergovernmental agreement on military-technical cooperation between the Russian Federation and Ukraine was signed in 1993), and a resolution of August 26, 2015 No. 632 terminated the agreement between the Government of Ukraine and the Government of the Russian Federation on production and scientific and technical cooperation of enterprises of the defense industry, concluded on November 18, 1993 in Moscow.

Similar decisions were made in Russia.

Such decisions of the leaderships of both countries, as well as the focus of the defense industry of Ukraine on solving the priority tasks of equipping the Armed Forces of the Armed Forces of Ukraine, have led to an additional reduction of the export activity of the state in the world arms market (according to SIPRI-2015 only deliveries of AME to Russia annually amounted to 500 million), the intensification of the policy of import substitution of Russian AME and the policy of import of foreign-made AME.

The focus of the domestic defense corps on ensuring the fighting capacity of its own army has led to a serious lag in the implementation of contracts already performed. Thus, only in the middle of 2018, a large contract for the supply of tanks "Oplot" main battle tanks for the total amount of $ 247 million was completed (with a delay of three years).

The prospects for continued cooperation with Pakistan are not clear. Although it continues to purchase a small number of engine-transmission units based on 6TD-2 diesel engines manufactured by the State Enterprise named after V. Malyshev Plant for Al-Khalid tanks (for the whole of 2018 - a total of nine pieces worth 3.03 million dollars), at the same time set up its own repair base of T-80UDs purchased in Ukraine, for the modernization of which it attracted Russia. And all this, despite a similar contract signed in 2017 with Ukraine, which has not yet come into force.

As a whole, services in repair and modernization of military equipment, as well as the supply of spare parts and components make up about 75% of total exports of military products.

According to the State Export Control Service of July 11 In 2018, at that time, Ukraine was executing about 40 contracts, reducing exports of military equipment by 71%.

An important trend in the export-import policy of Ukraine was the annual progressive growth in imports of military and dual-use items. If by 2014, the import component was ten percent, then by 2017–2018, imports had reached 20% or more.

Thus, at present, in the field of military and technical cooperation, Ukraine is in a state where imports are increasing and exports are falling.

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ON THE CONCEPTUAL APPARATUS IN THE FIELD OF MILITARY-TECHNICAL POLICY

An important role in the study of methodological problems of military-technical policy (MTP) plays the problem of accurately defining the concept of "military-technical policy of the state". Despite the large number of publications on the subject, this problem is still not fully resolved and remains relevant.

The analysis of the definitions of military-technical policy in numerous publications allows us to draw the following conclusions:

definition of military-technical policy, as a rule, is associated with its focus on the technical equipment of the Armed Forces, which, while emphasizing the main in its content, but violates its unity and integrity (the need to take into account the interests of all military formations of the security and defense sector of the state), and also diminishes its status as an important component of a state's military policy, in the preparation and implementation of which the decisive role must be vested in public authorities;

definitions of military-technical policy are distinguished from the structure of the MTP and consider separately its most important component as "military-industrial policy";

military-technical policy is seen as an element (subsystem) of other systems, which also reduces its status, while substituting the concept of influence of these systems on military-technical policy by its structural subordination;

definitions of MTP contain logical and meaningful errors: it is defined through other concepts that themselves require definition. The definition is given by scientific phrases that not only do not explain the essence of military-technical policy, but on the contrary, further confuse it.

When defining the concept of "military-technical policy" it is necessary to consider:

1. The nature of military-technical policy is influenced by measures carried out within the framework of socio-economic, scientific-technical, industrial policy, etc. In turn, measures taken within the framework of military-technical policy affect other spheres of public life.

2. Military-technical policy is an important direction of the general policy of the state for ensuring national security and is in dialectical relation with other components of the unified state policy, which, in particular, is manifested in the following:

quantitative and qualitative composition of armaments and military equipment (AMT), created during the implementation of programs of development of the weapons system within the framework of military-technical policy, on the one hand, is determined by the economic capabilities of the state, accumulated scientific-technical and production and technological potentials of industry, on the other - affects the volume of exports of military products and the implementation of programs of socio-economic development of the state;

the policy of placing the State Defense Order, which implements the adopted programs of development of the weapons system, at the enterprises of the defense-industrial complex in the regions directly affects their socio-economic status. Conversely, the regions, by ensuring the efficient operation of defense enterprises, contribute to the implementation of the military-technical policy of the state;

arms and military equipment created in the course of the implementation of military-technical policy, delivered to other countries in the framework of military-technical cooperation with foreign countries, directly affect the effectiveness of the foreign policy of the state.

3. The definition of military-technical policy must be properly constructed. It should consist of the following elements: a definite concept, a generic trait - a quality that combines the traits of related phenomena, and species differences.

In view of the foregoing, the conceptual definition of the term "**military-technical policy**" can be formulated as follows:

military-technical policy - a system of official views and activities of state authorities related to the solution of scientific, technical, technological and organizational issues of the development of armaments and military equipment, equipping them with armed forces and other military formations, maintaining the military-combat armament and military-technical cooperation with foreign countries.

In this definition, "military-technical policy" is a defined concept; "the system of official views and activities of public authorities ..." is a generic feature; "... related to the solution of scientific, technical, technological and organizational issues of the development of armaments and military equipment ..." - a kind of difference.

The definition of a military-technical policy in a concentrated form contains the basic conceptual provisions of this policy: purpose, content, goal and objectives.

The main purpose of military-technical policy is the development and implementation of measures to support and develop the technical component of the country's defense potential and its rational use in the interests of technical security of the state.

The content of military-technical policy is the activity of state authorities, aimed at comprehensive, coordinated by goals, tasks, resources and terms of solving problems of equipping the Armed Forces and other military formations with armaments and military equipment.

The main goal of the state's military-technical policy is to equip the Armed Forces and other military formations with armaments and military equipment to perform their assigned functions.

The main tasks of military-technical policy in modern conditions are:

creation of a rational weapon system of the Armed Forces of Ukraine;

support for existing armaments and military equipment in a capable state;

ensuring the development, production and supply of samples of armaments and military equipment necessary for the Armed Forces of Ukraine and other military formations taking into account the economic capabilities of the state,

prevention of scientific, technical and technological backwardness from the developed countries of the world in the main directions of AME;

preservation and development of the scientific, technical and production potential of the defense industry for the creation and production of new samples of AME, modernization of morally outdated samples of AME;

formation of scientific and technical achievements in the field of basic and critical technologies, including dual-purpose technologies;

ensuring the required level of mobilization readiness and creating conditions for mobilization of the AME output;

ensuring the development of interstate military-technical cooperation.

The formation of the military-technical policy of the state should be based on the following basic ***principles***:

unity and integrity of military-technical policy for all military formations of the security and defense sector of the state;

compliance of the military-technical policy with the strategic goals of the state's security and defense sector;

adaptability of military-technical policy to the dynamically changing situation in the world;

the complexity of solving problems of military-technical policy;

development of scientific, technical and technological base due to the need to use the latest scientific achievements in creating new models of armaments and military equipment;

conformity of MTP to the economic capabilities of the state;

economic feasibility and efficient use of material resources provided for defense purposes;

the rejection of rivalry in all aspects of military confrontation and the selection of such vulnerable links of the enemy's military mechanism, the break of which should lead to its general depreciation (the principle of "asymmetry").

Military-technical policy should be one of the priority directions of the general policy of the state. Without the perfect technical equipment of the military formations, its security and defense sector will not be able to effectively and fully fulfill the defense's mission and ensure its military security, implement a strategy of deterring potential aggressors and successfully counter the military threats.

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ON CREATION OF MONITORING SYSTEM OF MILITARY-TECHNICAL POLICY OF UKRAINE

Formation of military-technical policy (MTP), creation of an effective, balanced, economically and technically implemented system of weaponry of the security and defense sector of the state, involves, first of all, development of reasonable normative documents regulating the development of arms and military equipment (AME), aimed at maximum adapting to modern realities, ensuring a coherent and clear interconnection of long-term (long-term), medium-term and short-term (current) planning for the development of weapons systems. In Ukraine, the basic regulatory framework for planning the development of AME is already created: it contains both newly developed documents in the field of defense planning and part of the normative acts of the former Soviet Union, first of all, a system of state standards for the development and production of samples (complexes, systems) AME.

At the same time, such sphere of management activity in the field of MTP implementation as monitoring, that is, continuous monitoring of the processes occurring in the MTP system, their analysis, forecasting, preparation and decision-making, is not only not covered by the proper legal support, but also does not have structures in place to deal with these tasks.

The absence of a monitoring system leads to the fact that management decisions in the military and technical sphere are usually taken without a comprehensive analysis of the influence of the determining factors on the MTP, proper scientific substantiation, mainly in the "manual" mode (that is to say, administrative-volitional methods), decision makers are not always sufficiently competent.

The necessity to set up a monitoring system is indicated in the recently adopted regulatory acts:

in item 4.2 of the National Security Strategy, approved by the Decree of the President of Ukraine of May 26, 2015 No. 287/2015, stated the need to ensure "***creation of a unified system for monitoring***, analysis, forecasting and decision-making in the field of national security and defense";

in the Matrix of achievement of strategic goals and fulfillment of the main tasks of the defense reform of the Strategic Defense Bulletin, approved by the Decree of the President of Ukraine of June 6, 2016 No. 240/2016, is identified as one of the main objectives of the defense reform "Objective 2.2.2. ***Creation of the process systematic monitoring*** and state programs (plans) for the development of the defense forces ". And an indicator of the realization of this task is the creation of a working body with the functions of monitoring and evaluating the implementation of state programs (plans) for the development of the defense forces with a deadline of 2017;

in item 2 of Section III of the Concept of Development of the Security and Defense Sector of Ukraine, approved by the Decree of the President of Ukraine of March 14, 2016 No. 92/2016, one of the main ways of achieving the necessary operational and other capabilities of the components of the security and defense sector is defined "***creation of a monitoring system***, analysis, forecasting, modeling and decision support in national security and defense. "

The purpose of creating a system of state monitoring of the MTP is to ensure the collection, processing, storage and analysis of information on the state of military-technical policy, to forecast its changes and to develop scientifically sound proposals and recommendations for making appropriate effective management decisions. Monitoring of the state of military-technical policy should be carried out by specially authorized state bodies, as well as by enterprises, institutions and organizations whose activity is connected with the development, implementation and timely adjustment of measures on the issues of MTP. Specially authorized state bodies, together with relevant scientific institutions, should provide for the organization and monitoring of long-, medium- and short-term prognosis of MTP development, which should be taken into account when developing and implementing appropriate programs and activities in the MTP area.

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SCIENTIFIC AND METHODOLOGICAL APPARATUS FOR RISK MANAGEMENT IN THE DEVELOPMENT, MANUFACTURING, AND PURCHASE OF NEW (MODERNIZED) SAMPLES OF ARMAMENTS AND MILITARY EQUIPMENT

In today's context, the problem of providing the Armed Forces (AF) of Ukraine with modern models of Armaments and military equipment (AME) is increasingly exacerbated. The processes of development, production for batch production and saturation of troops with the latest and modernized AME samples are not only long-term (from 5 to 15-20 years, depending on the complexity of the AME sample), but also have many obstacles in the way of their successful implementation "thanks to" the emergence during this time of numerous negative circumstances and phenomena (challenges, uncertainties, unpredictability, obstacles, dangers, crises, catastrophes, insecurities, uncertainties, contingencies, etc.) that have both subjective and objective nature. These negative circumstances and phenomena, which are sometimes difficult enough to predict, confuse AME contractors in making a responsible decision, or refuse to start or continue planned work, or take on certain risks, overcoming the negative consequences of which, if they occur in different situations. the stages and stages of the life cycle of a newly created (upgraded or purchased on import) sample of AME, when a relevant real threat is identified, or if real prerequisites are identified.

However, based on the analysis of numerous publications on the topic of risk theory, it is possible to make some generalizations and provide some modified interpretation of the terms "threat" and "risk", which, in our opinion, more accurately reflect their meaning, based on the topic of research (R&D) “Controlling”, which is being started at the Central Research Institute AME of the Armed Forces.

Threat - possible problem with a task that can lead to negative consequences when performing any work, in its various possible variants.

Risk is a value that characterizes the possible losses (financial, temporal and other) in the performance of any work due to the impact of foreseeable and unforeseen negative circumstances and phenomena. This is the most important thing - before starting work on solving the issue of equipping the Armed Forces of Ukraine with the required model of military-industrial complex, to predict the probability of occurrence of the widest possible range of negative circumstances and phenomena and the possible threats created by them during the implementation of the planned project, to calculate (predict, predict, etc.) their possible impact develop counteraction measures to minimize risks.

Based on these considerations, as well as on the fulfillment of one of the main tasks of R&D “Controlling”, which is to develop directions for improving the effectiveness of decision-making in the creation and procurement of modern AME samples and the formulation of measures of state AME development programs, taking into account the risks of their implementation. the scheme and content of the scientific and methodological apparatus (SMA) to conduct research on risk assessment and management in the development, production and procurement of new (modernized) samples of AME. This SMA, after its detailed specification, is intended to be used during the research in the interests of this R&D, as well as in the practical activities of relevant public administration bodies involved in the development and implementation of military-technical policy of Ukraine, in making specific decisions on the feasibility of equipping the Armed Forces of Ukraine with one or another required sample of AME.

Without going into detail in the analysis of this SMA (this is expected to be done in further studies and publications on this topic), it should be noted that its overall content is to perform a series of works in parallel, which include:

- selection, systematization, analysis and critical generalization of scientific, technical, regulatory and military-scientific literature on the subject of research in order to evaluate the possibility of application, in the development of recommendations on research and development, basic principles of risk theory and management;
- analysis and generalization of existing methodological approaches to the assessment and management of risks arising from the development, production and procurement of new (modernized) samples of AME in Ukraine and other countries of the world;
- development, on the basis of analysis and generalizations, of improved SMA assessment and risk management in the development, production and procurement of new (modernized) samples of AME;
- development of a recommendation to increase the effectiveness of decision-making in the creation and purchase of modern samples of AME and to formulate measures of state programs of AME development taking into account the risks of their implementation, etc.

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NEED FOR THE PROVISION AND FORECAST OF THE RISKS INFLUENCE OF THE NEGATIVE CIRCUMSTANCES AND THE EVENTS UNDER THE TIME OF THE DEVELOPMENT, MANUFACTURING, AND PURCHASE OF NEW (MODERNIZED) SAMPLES OF ARMAMENTS AND MILITARY EQUIPMENT

Analyzing the possible ways of providing the Armed Forces (AF) of Ukraine with various samples of Armaments and Military Equipment (AME) and the structure of their life cycles (LC), their individual stages, we can conclude that the main purpose of work on improving the technical equipment of the AF is to create a new a (modernized) AME sample or purchase it on imports that have high tactical and technical characteristics and combat capabilities, within a fixed (short) timeframe and with the lowest labor and material costs.

There are several components to achieving this:

- experienced staff of scientists, designers, technologists, workers, who will work on the creation, serial production and organization of operation (combat use) of this sample AME;
- material resources for creation and batch production of this sample of AME in the required nomenclature and volumes, their uninterrupted supply at all stages of the LC of the AME sample;
- the industrial base required to ensure the processes of creation, batch production and operation of this sample of AME;
- uninterrupted provision of processes for creation, batch production and operation of this sample of AME with financial resources;
- in case of purchase of sample of AME on import - uninterrupted supply (purchase abroad, organization of production on domestic industrial base, etc.) necessary for its operation (combat use) and repair of materials, components, equipment, etc., as well as financing of these processes in the required volume .

All this, at one stage or another, can be hindered by negative circumstances and phenomena that will pose a threat to the accomplishment of the tasks.

In general, emerging threats can cause:

- to the total failure to meet the tasks set for the creation of a new (modernized) sample of AME;
- to create a sample of military and technical equipment with combat and technical characteristics, which will differ for the worse from the set tactical-technical task;
- prior to the creation of an AME sample, the cost of which (in batch production and operation) is much higher than previously calculated (estimated);
- to delay the creation, organization of mass production of a new (modernized) sample of AME and provide it with the Armed Forces of Ukraine;
- the same thing - with excessive use of funds, which leads to a rise in the price of the sample of AME and delay the timing of its equipment.

Therefore, when justifying the need to create a new (modernized) sample of AME at the enterprises of the domestic industrial complex, or to purchase it on import, all possible negative circumstances and phenomena that may arise during the implementation of works at all stages and stages should be anticipated (predicted). its LCs, evaluate (calculate) the possible threats and risks and their consequences, outline possible ways of neutralizing or eliminating them, and only then, taking into account all circumstances, make a responsible decision to start (continue ting) works with this equipment AP weapons and equipment for the various possible options for its delivery (receipt).

Thus, preliminary calculations of threats and risks and their possible manifestations and negative impacts should be carried out during the R&D on the justification of the need and concept of this sample of AME, and specified during the conduct (completion) of the R&D for the creation and carrying out tests of test specimens of AME of the desired type (type). These revised calculations of possible threats and risks should relate to the decision on the feasibility (military and economic feasibility) of adopting a created sample of AME for arming the Armed Forces and organizing its mass production.

At the same time, the set of possible negative circumstances and phenomena, the degree of their influence on the military and economic indicators of creation, mass production (acquisition by import, etc.), operation (combat use), and accordingly - on the magnitude of possible threats and risks, should be individual for each type and type of sample AME, for each possible source of its receipt for the equipment of the AF, as well as for each stage of the LC.

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FORESIGHT FOR THE SELECTION OF CRITICAL TECHNOLOGIES

The implementation of scientific research in all areas requires considerable cost, which is why the governments of the countries concentrate their efforts on the development of the most important, key scientific areas and technologies - critical technologies (CT). The main tool for CT detection is predictive research, better known in foreign practice as foresight.

The first countries to use foresight, as a tool of development , were Japan and USA. In the early 1970s, the Delphi method was used in Japan to predict scientific and technological directions. After that other countries have also started this process. The number of publications has followed the trend of significant popularity of these topics since the early 1990s, and then since the 2000s.

Analyzing the works of both Ukrainian and foreign scientists, the rating of the foresight methods, which were the most often used for scientific and technological forecasting, was determined.

1. Delphi
2. SWAT analysis
3. Expert panels
4. Scenarios, roadmaps and modeling
5. Bibliometric analysis
6. Conferences, seminars
7. Brainstorm
8. Patent analysis
9. Interviews

10. Benchmarking.

Experts agree that there is no universal foresight methodology, a combination of 5-6 methods (out of the 33 most popular) is enough for qualitative foresight.

The analysis showed that methods such as benchmarking, surveys, brainstorming, roadmaps and scenarios, conferences and seminars, SWOT analysis do not meet the established requirements.

The Delphi and Expert panels methods are the most appropriate for the technological foresight. But, the use of only expert methods is not possible, because the expert estimates have a some mistake. For qualitative foresight, it is suggested to combine statistical and expert methods (Delphi, expert panels, bibliometrics and patent analysis).

Statistical methods are the most objective and they can indicate the trends, but their use is excluded, if it is not a lot of statistics.

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THE METHOD OF CRITICAL TECHNOLOGIES

In 2019, the critical technologies (CT) list in the defense sphere of Ukraine will be updated, which essentially means carrying out a Foresight project. The authors propose a method of critical technologies that takes into account not only the global trends of Foresight, but also the specifics of Ukraine's defense sphere.

At the first stage, the organizers of the survey form an expert commission, which consists of the most qualified specialists. The majority of votes should be provided by the scientific community, which is specializing in the development and research of advanced technologies. It is proposed that 40% of experts choose from the research institutions of the Ministry of Defense of Ukraine, 30% - from the National Academy of Sciences of Ukraine.

Representatives of the defense industry enterprises - 15%. The purpose of a business is to make a profit, not to create quality products, so objectivity of experts can be questionable. However, we cannot ignore their votes, their enterprises will implement CT into the industry and only experts from the defense industry have information about the developments that are already underway and promising.

The Defense Ministry experts, as the main customer, will be able to correct the CT list according to their votes - 10%. The representatives of the Ministry of Economic Development, whose part is 5%, will evaluate the possibility of dual use of technologies by civil enterprises.

Then the organizers form a questionnaire.

The second stage (basic) includes two levels of expert interviews, patent and bibliometric analysis and results processing.

Questionnaires are sent to experts and they can adjust the list of technologies and criteria.

After assessment the survey results, the organizers form a second level questionnaire. New criteria and technologies are taken into account, if more than 20% of the respondents proposed them to be included in the list, and vice versa excluded, if more than 50% of experts voted for it.

The organizers form tables of paired comparisons (Saati method). CT are distributed in scientific directions (thematic groups). The matrix of paired comparisons should not exceed size 15x15.

The questionnaires are sent again to experts, who evaluate the importance of the criteria and the criticality of the technologies.

The results of the second iteration give us a preliminary CT ranking. Analytical group conducts patent and bibliometric analysis for each CT. In order to follow trends, the analysis should be conducted for a period of at least 8-10 years. The statistics help us to calculate the additional coefficients (Kp and Kb), that characterize the dynamics of the development of CT.

The priority coefficient (obtained by the Saati method) and statistical coefficients are multiplying, so we get a final CT ranking.

The third stage (final). The ranked CT list is submitted to an expert commission to discuss. After, the list is submitted for approval to the Cabinet of Ministers of Ukraine.

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GLOBAL SCIENTIFIC AND TECHNOLOGICAL TRENDS IN DEVELOPMENT OF ARMAMENTS AND MILITARY EQUIPMENT

The latest technologies are a fundamental factor in the socio-economic changes in the country and its security and defense. Modern innovations in robotics, autonomous systems, information and cognitive technologies, nano and biotechnology, materials science and quantum computing will trigger social transformations worldwide.

In addition, important areas of global technological trends are artificial intelligence with the Internet of Things, blockchain and machine learning, 3D printing, new methods of energy storage and use, and 5G. These technologies will have the most significant impact on the future of Europe and the world. They will form the basis of the "Fourth Industrial Revolution".

The fourth industrial (technological) revolution is characterized by the penetration of nano-bio-info-cognitive (NBIC) technologies into virtually every sphere of human life through the introduction of cyber-physical complexes.

The Cyber-Physical Complex (CPC) is a kind of mechanism that is controlled or tracked by computer algorithms and is closely linked to the Internet. In CPC, software is closely related to physical objects. CPC components interact at different temporal and spatial levels and may have different, distinct behaviors and interact with each other in different ways that may vary depending on the context.

Examples of cyber-physical complexes include smart power systems, unmanned aerial vehicle systems, automated control systems, robotic systems, self-propelled aircraft, and the like.

The fourth industrial (technological) revolution is based on the following principles:

interoperability of human and machine, possibility of direct contacts between them via the Internet;

translating into the machine a wide range of functions and tasks that pose a risk to humans;

the ability of the machine to independently and autonomously make the necessary decisions (artificial intelligence) as a result of the accumulation of information, its processing, analysis and creation of large databases;

the ability to create a virtual picture of the physical world through the availability, transparency and completeness of the information required, as well as the capabilities of computer technology.

The capabilities that these technologies can provide will directly or indirectly affect the level of challenges and threats to the country's military security, changes in the forms and methods of deploying forces. These technologies are changing the methods of warfare from the "classic" kinetic wars to political agitation, misinformation and infiltration, totalitarian control and misinformation, so-called constitutional wars are emerging. Such wars, unlike open military actions, are not aimed at capturing the enemy's territories by introducing troops, but at capturing the consciousness of the people living in these territories.

It should be noted that defense and arms spending is rising worldwide. According to data from the Stockholm International Institute for Peace Studies, global military spending in 2018 rose to $ 1822 billion, up 2.6% from 2017. The United States, China, Saudi Arabia, India and France are among the top five countries with the largest military spending in the world. They accounted for 60% of world military spending. Such spending in the United States has increased since the end of the Cold War for the first time since 2010, while China's steady increase in spending has been observed since 1995.

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BASIC DIRECTIONS OF STATE POLICY IN SAFETY AND DEFENSE AREA OF UKRAINE

Arising and establishment of Ukrainian state have clashed with dramatic changes of bi-polar world and with processes of principally new approaches and global and Euro-Atlantic safety formation, which are very far from finalization still.

Increasing of aggressive Russian policy directed to achievement of it interests due to expansion of influence zone (at the first, on post-soviet space) is one of determined trend of nowadays. It is accomplished by force demonstration and energetic and trade wars.

Forwarding to disturb the Ukrainian people will to European future, Russia has occupied a part of Ukrainian territory – Autonomy Crimea republic and Sebastopol city, it began a military aggression on East of Ukraine and it tries to destroy the democratic world unity, to revise the world order, which is formed after finish of the Second World War, to disrupt the international safety and law bases, to do possible the unpunished force application on international scene.

In a similar vein, there is impossible practically to create and implement the effective system of international safety without deep scientific research of the fundamental problems of human society organization and development, it interests nature research, contradictions and mechanisms for its solution.

The attempts for empiric solution of the modern problems of international safety (plurality of these problems has not analogs in history on content and scope) give not the desired results and sometime they enforce the negative consequences.

Multi-vector nature of international safety area demands the system-related and complex research of the events, processes and occurrences, coordination of different knowledge in different science fields, international relations and world policy, international law. Every science has its specific, logic, scientific apparatus and own terminology finally. So, superposition of the different theories on practices and determination of fact, which permits to forecast better the processes way, is objective criterion for assessment and getting reality of one or other regularity for events development.

International safety theory, which in necessary scope should ensure the scientific grounded approach to complex solution of all fundamental issues, is not formulated finally up to now. Formation of its specific bases, including determination of principles, methods, terms etc. is running up at the same time.

Such way, there should be selected global, regional and sub-regional levels in international safety.

Global international safety is international safety in planet scale, which deals with the interests of all humanity whole. World globalization, interdependence of some countries from events in one from them (armed conflicts, destroy of dangerous objects of nuclear energetic and chemical industry etc.) set a task on global safety ensuring, which becomes further more various-subjective and inseparable.

Regional international safety is international safety within one world part (region, continent).

State of the relations within social-territorial formations of relevant world region and between formations, when safety and possibility to implement the existential interests, durable existence and stable development is ensuring for all state, nations, people, society institutions and groups of that region is proposed to understand under notion *Regional international safety*.

Sub-regional international safety is international safety within some geographically close states of one region.

Cardinal changes of geopolitical, geostrategic and geo-economics spaces demand further development of theory and practice for *national safety* ensuring. So, solution of problem of national safety ensuring becomes inseparable and very complex function for every independent state and it is basic aim for activity its political and state institutions.

National safety of every state is aimed on ensuring of favorable conditions for existence and development of nation, saving and augmentation its material and spiritual values.

National safety is obligatory attribute of the international and military-political conceptions, analytical and prognostic elaborations.

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MAIN TASK OF THE INITIAL STAGE OF THE REFORMATION OF THE DEFENSE-INDUSTRIAL COMPLEX

Looking for a contemporary look at the Defense-industrial complex (DIC) of Ukraine the basic question remains a concise answer to the question "Where to start and in which direction to move?".

In conceptual terms, this problem has been worked out quite thoroughly: there is not missing of scientific papers and publications devoted to assessing the potential of the Ukrainian DIC, its historiography, the analysis of foreign analogues, and so on. But at the same time, with the scientific and methodological apparatus, the implementation of the first steps in the mature transformation of the defense industry is somewhat more complicated. Any attempt to move in this direction:

or remain in the midst of numerous strategies and concepts, without falling into the level of scientifically grounded applied methods;

or they are reduced to writing regular business plans, the content of which is determined not by a sober scientific analysis, based on the patterns of defense-industrial activity, but by the commercial imagination of their authors, formed in most cases in industries far from the defense industry.

The main task of the initial stage of reforming the DIC is comprehensive optimization of the economic activity the economic activity of its core unit, defense enterprises, their full adaptation to the conditions of the market environment and purposeful preparation for corporatization.

But to solve it with such a marked diversity of objects of research and uncertainty of the original data, it is necessary to have an appropriate scientific and methodological apparatus, which allows to objectively evaluate the achieved status and prospects of further functioning of each entity of the defense-industrial complex with the existing economic structure for all the range of relevant universal criteria.

The main assumptions of this stage of research:

the nature and basic principles of building the legal and economic space in which Ukraine's defense industry was formerly operating now and will function and develop in the future, well-known and now relatively stable;

in case of any changes in the current regulatory framework and the external economic environment, it will be possible to regulate their impact through the tried and tested management tools.

These assumptions are fundamental in terms of:

an objective assessment of the potential of each individual defense-industrial enterprise now;

ensuring the content, logic, completeness and consistency of the proposed methodology.

It is for this reason that the first recommendation begs that, at the outset, close attention should be paid, as far as possible, to the dynamics of some of the most versatile indicators of activity of each enterprise of the defense industry in the last years preceding Ukraine's independence.

For example, you can take the return on production of one worker per year, annual withdrawal of marketable products from one square meter of production space for 1989-1991. Comparison of these indicators for 1989-1991 and, say, for the years 2013-2018 gives a primary idea of the degree of crisis (or, conversely, the success) of the current state of the entity on the main issues of its effectiveness:

growth rate (falling) production;

capacity of the existing structure of the means of production (available experimental and production capacities);

use of labor resources.

Developing a more detailed methodology for an in-depth technical and economic analysis of the economic activity of each entity has one common goal - to classify all defense enterprises depending on their current status and ability to continue independent work on the following features:

enterprises that have been able to solve the problem of adaptation to market conditions on their own, have positive results and are ready for further stages of reform;

enterprises in need of restructuring, which will allow them to retain their role and importance in the defense industrial sphere after all stages of reform;

enterprises that have retained capacity but have lost their defensive purpose and are of interest to other sectors of the economy;

enterprises that are unable to organize their own independent work with respect to the requirements that are being made and are therefore subject to reorganization or liquidation.

This orientation is explained by the need to:

the establishment of defense enterprises, designed to form the basis of a new look for the defense-industrial complex, in full readiness for the next stages of reform (restructuring, reorganization, corporatization and implementation of the corresponding functional and administrative transformations that follow);

getting rid of existing ballast, which does not carry any meaningful and functional load in the defense-industrial complex, but is able to significantly complicate the implementation of a mature structural restructuring in the defense-industrial complex.

From the very beginning, it is useful to keep a register of intermediate results in order to systematize the information obtained in the course of analyzing the economic activity of a particular defense-industrial enterprise. Its existence will subsequently greatly facilitate difficult management decisions in the face of contradictory factors or, moreover, in the face of uncertainty.

In this case, it should be emphasized: in contrast to everyday analytical work, the essence of which is to identify negative deviations from the acceptable values of the studied parameters and develop measures to return them to stable equilibrium, in this case, the emphasis changes somewhat.

At the initial stage of reforming the defense-industrial complex it is fundamentally important to get answers to the following questions:

the extent to which fatal deviations have been identified to implement the full cycle of enterprise reform;

whether it is possible to overcome (minimize) the negative impact of these deviations in the short, medium and long term;

which requires intellectual, organizational, material and other resources;

whether the company owns such resources or is able to obtain them in the foreseeable future.

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PARAMETER ASSESSMENT MODELS OF STOCHASTIC DYNAMIC SYSTEMS RADIO ELEMENT PARAMETER ASSESSMENT

The estimation of the parameters of the models of stochastic dynamic systems of estimation of radioelement's (RE) parameters in the state space can be carried out either by processing all the accumulated by the end of the experiment identification of the measurement data, or in real time, when the estimates of unknown parameters are regularly recalculated. In the first case, the least squares (LS), maximum likelihood (ML), and maximum posterior probability (MPP) methods are used. In the second case, an extended (generalized) Kalman filter is widely used, which involves changing the state vector of the model under consideration by including the estimated PE parameters in it.

Estimation of RE-parameters of continuous-discrete models with nonlinear deterministic equations of state using LS. This method was used to estimate the parameters of the PE model estimation models, discrete and continuous-discrete linear stationary systems in the time domain. The ML of models of nonlinear continuous discrete systems with deterministic and stochastic state equations is calculated, in which case the linearization of the model in the time domain is performed and the Kalman probability function extends the filter equation.

The probability function record uses square root filters, but with respect to linear non-stationary discrete models. Model parameters of nonlinear continuous-discrete systems with deterministic state equations are estimated using MPP. Advanced parametric identification methods used in the construction of stochastic models of linear stationary discrete systems implemented within the tool group of MATLAB system identification tools include a family of so-called subspace methods (in English, subspace methods) to which methods belong N4SID (Numerical Algorithms for Identifying Subspace State Space Systems), MOESP (Multidimensional Output Error Space), and CVA (Variable Change Analysis). These methods do not provide a numerical solution to the problem of nonlinear constrained programming, which eliminates the inherent problem of LS, ML, and MPP in finding global extremum, and work most effectively when using canonical representations of multidimensional model structures.

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PREREQUISITES FOR ORGANIZATION OF THE PRICING PROCESS FOR THE PRODUCTION OF DEFENSE TECHNOPARKS

In order to stimulate investment and innovation activity of Ukrainian defense industry enterprises, it is necessary to systematically and consistently introduce advanced organizational forms of innovation activity, such as technoparks, technopoles, incubators, associations, strategic alliances.

The unformed basis of innovative development and the unsystematic nature of R&D funding impedes the transformation of innovation activity in the defense sector of the state into a continuous process - from research and development to product realization, which leads to a low level of innovation activity of enterprises of the industry (7-13% at world standards of 70-80%).

Own funds of enterprises and organizations continue to be the main source of investments in industry - their share in the total volume of investments of the industry in 2010-2019 is on average over 75%. Thus, the current economy of the state is 95% based on the third and fourth technological structures, which account for almost 96% of output, 95% of investments and 90% of costs for innovation.

The experience of the USA, Europe, Australia and Canada shows that modern organizational forms of innovation accelerate the development of participants by 22 times, reducing the share of outsiders in business from 60% to 20%.

There are certain attempts to use modern forms of defense innovation in Ukraine, namely the organization of the Innovation Park Innovation Park platform with the creation of an incubator for defense innovation research and development. The main goal is to create successful companies (usually within 2-3 years) able to function independently in the market, for which it is planned to create technoparks in the future.

Technoparks are zones of economic activity that combine the potential of universities, research structures, industrial enterprises and entities of innovation infrastructure of regional national and international levels, contributing to the optimization of the process in the chain "science - production".

During 2000-2019, a system of about two dozen technoparks in Ukraine became the most effective organizational and economic form of integration of science and production among all other innovative structures.

Registration of innovative activity of the subjects of management of the defense industry in the form of a technopark will allow to use widely such nomenclature of related services as information, communication, advertising-publishing, leasing, intermediary, patent-licensing, marketing, consulting, financial, trade, residential - household exhibition complexes whose multiplicative effect will ensure reduction of fixed production costs and concentration of financial and material resources in key areas.

As the products of the defense industry by their economic nature have a specific characteristic and functional purpose, which is not peculiar to consumer goods, the institute of "defense technopark" is organically distinguished as a subspecies of the territorial-industrial scientific complex.

There is a major role of the state in the face of its authorities in the formation of legal, organizational and economic preconditions and mechanisms that motivate the participants of the process to obtain a sufficient level of legitimate profits in order to transform the results of scientific research into knowledge-intensive product. In these circumstances, the classic forms and methods of state support for the development of civilian sector technology parks (eg, preferential or preferential tax treatment) are reduced to ancillary tools. Given these features and the presence of the main customer in the person of the state, the sale of defense technoparks should be regulated by the legislation on pricing for defense products within the state defense order as a key tool for innovative development of the defense industry of the state.

The analysis of the Resolution of the Cabinet of Ministers of Ukraine of April 27, 2011 №464 "Issues of the State Defense Order" shows that there is no mechanism to encourage the innovative activity of the defense industry enterprises. In fact, the rule of paragraph 26-3, which enables an entity to use up to 30 percent of its profits for the development of production (reduction of labor, material consumption, energy consumption and general production costs), encourages the industry to extensive development, increase production of products of the third and fourth technological structures. There is an urgent need to supplement this government document with scientifically substantiated concepts and pricing methods for innovative products of defense enterprises, and to determine separately the preferences for technology parks in the field of defense and industrial production.

Thus, the prerequisites for organizing the process of pricing for defense technopark products are contained in the plane of solving the following problems:

1. Research of modern methods of pricing for innovative products of defense enterprises in the framework of economic theory.

2. Analysis of pricing processes on the example of manufacturing innovative products of leading defense companies in the US, Europe and Asia.

3. Borrowing foreign experience in the creation and operation of organizational forms of innovative activities in the field of defense: defense techno-parks and policies "Istanbul" (Turkey) and KINFRA (India), "ERA" (Russia), etc.

4. Improvement of legal, organizational and economic preconditions of the mechanism of activity of technoparks in Ukraine.

5. Formation of the legal framework regarding the establishment and functioning of the Institute of "defense technopark".

6. Definition of placements, development of development strategies and organization of defense technoparks activity, taking into account the specialization of the region and competitive high-tech and innovative directions for Ukraine (aerospace, shipbuilding, nanotechnology, etc.).

7. Development of methodological recommendations of pricing for innovative products of defense technoparks.

8. Testing of current pricing methods for defense technopark products, taking into account their specialization and economic situation of the state (region) and adjusting the legal framework.

DEVELOPMENT PROSPECTS OF THE GROUND FORCES ARMAMENT AND MILITARY EQUIPMENT

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ANALYSIS OF THE PROBLEMS AFFECTING THE SCIENTIFIC SUPPORT OF THE RESEARCH AND CONSTRUCTION WORKS ON THE DEVELOPMENT AND MODERNIZATION OF THE ARMS AND THE ARMS AND THE POSSIBLE WAYS TO SOLVE THEM

The ground forces are the most numerous and diverse in terms of weapons and methods of combat. Modern Land Forces have long-range precision weapons, which allow them to destroy the enemy without entering into melee. These are missile systems, rocket-propelled rocket systems, long-range artillery, anti-tank missile systems, and more. In addition, the effective firing range of small arms, tanks, armored infantry vehicles, armored personnel carriers, grenade launchers is constantly increasing.

Taking into account the experience of wars and military conflicts of the present, as well as taking into account the experience of conducting anti-terrorist operation (operations of the combined forces) in some areas of Donetsk and Lugansk region, it is necessary to talk about the need to equip the Land Forces with modern long-range high-precision means of defeating the enemy, priorities of their development at the present stage.

The Research Directorate for the Development of Weapons and Military Equipment of the Land Forces is conducting research and scientific and technical support of the development and design work on the development and modernization of armored, rocket-artillery weapons and military equipment, general-purpose equipment and training and training equipment, Special Operations Forces, Weapons and Defense Weapons and Defense Equipment, Weapons, and Ground Robot Development s systems.

In the course of scientific and technical support of the development and design work on the creation and modernization of the armaments and military equipment of the Land Forces, a number of problems arise, the main ones being:

the inability (unwillingness) of the main contractors to develop cooperative enterprises to develop and manufacture basic models of armored weapons and equipment;

the inability to purchase small batches of armored counter-hire of domestic production due to the reluctance of the State Concern "Ukroboronprom" and private sector enterprises to participate in the creation of armored rolled stock;

lack of production of domestic military engines;

the absence of domestic photodetectors to create night vision devices for weapons and military equipment;

absence of low-tonnage production of powders and explosives;

absence of a closed cycle of production of ammunition for small arms and artillery including 155 mm artillery rounds for testing of "Bogdana product".);

there is no testing base for the development and production of ammunition (requires extensive reconstruction of the artillery range);

when carrying out research and development works, the actual capabilities of the enterprises-developers do not allow to fully meet the requirements of consumers;

the absence of certain types of ammunition (including armor-piercing ammunition and shells - to check the stability of armor materials; inert grenade launchers, mines, shells - to check the strength of the barrels, firing at critical aiming angles) limits the quality of preliminary tests;

absence of a polygon base (support stations, telemetry equipment, rocket emergency system, target setting) for launching long-range missiles.

Thus, the possible ways of solving the above may be:

involvement of national innovative technologies in the development and modernization of weapons and military equipment;

concentration of technological, financial and organizational efforts to solve the most urgent (priority) tasks in the development and modernization of weapons and military equipment;

deepening military-technical cooperation with partner countries.

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RESEARCHES OF SMOOTHNESS OF THE COURSE OF ARMOURED VEHICLES

The development of new types of armored vehicles is impossible without determining the dynamic characteristics that affect their performance.

When moving an armored vehicle on a road with a rough surface, it makes forced oscillations, the size of which depends on the dynamic properties of the car, its speed, and the profile of the surface of the road. An important characteristic of an armored vehicle is the smooth running, which determines the comfort of the crew, affects the handling of the car, increases the accuracy of the target's impression in motion.

In tests, an assessment is made of the conformity of the limiting parameters of oscillation in the crew working positions, landing gear, control bodies, surfaces of the body of the sample with which the body parts contact with them should be carried out in accordance with the requirements of State standards and local military rules.

To assess the smoothness of the course, according to State standards road tests for the smooth running of cars require hard-coated road sections and a special controlled profile of 250 to 1000 m in length from 10 to 60 kilometers per hour in the vehicle, low-frequency vibration meters with the ability to register vibration acceleration leading to certain technical difficulties in testing.

Rigid requirements to the conditions of the test, special measuring instruments, leads to the fact that experimental tests on the smooth running are carried out with certain complications,

In the technical literature, based on the study of the dynamics of trucks and their practical use proved, if the first frequency of oscillation of the body does not exceed 1.7 Hz, the vehicle has a satisfactory smoothness of the course. The most important for assessing the smoothness of the vehicle are considered its movement in the longitudinal direction (plowing and galloping).

This gives an opportunity to experimentally evaluate the smoothness of the vehicle in a theoretical way. Experimentally, the tests determine the inertial and rigid parameters of the product, and the calculation of the frequency of oscillations is determined theoretically.

In the study, two dynamic product models were considered.

The first model includes the body of the vehicle (mass M and moment of inertia I around the horizontal axis perpendicular to the direction of motion of the support for two elastic elements whose rigidity is equivalent to the rigidity of the ridge and tires.

The motion of the mechanical system is described by two generalized coordinates: the displacement of the center of the masses of the subjected body in a vertical direction Z, the angle of inclination of the main central axis of inertia (HTSOI) of the body in the longitudinal direction.

The second model includes the body of the vehicle (mass M and the moment of inertia I around the horizontal axis perpendicular to the direction of motion of the resistor on the springs, front and rear axles with wheels with masses, respectively, on the tires.

The motion of the mechanical system is described by four generalized coordinates: the displacement of the center of the masses of the submerged body in a vertical direction Z, the angle of inclination of the main central axis of inertia (HTSOI) of the body in the longitudinal direction, the displacement of the centers of the masses of the front and rear axles in the vertical direction Z1, Z2, respectively.

Using the expressions of kinetic and potential energies, using the Lagrange equations of the second kind, we obtain for the first model a system of two differential equations of second order, for the second model a system of four differential equations of the second order describing the free oscillations of the mechanical system.

The first mathematical model allows to determine two, and the second four values of the frequencies of the internal oscillations of the mechanical system in the vertical direction.

Determination of the frequencies of the machine's own oscillations is reduced to the standard task in the Macht 15.

The method was tested on the upgraded BRDM-2L.

For the first model:

- for the loaded product mass $\omega_1 = 0.636$ rad / s; $\omega_2 = 0.718$ rad / s;
- for the total mass of the product $\omega_1 = 0.599$ rad / s; $\omega_2 = 0.668$ rad / s.

For the second model:

for the mass of the product ω_1 = 0.617 rad / s; ω_2 = 0.896 rad / s; ω_3 = 6.436 rad / s; ω_4 = 6.437 rad / s.

for the full weight of the product ω_1 = 0.581 rad / s; ω_2 = 0.648 rad / s; ω_2 = 6.436 rad / s; ω_4 = 6.437 rad / s.

The obtained results allow to draw the following conclusions:

Both methods give the first frequency of eigenvalues less than 1.7 Hz, which ensures smooth running for the fitted and full mass.

Both methods give close results, which allows us to recommend a simplified first method for use.

The proposed method will allow at the stage of testing theoretical and experimental method to assess the smoothness of the armored vehicles, which significantly reduces the time and cost of testing armored vehicles.

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STRENGTHENING OF TUNGSTEN HARD ALLOY BY COLD PLASTIC DEFORMATION METHOD

The use of heavy tungsten alloy has recently been extended, both in civilian applications and in the manufacture of dual-use parts. This alloy is formed on the basis of tungsten and a small content of other chemical elements (Ni, Fe, Co, etc.). The formation of the alloy consists of several stages (treatment of raw materials, forming, sintering) and ends with the heat treatment of sintered billets in a vacuum. Alloys of the W-Ni-Fe system after the sintering and vacuum annealing acquire certain physical and mechanical characteristics (tensile strength and plasticity) required for the next deformation strengthening operation. After this operation, the material acquires the necessary characteristics for its further use in industry.

There are a number of technological schemes of plastic deformation of alloys of the W-Ni-Fe system, which can be used for their strengthening: hot extrusion, hydroextraction, even-channel angular pressing, rotary compression, high-speed twisting, rolling, etc. It should be noted that the above methods are energy intensive, requiring the use of complex technological equipment, therefore processes of deformation strengthening of alloys based on tungsten are currently actively explored.

At the V. Bakul Institute for Superhard Materials NAS of Ukraine a study of the process of deformation strengthening of finished products from the alloy of the university of 89 % W and 90 % W reduction after annealing are conducted. We used a technological scheme in which the workpiece was pushed through the hole in the tool.

The experimental study consisted of two stages. At the first stage, the maximum one-time deformation of the sample was determined, in which it does not collapse and does not lose stability. At the second stage, the samples were subjected to multi-cyclic deformation to achieve maximum strengthening.

In the first stage, drawings were used from the solid alloy VK15 with Ø 6H8 hole, with working angles of 3° and 7°. Different degree of deformation was achieved using samples of universities of different diameters. During processing, the axial load was recorded for example. After reduction, the length and diameter of the reduced samples were measured, and hardness and structural changes were investigated in the plane of the diameter of the sample. Hardness control was carried out by the Vickers method at a load of 300 N. The initial diameter of the samples was 6.5; 6.8; 7.05 and 7.2 mm, which corresponded to 10 %; 20 %; 25 % and 28 % deformation.

The procedure of deformation strengthening of samples of alloys was carried out in two stages. At the first stage, the maximum one-time deformation of the sample was determined, in which it does not collapse and does not lose stability. At the second stage, the samples were subjected to multi-cyclic deformation to achieve maximum strengthening. Reducing of the prototype samples was carried out on the hydraulic press IPP-200, as a lubricant, the substance was used on the basis of fine-grained graphite.

When using the tool with the angle of the working cone $\alpha = 3°$, the stability of the samples of higher educational establishments occurred at a deformation of 20 %, for specimens with $\alpha = 7°$ – at 28 %. After reduction, the elastic restoration of the sample takes place, due to which its diameter increases from the diameter of the drawing to 0.04–0.11 mm, and at removing the lubricant – to 0.04–0.08 mm. As a result of the study, it was found that the initial hardness of the sample is 90 % W greater than that of the sample of 89 % W. But even with a deformation of 15–18 %, the hardness of the sample from 89% W exceeds the hardness of the sample from 90 % W, that is, the material 89 % W has greater ability to deformate hardening.

When multi-cycle processing, the distribution of total strain on the coils was as follows: 1st shaft – 20 %; 2nd – 33 %; 3rd – 43 %; 4-th – 51 % of the initial state of the sample. Each subsequent deformation pass was performed in the opposite direction. The reduction of deformation for each subsequent passage is explained by the fact that after each cycle the hardness of the reduced sample rises, that is, the forces of reduction are reduced and the ability of the alloy to strengthen is reduced. It was established that the sample at strain 51 % is lengthened by almost 2 times. Investigation of the hardness of the samples showed the uniformity of its distribution both along the axis of the sample and normal to the axis. This gave reason to operate the average hardness for each sample.

The results of experiments confirmed that the strengthening is more intense on samples of the alloy containing 89 % W. Although the initial hardness of this alloy is slightly lower (305 H_V) than the alloy with 90 % W (332 H_V) already at a deformation of 20 % they are equal, and at strain 51 %, the hardness of the alloy from 89 % W is significantly greater than that of the alloy with 90 % W. The results of the study of the influence of the deformation degree on the structural changes in the alloy showed that with increasing deformation of the location of the grains of the matrix of the bond is densified, and themselves grains lengthen in the direction of deformation, i.e. BTU appears texture.

Thus, as a result of a study to strengthen the tungsten heavy alloy in a cold state, it was possible to obtain the physical and mechanical characteristics required for the data (tensile strength, relative elongation, relative constriction, etc.).

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PROSPECTS FOR DEVELOPMENT OF ALL-TERRAIN VEHICLES FOR THE NEEDS OF SPECIAL OPERATION FORCES OF THE ARMED FORCES OF UKRAINE

Special operation forces (SOF) of many world countries are usually the first to respond to traditional (with generally accepted tactics) and non-traditional threats (such as, for example, insurgents using asymmetric tactics), this implies the need for a constant development of their professional skills and competencies that contribute to the implementation of various combat missions against combat state and non-state “players”. The current conflicts in Eastern Europe (Ukraine), Africa (Burkina Faso, Chad, Mali, Mauritania and Niger), the Asia-Pacific region and the Middle East (Libya, Syria and Iraq) make it possible to clearly define the current requirements for SOF units. More countries are now recognizing them as a means of increasing combat capabilities to fulfill a wide range of tasks, including rebel fighting, rapid response, special intelligence and military assistance. However, these traditional SOF capabilities are currently expanding due to the particular attention to information operations, including psychological and cyber wars.

For the Special operations forces (SOR), ground vehicles and combat platform are also important means of implementation, which are developing in accordance with the concepts of future conflicts for rapid response and expeditionary nature of the conduct of hostilities.

The analysis of the use of ATVs in the armed forces of the world leading countries shows that this type of armament was used by SOF in some cases in the absence of an engagement with the enemy (lack of anticipation of the enemy's fundamental actions) in territories with low population and favorable climatic conditions. ATVs were most effectively used for patrolling zones, areas and committing sabotage activities.

ATV is a lightweight frame universal tactical vehicle designed for fast transport (delivery, evacuation) of the SOF personnel, as well as for the transportation of weapons, explosives and materials.

ATV has to perform its functions 24-hours in moderate climate areas irrespective of the season and on roads with different coatings and in off-road conditions.

ATV should solve the following tasks:

- quick transportation of the personnel to (from) the theater in conditions of cross-country;
- patrol;
- conducting intelligence in the enemy's rear;
- transportation of weapons, ammunition and material and technical means.

ATV must consist of a chassis, a body, a cargo platform, spare parts and accessories, documentation.

The type of sample is wheeled, all-wheel drive, transportable vehicles by military transport aviation, an all-terrain vehicle with high dynamic properties, increased passing abilities and smooth running, able to overcome significant distance in cross-country.

The main components of the sample: the cross-country chassis; strong metal case; cargo body; communication and navigation complex; electrical equipment; masking means; capstane engine; set of spare parts and accessories; set of operational documentation.

ATV should provide space for mounting:

a cargo platform with a total carrying capacity of 270 kg;

containers for drinking water with a total volume of 10 liters;

food rations for three to five days for the crew.

The standard ATV crew consists of two (three) persons: a driver, a commander (machine gunner).

The body must be strong, provide a crew, power plant, powertrain, chassis and external equipment.

The complex of communication and navigation facilities should provide at the parking lot and during the movement: internal communication between the crew members, secured telephone radio communication and data transmission on the radio network of the ultra short-wave band, secured telephone radio communication and data transmission on the radio network of the trunking range, as well as determining the location of ATV in the area with the mapping of the location on the electronic map and its automatic transmission by secured communication channels.

ATVs must act as part of intelligence units (units of the Special operations forces), as well as on their own.

The characteristic conditions for the use of ATVs are dynamism, intensity and maneuverability of combat missions, in conditions of massive use of high-precision and conventional weapons by an enemy.

Such ATVs have a number of advantages – they can easily pass through the minefield, work in the area of destroyed buildings, where conventional military off-road vehicles are not suitable, ATVs can make rapid breakthroughs, since it can move across rough terrain at speeds of 60 and above kilometers per hour. In this case a driver can even attack by fire on the way of ATVs, unlike a motorcycle.

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POSSIBILITIES OF LASER RADIATION TO IMPROVE MILITARY PRODUCTS QUALITY

Improving the quality of military machinery is an extremely important task to increase the defence capacity of Ukraine. Its solution is connected with the development of new technologies for manufacturing high-quality materials and products based on the use of concentrated energy sources as a laser beam, plasma, etc.

The department of Laser Systems and Physical Technologies in NTUU "Igor Sikorsky KPI", developed a number of fundamentally new technologies, among which are high-performance bimetal manufacturing processes. It is known that existing methods for the production of bimetals, such as electroslag and multilayer arc surfacing, diffusion welding, casting, plastic deformation, have certain disadvantages in terms of cost, productivity, quality, etc.

The most common methods of their manufacture, providing a metallurgical connection between the components are explosion welding, electric arc and plasma surfacing. These technologies are in high demand even though they have certain drawbacks.

Our department in cooperation with the Institute of Metals and Alloys of the NAS of Ukraine developed and implemented a high-performance laser-foundry and several combined bimetal manufacturing processes. According to one of them, a focused into a line segment laser beam is directed to the functional component of the bimetal, which is placed in the matrix and moves along with it. In the area of the laser beam from a special tuyere with a certain flow rate melt is fed to the second structural component of the bimetal. At the cooling stage, the crystallized bimetal is compacted with a deforming element.

Of considerable interest are the processes of laser shaping of metallic spatial sheet structures of complex configuration; increase of wear resistance of parts of heavily loaded friction units of machines operating under extreme conditions; combined plasma-laser processes of applying functional coatings with adhesion strength up to 100-150 kg / mm^2 (usual plasma spraying - 10-15 kg / mm^2); combined processes of laser chemical-heat treatment, allowing to obtain high-quality nitrided layers up to 0.5 mm thick while reducing the duration of the process.

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INSURANCE DOCUMENTATION FUND FOR THE PRODUCTS FOR DEFENSE AND MOBILIZATION USE

In Ukraine for the long-term reliable storage and state accounting of documents required for the production, operation and repair of defense and mobilization products during emergency situations and in the special period, in case of loss or damage of the original document, there is a special structured bank of documents, recorded on micrographic film or other compact data carrier - Insurance Documentation Fund (IDF) of Ukraine.

Formation of the IDF of Ukraine is carried out on a planned basis through the development and implementation of the State Program - for the formation of the IDF for the products for mobilization and defense use, as well as departmental and regional programs - for the formation of departmental and regional IDF.

Keeping of the IDF of Ukraine ensures compliance of IDF documents with the original documents, their long-term storage, transfer to archival storage or cancellation, as well as making timely amendments to the IDF documents. They are recorded to the State register of IDF documents of Ukraine, which is maintained by the IDF State Department within the State Archival Service of Ukraine (Ukrderzharhiv).

Among the problematic issues in the field of formation and keeping of the IDF for the products for mobilization and defense use are the following:

1. At present, in the Ministry of Defense (MoD) of Ukraine creation, formation and keeping of the IDF for the products for mobilization and defense use are not actually carried out by any body or component of the MoD of Ukraine. The MoD does not participate in the development and implementation of the State Program for the formation of the IDF for the products of mobilization and defense use, monitoring its implementation. In the MoD of Ukraine there is also no information on the status of formation and keeping of the IDF.

2. When concluding government contracts within the state defense procurement order, the provisions regarding contractors' obligation to provide the technical documents developed to the IDF at the stage of production development and providing supporting documents are not included.

3. Control over providing technical documents to the IDF at the stage of production development when making a decision to award contract is not performed.

In order to involve the MoD of Ukraine in the creation, formation and keeping the SPF for the products for mobilization and defense use, it is necessary to:

1. Ensure the interaction of the MoD of Ukraine with the IDF State Department of the Ukrderzharhiv by obtaining information on the progress of the State Program, status and problems of the IDF formation and functioning; to identify the MoD component to be responsible for keeping the IDF and to ensure its participation in determining the lists of enterprises, products and objects, the documents for which

are to be provided to the IDF, development and approval of the State Program for the formation of the IDF for the products for mobilization and defense use for the future periods, making adjustments to the current State Program, monitoring its progress, drafting plans for the documents supply for the IDF documents production.

2. Ensure changes to the provisions of the state contracts regarding the state defense contractors' obligation to provide technical documents to the IDF and relevant documents at the stage of production development, setting the terms for their provision and responsibility for non-compliance with the state contracts provisions.

3. Ensure control over technical documents supply to the IDF by the military representatives at the stage of production development when making decision whether to award government contracts.

Implementation of the proposed activities will ensure the MoD involvement in the formation and keeping of the IDF for the products for mobilization and defense use.

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METHODS OF EXPERIMENTAL DESIGN THEORY IN DEVELOPMENT AND OPTIMIZATION OF SOLID PROPELLANT (SP) FORMULATIONS

When designing solid propellant rocket motors (SPRM), the work on development and optimization of rocket propellant (RP) formulation is one of the most complicated and labor-intensive tasks and requires considerable material-technical resources for their trials, namely - carrying out a large number of experiments. The use of the methods of experimental design theory makes it possible to significantly reduce labor intensity when performing such type of work.

The authors of the paper considered an isolated case of development and optimization of RP formulation by example of optimization and determination of the effect of oxidizer fractional composition on the RP properties range, since the oxidizer has significant impact on the wide range of RP physical-chemical and processing properties, that is a rather critical task.

Within the experimental design theory, the authors used its isolated case - namely, building up "composition-property" diagrams under Scheffe method simplex-design. The use of the Scheffe method is conditioned by the greatest distribution efficiency of experimental points along the experimental simplex-design and allows the number of experiments, required for the classical approach in the development and optimization of RP formulation, to be reduced by ~ 70%.

Based on the mathematical model by the Scheffe method, the simplex-design was formed which allows building up "composition-property" diagrams, that, in their turn, allow accurate prediction of the RP properties under investigation in the whole range of fluctuations of the oxidizer fractional composition; and also they enable a numerical optimization of the RP formulation with no need for additional experiments to be conducted in terms of selected properties in order to achieve desired parameters.

The results obtained from the development and optimization of the RP formulation using the experimental design theory showed an acceptable correlation with the experimental data, and the deviation did not exceed 5%.

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METHODOLOGICAL BASIS FOR JUSTIFICATION OF MEDIUM-TERM ARMAMENTS PROGRAMS DURING THE SPECIAL PERIOD

Theoretical and methodological principles for scientific studies and organizational activities for justification of quantitative and qualitative indicators of the armaments program in peace time are proposed to be divided into three stages:

determining the quantitative and qualitative composition (QQC) of the weapon system in the programming period, representing the objectives of the program;

planning of terms for armaments development and acquisition in the program period;

scientific and technical support (STS) of development activities and armaments programs implementation.

In peace time, the so-called “direct” military and economical analysis (MEA) task is solved in armaments development planning, that is, achieving the maximum effectiveness of the armaments program within the budgetary allocations.

In the armament development planning in peace time a balanced development of the Security and Defense Sector (SDS) must be pursued. There are severe constraints on budgetary funding which affect the need for the QQC of the weapon system and the process of justifying the program's objectives and activities.

The obtained list of activities for the armaments development and acquisition of new and modernized weapon systems, which the state is able to fund in the medium-term perspective, provides an opportunity to continue planning for the years of the programming period.

These inputs allow to conduct a complex of scientific studies and to form the finalized draft of the program which includes concerted over the years of the programming period activities within the budgetary allocations. As a result, the goals of the program for the annual deployment of the planned number of certain weapon types should be achieved.

During the planning of the armaments development in the special period the “backward” MEA task is to be solved: achievement of the required effectiveness level of the armaments program with the minimum funding.

During the peace time the balanced development of the armaments system of the SDS was carried out on the basis of the economical capacity of the state whereas during the special period the forces involved or to be involved in hostilities are determined. In the first place the main efforts are directed to equipping and development of these forces, and in the short-term perspective - to the modernization of weapons within their armaments system. This allows to identify the need for the QQC for the program's objectives and activities. The distinguishing feature of this process is the overwhelming impact of needs over funding, not the other way around like in peace time.

During the special period it is necessary to accelerate new and upgraded armaments deployment which requires optimizing some of the armaments development processes, construction of a more flexible system for their development and production. In each case, the possibility of reducing the terms of the development activities by reducing the number of stages, using existing technological achievements and simplifying the process of adopting new weapon systems being purchased or obtained abroad or proactively developed by domestic industries, is considered.

In addition, the special period conditions require a significantly larger number of new armaments to be deployed annually, and a new task to repair and restore them after combat damages is set. Accordingly, in some cases this requires to increase the production capacity of domestic industries and their repair capacity.

During the STS of development activities and the program as a whole, in the conditions of a special period, there is a need to respond promptly to changes in the forms and methods of warfare, which may place new requirements on the technical features of existing armaments. In some cases, it is necessary to carry out their modernization and deployment as soon as possible. All this requires adjustment of the State Defense Procurement Order or the program as a whole, which is different from the support process during the peace time.

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NEW GENERATION OPTICAL GLASSES TO IMPROVE THE INFRARED SIGNAL QUALITY OF GUIDANCE SYSTEMS

One of the important issues of optoelectronic systems is to increase their accuracy by improving the signal quality of the transmitter. A special place is occupied by systems operating in the infrared spectrum. Nowadays, these systems, besides the defense industry, are widely used in medical research, cosmology, cinema and photo equipment. A separate site in this spectral range is occupied by optoelectronic systems (OES) which transfer and absorb encoded signal of solidstate neodymium laser (Nd: YAG or glass GLS-21, 22, 32). The signal these systems has work wavelength at 1060 nm. In this system optical colored glasses act as filters.

Their main function is blocking ultraviolet, visible and near-infrared (up to 950 nm) radiation. This spectral range is a noise for the receiver.

One of the practical solutions to increase the accuracy of such systems is the increasing the signal strength of the transmitter. This is achieved by upgrading its radio engineering component. In practice, the signal strength increasing is directly proportional to the noise increasing. In addition, raising the signal level of the transmitter also increases the possibility of detecting such optoelectronic system by hostile search engines. To solve this problem, it was proposed to develop new infrared glasses that would have improved spectral characteristics, namely, increased transmittance at a wavelength of 1060 nm and increased absorbance up to 950 nm. It's became the goal of work. Such glasses should improve the quality of the signal without increasing its strength level. Since such glass could be used in harsh conditions additional conditions for performance such as heat resistance and chemical resistance are put forward to it. And for mass production, the glass should be technological, in relation to the absence of bulk crystallization.

Existing optical glasses operating in infrared systems include selenide, non-oxide, germanium and oxide silicate glasses. It has been established that the spectral characteristics of these glasses don`t allow to completely solve a given problem by spectral characteristics, or technologies of their production are unprofitable, and their mass production is non-technological.

The work consisted of two main stages. The first stage is the development of glassmatrix. The second stage is the study of the influence of colorants on the spectral characteristics of glass in the IR spectrum. A system of R_2O-PbO-SiO_2 was chosen as a glass matrix. The glass matrix has the following parameters. The transmittance at wavelength τ (λ) 1060 is 91%, thermal resistance is more than 80°C, and chemical resistance corresponds to A1 category. Studies on the crystallization ability of the glassmatrix have established that only film crystallization without bulk crystallization takes place at 24-hour endurance (at temperature range of 650-810°C). This allows us to predict the technological of the glass at the production.

As a result of researches of the colorants influence on the glassmatrix spectral characteristics the system Cr_2O_3-Mn_2O_3 was chosen. Also, a negative absorbing effect in the range of 1000-1100 nm of iron oxide (II) was found. Iron oxide is an impurity of raw materials. To reduce this effect quartz sand was replaced by quartz grains, in which the content of impurity iron is much smaller. The research on the provision and regulation of spectral characteristics in the IR-spectrum by the colorants system allowed obtaining glasses with the necessary spectral characteristics to solve variation problems. It was established that the heat treatment of glass allows increasing the transmittance at a wavelength of 1060 nm by 5% due to the partial transition of iron oxide (II) into iron oxide (III) and manganese oxide (III) to manganese oxide (III). An additional improving of spectral characteristics (full absorption at the range 900-950 nm) is possible due to the use of α-Si thin-film coating. All the necessary technological parameters for the production of optical infrared glass with a high percentage of the corresponding products production are developed. Thus, an optical glass was obtained for the manufacturing, which absorbs the noise spectrum and filters the passage of the infrared signal of optoelectronic systems of the required level.

A further promising area of research is the study of the influence of rare earth metals on the absorbing effect at the range 950-1000 nm of developed glass, as well as the study of luminescent properties of such glasses, which theoretically can increase the signal passing through the filter of them.

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FORECASTING THE DEVELOPMENT OF COMPLEX TECHNICAL SYSTEMS

The analysis of the world experience in the development of complex technical systems (CTS) and the organization of scientific and technical research shows that the major achievements of science and technology are ultimately reflected in patent information (patents). What is now reflected in the patents is coming into practice in the near future. Conversely, embodied engineering solutions have been patented previously.

Patents (Patent Information) provide an opportunity to evaluate the level of technical systems and technical solutions, are a means of monitoring innovations, and are vital when planning scientific and technical research and further development of the CTS.

One of the ways to determine the requirements for the parameters of prospective CTS samples is to use forecasting methods that provide scientifically valid variants of development (dependencies of change) of characteristics, indicators of CTS status in time and space (technical level of the sample and the level of compliance by purpose). In solving the problem of predicting the parameters of the CTC and making decisions a significant problem is the amount and quality of processing the necessary information. Patent research can be a source of information. It is suggested to use the morphological analysis method to predict and describe the optimal CTS parameters during patent research of the CTS.

Any holistic technical system has a clear orientation of principles of action and structure, the analysis of which allows morphologically to describe its structure and, depending on the method of its application, to be able to predict the development of its purpose parameters.

Morphological analysis is used to predict possible consideration of the results of basic research and to formulate new requirements for the CTS by obtaining systematic information on all possible options for solving the problem. The main advantages of this method include the fact that it allows to determine future scientific and technological achievements. The disadvantages are that this method requires the experience of developers and their knowledge of the problem structure. It is time consuming enough for practical implementation because of the need to sort through many options. The method involves solving the following problems: formulating the problem; parameter analysis; construction of a “morphological box”.

The scientific task is formulated as follows: on the basis of the analysis of the characteristic parameters of modern CTS and patent information on the CTS, to formulate requirements for the optimal characteristic parameters of the CTS, which will provide an adequate level of development of complex technical systems of weapons and military equipment.

To solve this problem it is advisable to apply a methodological approach based on the method of morphological analysis. Eight tasks should be considered as the main stages of such an approach for forecasting the development of the CTS:

1. Formulation of the task and definition of a set of CTS (classification of means by typical principles of action or design features) necessary for the performance of given functions;

2. Determination of the morphological features of the CTS (essential elements that determine its basic functions and change in which leads to the creation of a new type of CTS sample);

3. Development of a morphological model (in the form of collapsed and expanded matrices), for each morphological trait, all possible alternative variants of their realization are determined;

4. Determination of the criterion for evaluating the effectiveness of different options for the implementation of selected characteristic parameters of the CTS;

5. Analysis of simulation results. Identification of unnecessary components of morphological features. Identification of the morphological features of the CTS that are suitable for finding new options for technical solutions of the CTS samples;

6. Synthesis of possible combinations of states of the selected characteristic parameters that determine the structure of the CTS sample implementation by selecting one element from each row of the morphological matrix and combining them;

7. Identification and elimination of combinations of characteristic parameters not described in patent documents and technical literature;

8. Evaluation of the effectiveness of new combinations of characteristic parameters (to make comparisons) and selection of those that it is expedient to develop.

This methodological approach allows identifying: basic functions, possible alternative options for their implementation, evaluate the effectiveness of different options, to perform synthesis of possible characteristic parameters.

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DEVELOPMENT OF PROTOTYPE OF TRAINER FOR DOMESTIC REACTIVE INFANTRY FLAMETHROWER

The need for this development is conditioned by the need for short-term training of military personnel for the effective use of new, modern weapons with minimum financial costs for such training. The latter is especially important, considering that the cost of one shot from the flamethrower RPV-16 is several tens of thousands of hryvna, and dozens of shots are needed to train a flamethrower gunner.

Flamethrower is one of the effective and relatively cheap means of fire damage of the enemy. Today there are no simulators for the training of flamethrower operators in the Armed Forces of Ukraine. Thus, the creation of simulators that can most likely simulate the work of flamethrower weapons has a significant practical value. This is also relevant in connection with the aggression of the Russian Federation in the East of Ukraine and the need to establish an effective military counteraction to the Russian occupation forces on the collision line.

The RPV-16 simulator is a training device intended for training the operator and improving the practical skills of using a flamethrower in a classroom environment without the use of ammunition, which provides:

- theoretical training of the operator (study of parameters, characteristics, composition, rules and methods for use),
- the improvement of the skills of searching, detecting, recognizing, tracking and defeating simulated goals in different conditions,
- execution of simulated launches without the cost of ammunition and flamethrower's resource,
- control and evaluation of the quality of theoretical knowledge and practical skills.

The trainer includes: flamethrower simulator, optical sight simulator, multimedia projector, computer, projection screen, software, electronic database (3D scenes, objects, exercises, scenarios, results), infrared camcorder to capture the moment of the shot and coordinates laser pulse on the screen, acoustic system. The flamethrower trainer also includes a laser emitter, fuse and trigger sensors, a battery with a charge level indication, a device for determining the angle of the location and the azimuth of the simulator at the moment of the shot, a simulation of the light /

smoke effects of the shot, and the dynamic effect of the release of the shell prototype.

The theoretical training is provided by the instructor with the help of the software "Program-methodical complex of theoretical teaching and knowledge control of the use of a flamethrower RPV-16". Practical training is carried out under the computer software "Program-methodical complex of formation of practical skills of the use of RPV-16". Results of knowledge control and execution of shooting exercises are automatically stored in the database, displayed on the PC screen, printed, and evaluated their mark with errors of the operator's actions.

Conditions of use include different types of landscape, different meteorological conditions, day and night, summer and winter. Exercises include target exploration, training and firing in accordance with the "RPV-16 Shooting Raid" and other documents that guide the rules for its use, as well as other exercises that an instructor may create in accordance with the supervisor's plan.

Thus, the trainer provides the training of servicemen in order to develop the skills of the effective use of the RPV-16 flamethrower for damage to automotive and light-armored machinery, engineering structures, including dugouts, ditches, checkpoints, in order to eliminate them and destroy weapons, military equipment, ammunition, as well as the military personnel of the enemy, who are located inside the said military equipment or fortified buildings.

As a result, the trainer is based on modern solutions in the field of information technology, its use in the troops should improve the quality, accelerate and reduce the cost of the combat training of flamethrower operators.

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METHOD OF EVALUATION OF EFFICIENCY OF FLIGHT TRAINING OF CADETS FOR TACTICAL AVIATION OF AIR FORCES OF UKRAINE

The Air Force has implemented a three-stage system of flight training of cadets, which allows to ensure a sufficient level of their training for flight operation and combat use of tactical aircraft. The training system includes the step-by-step training of cadets on a motorized aircraft, a training aircraft and a combat aircraft. This training system requires new approaches to assess the effectiveness of flight training at each stage. This is due to the fact that at each of these stages, the cadets are trained on different types of aircraft and apply different approaches to acquire the necessary professional competencies. A comprehensive assessment of the results of the training of cadets is also required to monitor the compliance of training programs with the requirements of tactical aviation in the context of modern armed conflict and the timely implementation of lessons learned during combat operations at the OUF (ATO).

Application of statistical methods of research and analysis of quantitative and qualitative indicators of the system of training of cadets of pilots does not give to the full extent to receive an estimation of results of their preparation. Therefore, it is proposed to apply a systematic approach to develop a system of criteria for assessing the training of pilots. Obtained regularities will allow to build mathematical models and to develop a method of evaluation of training of cadets of tactical aviation pilots of the Air Forces of the Armed Forces of Ukraine.

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SECURITY OF MILITARY AND CIVIL OBJECTS UNDER LOCAL IMPACT LOADS

Many objects of modern technology are exposed to shock and impulse loads. Under the action of local impact loads, a three-dimensional dynamic stress-strain state arises in them. The processes of dynamic deformation proceed in the elastic-plastic stage. In this case, it is necessary to take into account the dynamic properties of the material, which depend on deformations and strain rates. At intense impact loads, finite deformations and displacements start to appear. Therefore, the analysis of dynamic stress-strain state is an actual and complex problem. It requires the construction of three-dimensional mathematical models that consider all features of the process of high-rate deformation.

Solving the problem of protection of civil and military installations includes experimental studies of dynamic material properties, numerical studies of impact loads on critical objects of modern technology and development of measures to reduce danger of dynamic loads.

Experimental installations for high-rate deformation of specimens allow for determining the characteristics of dynamic properties of materials. These characteristics are presented in the form of dependences of stress intensities on the strain intensities and strain rates. All characteristics can change during deformation.

Investigations of variation of equivalent stresses, under shock loads in time, have been carried out what facilitates the choice of material for protective structures. The action of impact loads on protective elements is carried out using finite element method based on three-dimensional models.

Modeling of high-rate deformation of constructions, taking into account the dynamic properties of materials and large displacements, is carried out. Numerical studies of the dynamic stress-strain state of the structural elements of vehicles and gas turbine engine corps are carried out using the finite element method. The use of multilayered protective elements under the action of local shock loads is shown. Intensity of the stresses in local shock loads decreases rapidly in space and time. This makes it possible to use a denser grid in the area, where it is advisable to carry out specified calculations. In this case, the grid density varies tenfold.

Protective elements of the composites have the necessary dynamic strength and less weight than steel, although they experience great dynamic displacement.

The greatest impact resistance from the considered protective elements has a three-layer element, comprising thin layers of titanium alloy, between which there is a ceramic alloy. At high speeds of projectiles, even unless there is complete penetration in the top layer, the element saves it protective properties.

The results allow for giving practical advice to reduce dynamic stresses and to increase the dynamic strength of the elements of responsible structures.

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IMPROVEMENT OF THE CONTROL OF THE TECHNICAL STATE OF THE INFORMATION SYSTEM OF THE MANAGEMENT OF THE WARRIORS

At present, the conduct of military operations requires the effective operation of the means of information management of troops: communications, automation and management of units and weapons. Without reliable information on the preparation and progress of the operation, it is difficult to formulate management objectives, to properly assess the situation, to identify problems, to predict the development of events, to prepare managerial decisions, to control their implementation. The authenticity and speed of the transmission of information and control signals depends on the technical state of the information support system. That is, from timely control of the technical system of information management of troops.

It is substantiated that development of the information support system for troop control is possible in two directions:

ensuring the minimum cost of operation with increasing the level of quality and reliability of operation;

timely detection of failures to implement the required levels of resistance to failures, the required reliability, and the secrecy of the transfer of information.

The control of the technical state of the system of information management of troops is proposed to be improved on:

the use of information-measuring devices of high reliability with small weight and overall dimensions;

use of multifunction control devices for different types of electronic systems;

increase of reliability of software and hardware;

creation of an effective structure of management of stages of operation of software and hardware.

It is shown that in order to ensure reliable and safe operation of the information security system of troops, it is necessary:

to create specialized information-measuring devices for control of the main characteristics of software and hardware during operation on the basis of universal equipment (devices);

to increase the level of integrated data processing from information measuring devices for increasing the efficiency of functioning, resistance to failures, and the level of suitability for restoration (repair).

The presented proposals will increase the efficiency of the operation of the information security system of troops by increasing the reliability and efficiency of obtaining information and their technical condition.

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BotGRABBER: SVM-BASED SELF-ADAPTIVE SYSTEM FOR THE BOTNETS' DETECTION

BotGRABBER presents the SVM-based system for botnet detection with the ability to produce security scenarios for assuring the corporate area networks' resilience in the presence of botnets' cyberattacks.

The network's resilience is ensured by the network's dynamic adaptive reconfiguration. BotGRABBER is a multi-vector protection system as it combines the analysis at both network and host activity.

The combined information allows one not only to detect the botnet's cyberattacks but also to produce the needed security scenario of the network reconfiguration according to the type of cyberattacks performed by the detected botnet.

The system is a novel botnet detection framework with the key features given below:

1. ability to detect the most known botnets' cyberattacks;
2. ability to detect botnets that use DNS evasion techniques (cycling of IP mapping, "domain flax", "fast flax" and DNS-tunneling);
3. ability to self-adaptive appliance of the security scenarios for the cyberattacks’ mitigation;
4. assuring the corporate area networks' resilience in the presence of botnets' cyberattacks;
5. assurance of the multi-vector protection for corporate area networks.

BotGRABBER’s architecture is presented on the figure 1.

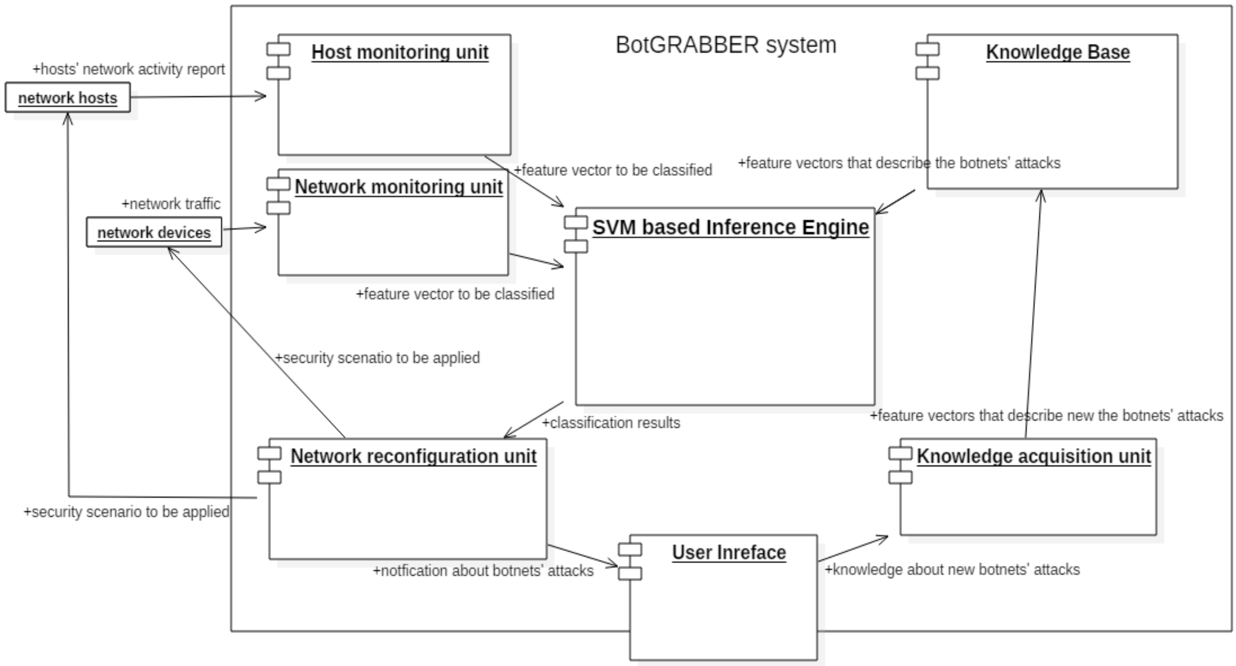

Figure 1. BotGRABBER's architecture

The process of the classification is divided into the several iterations. On the first iteration, the classification objects are divided into two classes: malicious traffic and benign one. Then classifiers divide objects into another two classes, for instance: malicious traffic and spoofing traffic. Next iterations separate malicious traffic and another classes of attacks and so on until all of them are totally divided.

Experimental results of different SVM classifiers elucidated, that the linear and polynomial classifiers provide the worst result. They are characterized by low rates of the execution time, distance between hyperplanes and overall classification accuracy. Non-linear classifiers demonstrate better results, where B-Spline provides more optimal results, then other ones.

Thus, for an experimental evaluation samples, the most effective classifier using the SVM was the B-spline, since it provided the greatest distance between hyperplanes, the shortest time of the evaluation, and best accuracy of the classification, and was employed as basic in the SVM-based inference engine of the BotGRABBER system.

The results of the experiments of the botnet detection are presented in Table 1.

Experimental research showed that the SVMs are able to produce the accurate classification results.

Implementation of the SVM-based inference engine into the BotGRABBER' s structure as well as the addition of new botnets' attacks features allowed to increase its mean accuracy from 88.16% to 95.62% in comparison with previous version.

Experiments demonstrated, that system is able to detect different types of attack in the range from 90.40% to 98.42%.

Table 1. Test results for different classes of the botnets attacks

Attack, performed by botnet	T	E				Results				
		Malicious		Benign		SN, %	SP, %	Q, %	Q_{old}, %	SR, %
		TP	FN	TN	FP					
DDoS	574	661	16	489	14	97.64	97.22	97.46	93.23	73
ping flooding	564	585	11	465	13	98.15	97.28	97.77	93.90	76
smurf attack;	364	568	15	429	21	97.43	95.33	96.52	92.28	76
TCP SYN Flood	563	567	10	321	7	98.27	97.87	98.12	91.33	58
fragmented UDP Flood	554	384	33	323	29	92.09	91.76	91.94	88.98	77
DNS Amplification	421	435	38	553	41	91.97	93.10	92.60	91.99	73
TCP Reset	671	575	31	644	19	94.88	97.13	96.06	93.42	85
ICMP Flood	764	541	23	565	7	95.92	98.78	97.36	93.23	54
RUDY	198	764	36	548	39	95.50	93.36	94.59	92.53	77
SIP INVITE Flood	611	434	21	561	22	95.38	96.23	95.86	93.86	79
encrypted SSL DDoS	571	554	41	464	35	93.11	92.99	93.05	90.62	77
ping sweep attack	521	494	8	198	8	98.41	96.12	97.74	89.25	69
SQL /PHP injection	381	653	29	328	35	95.75	90.36	93.88	90.81	67
Cross-Site Scripting (XSS)	439	642	39	461	41	94.27	91.83	93.24	91.15	77
phishing	555	457	4	354	9	99.13	97.52	98.42	92.53	70
DNS spoofing	571	453	42	253	33	91.52	88.46	90.40	86.60	76
TCP scan	345	451	21	326	12	95.55	96.45	95.93	90.36	67
UDP scan	231	432	12	326	12	97.30	96.45	96.93	91.46	73
smurf	237	344	15	433	8	95.82	98.19	97.13	92.28	68
MAC flooding	655	556	13	326	11	97.72	96.74	97.35	91.57	52

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PERSPECTIVE DIRECTIONS FOR DEVELOPMENT OF FIELD ARTILLERY FOR PROVIDING LIFE IN THE BATTLE

The experience of carrying out an antiterrorist operation on the territory of Donetsk and Luhansk Oblasts (Joint Forces Operation) once again confirmed the significance of artillery as the main means of fire support for mechanized units in the battle. Up to 85% of the enemy's losses during the anti-terrorist operation on the territory of Donetsk and Luhansk oblasts were caused by the units of artillery.

At the same time, research results suggest that the level of real combat capabilities of artillery systems presented in the Army Armed Forces of the Armed Forces of Ukraine, does not fully meet the requirements of time. An analysis of trends in the development of artillery and means of combating it with leading countries of the world, proposes directions for the development of artillery systems that will ensure their survivability on the battlefield, namely:

1. Further modernization of existing and development of new artillery systems by:

- increase tactical mobility by creating self-propelled artillery systems on a wheelbase;

- increase in the autonomy of combat operations due to the equipping of artillery systems with modern means of orientation, means of intelligence, navigation and top-linking, guidance and control;
- ensuring the possibility of transition of artillery systems from the configuration of the march to shooting (and vice versa) in less than 1 minute;
- an increase in the distances overcome by the artillery system from the place for the first minute;
- providing for counteraction to high-precision weapons and unmanned aerial vehicles;
- the creation of artillery systems that will have at least 45 shots in the combat kit of the combat platform;
- increase of the index of maximum shooting distance up to 50-70 km;
- creation of artillery systems with the possibility of fire in the "squall of fire" mode.

2. Combining artillery systems with intelligence, control and security facilities in the interests of creating intelligence and fire systems (complexes).

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TRANSPARENT SYSTEM FOR TRACKING VOLUNTEER SUPPORT FOR SERVICEMEN

The present is characterized by the fact that every day the number of newest technological developments increases. Progress is bound to affect current trends and people's perceptions of how the familiar processes should look. The processes that previously required a lot of human time are replaced by digital services, which in turn allows troops to simplify their work.

More and more people become socially conscious and aspire to be useful in society, from simple activity on the Internet to volunteer care, which is of interest to young people, students and non-indifferent people in the first place. Digital volunteering services are rapidly developing, and nowadays we can help anyone regardless of location, the latest technologies allow humanity to communicate and help other people in relation to their needs.

Today's society's needs are conducive to the development of transparent systems that could be trusted. Transparent systems allow people to see where their money was transferred, where their material assistance went. At this stage, transparent systems exist in Ukraine only in the field of public procurement. Other sectors also need such transparent systems, while they should be independent from the state governing bodies in order to reduce the corruption level. All this will allow the user to be sure that his assistance has been received by the final recipient.

The need for a market is a reliable and transparent system of volunteer help for servicemen. The system provides the opportunity to be indifferent to the financial support of state advocates, and to be sure that assistance reaches the final recipient through feedback and displays a complete list of transactions.

The service combines many elements among themselves and provides an expanded function of those who receive financial assistance and distribute it further, and for those who provide this assistance. The main advantage of such a system is transparency, which prompts users to accurately see that its assistance has come to the final recipient.

So, the main purpose of the system is to convey and confirm that the user's help has come to the necessary people and organizations.

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TRENDS OF SMALL ARMS DEVELOPMENT IN THE LEADING COUNTRIES OF THE WORLD

In order to increase the capabilities of a single military serviceman in carrying out its combat missions, there is a need to conduct extensive experimental and theoretical tests in the field of small arms.

Military operations of the last decades have shown that the development of weapons and equipment in response to changing tactical techniques and methods of battle against irregular units took place in the directions of increased mortality, protection, mobility and situational awareness. This also concerns all types of equipment from small arms and ammunition to the equipment of the serviceman as a whole.

The development of individual complex of small arms is aimed at increasing their survivability, firepower and fire density, increasing the accuracy of firefighting, increasing the impact of munitions, reducing the mass and size characteristics, simplicity of maintenance and application. At this time, the NATO program of development of individual complex of small arms of the new generation preserve earlier produced tactical and technical requirements: multipurpose use of weapons due to modular design; ensuring intelligence, observation, detection and recognition of the target; ensuring effective defeat of a single or group target; 24-hour, all-weather and effective operation in conditions of limited visibility; the possibility of maintaining the target and adjusting the fire; reliability and high technical readiness in all conditions; ensuring high mobility on the battlefield due to the small mass and size of the weapon.

Modern assault rifles have a caliber that at this stage of modernization of small arms is being criticized by the military for the low power of ammunition in the target. This can be eliminated by increasing the ammunition caliber, but industry and military specialists are lobbying for the adoption of more powerful 6.5 mm and 6.8 mm bullets.

There is the process of development a cartridge with optimal characteristics that will replace the 5.56-mm cartridge in the USA. As a replacement, other cartridges, such as the 6.5 mm Grendel, are actively promoting, which is the optimum compromise combining ballistic qualities, affecting action, kickback and size, and mass of ammunition, between 7.62 mm and 5 ammunition, 56 mm.

American militaries want to get a more accurate bullet that can deliver more kinetic energy from short gun barrels, and obviously the 6.5-mm bullet represents a realistic offer with a polymer sleeve, which allows lowering the mass compared to conventional cartridges. The likelihood of hit and injury is increased so much that the overall probability of defeating the target increases significantly for sniper and assault rifles and machine guns. The damage targeting by the 6,5-mm bullet justifies all the disadvantages associated with the transition from a 5.56-mm caliber to a 6.5-mm caliber, while a 6.5-mm bullet due to its mass, jet impetus and combat charge on the final section of the trajectory compared to 5.56 mm and 7.62 mm is more effective.

As one of the promising models, it is also considered 40mm semi-automatic grenade launcher with a laser range finder, an electron and optical sight and a controlling microcomputer.

Calculations show that with the acceptable value of kickback at the moment of the shot, the specified effectiveness of the weapon can be achieved with a grenade mass of 100 - 150 g, a diameter of 20 - 25 mm and an initial speed of 115 - 155 m/s. The results of checking the reliability of the calculations on the prototype of the 40-mm semi-automatic grenade launcher (company "Aerojet"), demonstrate a given effectiveness of defeating group targets during firing at a range of 1000 m grenades weighing 140 g, having an initial speed of 152 m/s.

The main fields of development of small arms and close combat weapons, as elements of military equipment for a soldier, are: increasing the power of rifle weapons while simultaneously maintaining or reducing the mass of weapons by modernizing shots; by modernizing or increasing the caliber of shots; improvement of sighting devices in order to increase the situational awareness of the soldier and ensure ease of use; the development of universal small arms with interchangeable barrels and elements providing various combat missions in order to achieve a fundamentally new level of combat effectiveness, security and autonomy of the soldier's actions on the battlefield by equipping his new generation combat and subsystems integrated into a single complex.

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RESEARCH CREATING PROSPECTS SPECIAL WHEEL ARMS OF WEAPONS COMPLEXES

Special wheeled chassis (SWC) includes all-wheel drive chassis, which are created by the customer's tactical and technical task for mounting and transporting special installations and equipment. SWC is one of the largest classes of wheeled military vehicles used as a base for weapons and military equipment. Of particular importance and widespread use in the Armed Forces were the following SWC: MAZ-543, -543M, -7911, -7912; BAZ-5937, -5939, -5921, -5922; -6944, -6950, -6953, -135MB; Zil-135LM, -135LMP; their models and modifications. A considerable number of weapons complexes were mounted on their base: rocket launcher systems, anti-aircraft missile systems, tactical missile systems, operational-tactical missile systems, coastal missile systems, coastal artillery complexes, unmanned aerial reconnaissance complexes.

The results of the analysis of the state of the SWC fleet of the Armed Forces of Ukraine indicate the absence of weapons of the SWC: modular construction, unified, with increased security and undetectability, with the use in their design of elements with modern (unconventional) technical solutions.

An analysis of the main tactical and technical characteristics (TTC) of SWC has determined that the samples have low rates of maximum speeds of movement, mobility, time to capital repairs (resource) and high rates of fuel and oil consumption (especially operational) through the use of outdated power plants (from armored vehicles or carburetor automobile) and complex drivetrain designs.

According to the results of the analysis of normative-technical documentation for SWC, there are a number of disadvantages: there are no requirements for creation of unified families, modularity of construction, unconventional designs of transmissions, designs of basic units and units; there are restrictions on the number of axles, the axle load. However, there are also promising requirements for standardization and unification, as well as survivability and resistance to external influences, which are not consistent with the existing Armed Forces of Ukraine.

The conducted analysis of the state of the scientific and methodological apparatus of the prospective SWC study showed that the theory and methods of calculating multiaxial machines are aimed at improving the layout and design, and improving the performance and TTC of already existing SWC samples. They are based on the principle of symmetrical development, which consists in the comparative assessment of the CPS of close load capacity in order to maintain parity or to ensure the superiority of TTC over the SWC samples of the leading countries of the world. They allow you to calculate the design, evaluate the layout of the samples and design solutions, to calculate and predict the parameters of performance. However, there are a number of significant drawbacks: the existing theory is focused on the use of traditional engineering solutions; the inability to take into account the large number of internal and external factors associated with the conditions of use of the USSF weapons complexes in contemporary military conflicts; aimed at complicating the design of the SWC, while human capabilities (driver mechanics) are limited and do not allow to provide the required quality of control (implementation of all technical capabilities embedded in the design of the machine), and the theoretical foundations of the general system of automated control of the SWC by the existing theory are formulated only in a general form; research on separate sections of the theory is causally consistent; the use of the existing methodological basis (analysis) leads to deepening only some questions of the theory, but does not allow to justify the optimal complex characteristics and parameters of the SWC, their units and units.

Given the above conclusions from the results of the analyzes:

the practical contradictions between the impossibility of providing the required level of efficiency of the SWC by improving the TTC of existing samples on the one hand and the urgent need to increase them on the other, as well as the contradictions in the theory between the imperfection of the existing theory of SWC synthesis, on the one hand, and the need to obtain them, are formulated;

knowledge to determine requirements for promising SWC samples, which will increase the efficiency of their functioning, on the other;

a scientific and applied problem is posed, which consists in the necessity of solving the contradiction between the modern requirements to the level of efficiency of functioning of the school and the achieved level of development of theoretical bases of their research;

determined the purpose of research on the development of methodological foundations and scientific and methodological apparatus of structural-parametric synthesis of promising secondary school;

formulated the subject and object of the study, outlined the area of study and set the objectives of the study.

Thus, according to the results of the conducted analyzes of the state school of the Armed Forces of Ukraine, the main TTC, the analysis of the normative-technical documentation and the scientific and methodological apparatus for the study of the promising SWC, the contradictions were formulated in practice and in theory, the scientifically applied problem was set, the object was formulated and object, outline the area and set the tasks of the study.

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METHODOLOGICAL PRINCIPLES OF EVALUATION OF MILITARY AUTOMOTIVE EQUIPMENT TERRAIN CROSSING CAPACITY

The development of a new generation of military automotive equipment (MAE) for the needs of the Armed Forces of Ukraine is a priority task, which, on the one hand, is dictated by the need to upgrade the park of MAE for the successful conduct of the war in the east of the state, on the other hand, by the transition of the NATO bloc countries, China and Russia to new models of MAE, which meet the requirements of modern military conflicts. The experience acquired by Ukrainian military men allows to conclude that existing Soviet-era samples do not meet the requirements of modern times.

One of the important operational characteristics of MAE is its terrain crossing capacity. It is known that changing design parameters of a MAE sample to increase the terrain crossing capacity can lead to a decrease in its performance characteristics on highways. An important and relevant component of the development of advanced MAE is the choice of optimal design parameters that will allow to use it with maximum efficiency on public roads and on the ground.

Existing approaches to evaluating terrain crossing capacity of a wheeled MAE allow us to investigate its movement on hard bearing surfaces at an adequate level. At the same time, most of the real bearing surfaces are uneven and have different physical and mechanical properties, both in length and time of the year. The processes of interaction of wheeled MAE with deformed bearing surfaces are much more complicated and insufficiently investigated. Therefore, the improvement of the methodology for assessing terrain crossing capacity of wheeled MAE is an actual problem, the solution of which will increase the efficiency of its usage for the Armed Forces of Ukraine needs in conditions of heterogeneity of soils and uneven deformed bearing surfaces.

In addition, a paradoxical situation has emerged in Ukraine, when amidst the war with Russia and the strategic goal of joining NATO, approved at the legislative level, the requirements of normative documents developed in the 70-80 years of the last century still remain valid. These requirements have already been changed in Russia, both as a result of development of MAE, tactical and technical requirements to them, and the experience of modern military conflicts. Besides, they do not adequately meet the requirements to wheeled MAE of the NATO- member countries.

While researching, a comparative analysis of well-known researches and scientific and methodical approaches on evaluation of all-wheel drive vehicles off-road performance was conducted. According to the analysis, it has been determined that the current methodology for evaluating terrain crossing capacity is based on the principles and approaches that have traditionally been adopted in the Soviet Union, which according to indicators and evaluation criteria do not adequately reflect the approaches adopted by NATO. At the same time, the basic principles of the theory of vehicle movement, adopted in Russia and NATO-member countries are common. Significant differences in these methodologies for the evaluation of terrain crossing capacity begin with different indicators of support-coupling characteristics of the contact surface. Approaches in NATO-member countries are based on using the Cone Index as the index of bearing capacity of the contact surfaces. Based on the performed comparative analysis of these approaches, the bases of evaluation of MAE terrain crossing capacity have been worked out.

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METHODICAL APPROACH TO SOLVING THE INVERSE PROBLEM OF EXTERNAL BALLISTICS DETERMINING THE FUNCTION OF THE AIR RESISTANCE OF A BULLET WITHOUT USING SPECIAL EQUIPMENT

The solution of the inverse problem of external ballistics belongs to the class of the most difficult tasks. Its solution is associated with significant difficulties, which are determined by a nonlinear problem. The use of such approximations results in some, sometimes significant, differences in the result from the experimental data. In this regard, the most accurate, when solving this problem, is considered resource-intensive method of multiple numerical solution of the direct problem of external ballistics.

Experimental (outward-trajectory) methods of determining the air resistance function are based on measuring the flight velocity of a projectile, which is measured on the trajectory of a ball with some discreteness. The main disadvantages of the existing methods are:

the occurrence of large measurement errors at low velocities of the projectiles (due to low air resistance) and the inability to increase the measurement base due to a sharp fall in the flight path;

the need to perform a large amount of measurement preparation work and the use of sophisticated specialized equipment.

Therefore, the urgent task of determining the air resistance function of the ball flight is the formation of an experimental-theoretical approach to the determination of the air resistance function of the projectile without the use of specialized equipment.

An alternative approach to solving this problem is based on the inverse solution of a system of four first-order differential equations that describes the motion of a ball in air as the motion of a solid.

The approach offered allows us to solve with sufficient precision the inverse problem of external ballistics with a minimum of approximations. The accuracy of determining the law of resistance of the air is primarily ensured by the use as experimental data of experimental values of firing.

There is no need to use additional equipment for external trajectory measurements to obtain the output. Moreover, their disadvantage is the inability to obtain projectile characteristics at the end sections of the trajectory, which necessitates the use of additional radar equipment on the ballistic track.

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REDUCING THE LOAD OF THE CREW OF ARMOURED VEHICLES IN CASE OF EXPLOSION

The seats of modern domestic samples of armored combat vehicles (ACV) do not take into account the reaction of the human body to the action of explosive loading, as the basis of work is outdated standards that do not meet modern requirements.

The main role in minimizing the injuries of the crew is not the design of the seats, but the installation in the places of their attachment of energy absorbing elements (EAE), which perform the purpose of mine action by dissipating the energy of the explosion. A seating model is proposed, which involves the mounting of two EAE in the form of crashboxes, which are intended to absorb the impact energy directed along the axis of the element by multiple deformation in the predicted sequence.

To assess the injury when the vertical load criterion used integrated DRI - Dynamic Response Index of the spine on the vertical axis. In the study, the human spine was considered as a mechanical system consisting of a mass, a damper and an elastic element. The maximum allowable DRI value is ≤17.7, which corresponds to a probability of injury of 10%, with a vertical acceleration corresponding to this value not> 14.5g.

To adapt the operation of the EAE to specific loading conditions, depending on the explosive power and mass of the ACV, to prevent the exceeding of critical load values, it was succeeded with the help of the integrated software model model LS-Dyna, which allows to perform dynamic analysis of the blasting of the ACV.

The mathematical model using the explicit finite element method developed in LS DYNA software allowed to estimate the dynamic response of the man-seat system, to take into account the type, shape, amount of explosive, the dissipation of the energy of the explosion by the design of the ACV, to identify the locations of shock wave accumulation and stresses on the housing and take steps to strengthen them during the design phase.

To determine the load in the seats attachment, a numerical experiment was conducted to undermine the multi-purpose tactical Kozak vehicle. The adequacy of the developed numerical mathematical model was estimated by comparing the results of the calculation with the full-scale experiment of the sample, with a relative error of 8.5%. Peak blast acceleration was 28.5g and its duration was 1.8 ms, and the estimated 31g was 1.5ms.

With the help of the proposed approach, it was possible to reduce the crew load when exploding the Kozak armored car on a 6 kg explosive charge from 62g to 12g, ie 5 times compared to the regular seat, which minimizes the likelihood of crew injury. And when blasting 8 kg of BP from 90g to 13g, which corresponds to a probability of injury to the spine of less than 10% according to the maximum permissible values of the load of the human body.

The work carried out is the solution of an actual and important scientific and practical task, which is to increase the security of crews of combat vehicles by substantiating the rational parameters of the seat structure, estimating the explosive load of the crew, formulated and solved as a mathematical problem of mechanics and impact parameters of the EAE on the probability and severity of injury to the crew in in case of explosion of the combat vehicle.

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CONCEPTUAL BASIS OF SUPPLYING THE ARMED FORCES OF UKRAINE WITH DOMESTIC GROUND-BASED ROBOTIC COMPLEXES

The worldwide tendency to conduct combat operations is the intensive expansion of robotic (autonomous) weapons systems in the air, on land and at sea. The Armed Forces (AF) of the US, Russian Federation, China, Israel and other countries have developed strategic plans for the use of robotic systems in combat and humanitarian operations. The preconditions for the success of these countries in the creation of ground-based robotic complexes (GBRC) are the appropriate Concepts, "roadmaps" and National Target Programs for the GBRC Development, the establishment of GBRC Main Development Centers, and the financing of R&D (Research & Development) for the GBRC creation from the defense budgets of these countries. Scientific and production organizations of all forms of ownership are involved in the implementation of these measures, testing infrastructure is created, strategic plans for equipping the Armed Forces with GBRC are developed.

Ukraine is far behind the leaders in the creation and implementation of the GBRC. The creation of GBRC in Ukraine is driven by the working capital of enterprises and scientific organizations, mainly non-state ownership. Research and design samples of GBRC created by enterprises at their own expense do not meet the existing requirements of the Ministry of Defense of Ukraine and the level of foreign samples-analogues.

The conceptual bases of equipping the units of the Armed Forces of Ukraine with the NRC envisage conducting researches and implementation of measures concerning: strategic planning of problems of the GBRC development;determining the needs of the GBRC for the Armed Forces of Ukraine, forms and methods of their application; determining quantitative and qualitative indicators of GBRC's application; conducting tenders for the development and procurement of domestic and foreign GBRC; organization of cooperation of domestic and foreign enterprises and institutions; development and production of domestic NRCs with the use of foreign components; setting up licensed production and offset programs for the GBRC in Ukraine; creation of verticals of governing bodies in the MoD(Ministry of

Defence), Armed Forces of Ukraine, which are responsible for the development and application of the GBRC, including scientific organizations of industry, MoD and Armed Forces of Ukraine, NASU(National Academy of Sciences of Ukraine) and the Ministry of Education and Science of Ukraine; development of program documents for the development of the NRC and equipping the AF with it; ensuring the financing of R&D (Research & Development); creation of the Faculty of Robotics to train specialists in higher educational establishments of the Ministry of Education and Science of Ukraine and the Ministry of Defense of Ukraine.

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AUGMENTED REALITY TECHNOLOGY IMPLEMENTATION IN MILITARY EQUIPMENT IN UKRAINE

Augmented reality (AR) is technology of superposition of graphic, text and raster information with picture of observed space in real time. Just synergy of the calculation devices with real space picture differs that technology from virtual reality

As have shown last international exhibitions of armament and military equipment (AME), AR technology finds the wide usage in military technique of the developed countries. Not to mention certainly about aviation, where that technology was used at first (in creation of aviation sights, head-up displays, helmet mounted targeting systems), AR technology is implementing in other armed services branch. In land forces: helmet mounted system for all-round observation for teams of battle armored vehicles; supply to soldier the necessary information from command staff or reconnaissance center in on-line regime; illumination of the targets and imaging of soldier position on map and supply information about distance to target at complex with laser; identification of objects belonging with application of night vision device, when soldier is equipped with infrared sign; integrating additional information about tactical scenario into ocular in view of standard conditional symbols. In special forces: soldiers training, workup of tactical procedures at planning and execution of special operations; concealment sighting. At creation of the simulators for training of heavy armored vehicle drivers, pilots, paratroopers, when image of ground form is imaging in helmet mounted display, etc.

Today, usage of AR technology in Ukraine is limited aviation systems (helmet mounted targeting systems, aviation sights, producer – SDP SE “Arsenal”), because of the all-round observation system (designer – Limpid Armor Inc.) is not assessed by military specialists in full measure.

Wholly, wide using AR technology by Armed forces some state will increase significantly its battle effectiveness due to improvement situation knowledge of soldier in real time, and capability to accept weighted decision during battle actions. Therefore, on our opinion, implementation of AR technology in AME production in Ukraine should be priory direction for researches under auspice of Defense ministry of Ukraine.

Authors deem it advisable to create Coordination Council for elaboration of AR technologies for Armed forces of Ukraine. The representatives of Defense ministry of Ukraine (Central RI of AME of AFU), National Academy of Science of Ukraine (Physic Institute), Ministry of Education and Science (NTUU “KPI”, Taras Shevchenko NU of Kyiv), SDP SE “Arsenal”, Limpid Armor Inc., RPA.UA and other interested organizations.

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SOLVING THE PRACTICAL NON-LINEAR TASK OF ANALYZING THE MOVEMENT OF ARTILLERY AMMUNITION

One of the current tasks of modern navigation of elements of the high-precision weapon system, namely artillery ammunition (conventional fragmentation shells of 122-203mm calibre), which are equipped with "intelligent" fuses and have several actuation units and their own system, using space radio navigation system (SRNS) data for guidance and correction of trajectory, is the task of improving accuracy of coordinate determination. This problem can be solved by applying various variations in the integration of navigation systems.

One option to solve the practical non-linear problem of analysis of artillery munition movement is to complex the combination of GPS navigation with Kalman filter, which estimates accuracy with the help of incomplete and measurements having noises. The correction circuit with the estimation algorithm is preferably used under the conditions of correction of inertial navigation system (INS) from an external navigation information sensor. Various modifications of the Kalman linear filter are used as the estimation algorithm, and modifications of the non-linear Kalman filter (NFC) are used for high-precision correction.

At present, there are two main directions of research development abroad: study and analysis of Bayes theory and application of modern evolutionary algorithms, namely neural networks, approach of self-organization and their combinations for modification of traditional Kalman filters. Based on the analysis of the work of specialists on this issue, it can be concluded that direct modifications of the Kalman filter - adaptive algorithms - work quite effectively in the absence of reliable a priori information on incoming noise, as well as in conditions of unreliable information on incoming and measuring noise.

The highly accurate correction of navigation information requires a more accurate description of the INS error values, namely the nonlinear model and, accordingly, the NFC. Practically, a priori nonlinear models of INS errors are inadequate to real processes, so implementation of NFC for INS correction has certain difficulties.

It is possible to take full account of all the characteristics of the nature of changes in the errors of navigation information and, most importantly, of a specific navigation system in the conditions of each particular trajectory movement by constructing a non-linear model using evolutionary algorithms (for example, genetic).

Thus, solving the practical non-linear problem of analyzing the movement of artillery ammunition in determining coordinates by applying various variations in the integration of navigation systems (combination of GPS navigation with modifications of traditional Kalman filters) makes it possible to create the necessary models of operation of a multifunctional fuse, which, in turn, can be used in the development of artillery weapons of the Armed Forces of Ukraine.

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RESEARCH OF ARMED STEELS OF FOREIGN PRODUCTION OF ANTI-MINE PROTECTION OF BATTLE ARMED MACHINES

Since the beginning of the Armed Conflict in eastern Ukraine, the need to upgrade the fleet and armored combat vehicles armed with the Armed Forces has become urgent. The overwhelming number of new BBM samples entering the military have been developed and manufactured at state and private enterprises in Ukraine.

The aging of the production base, the loss of skilled personnel in the absence of state funding for new developments in the military field, the lack of necessary experience in a number of enterprises focused on the production of military equipment, cause numerous cases of defects identified during the testing and operation of new machines of the country, refers to light armored combat armored combat vehicles with armored shells consisting of welded space sheet thin sheet structures removable from exterior panels made of alloy armored steel, interconnected and an internal power frame. The occurrence of cracked defects on welded BBM body armor results in a sharp increase in the likelihood of crew damage, which is absolutely unacceptable.

Significant changes in the nature of the armed struggle make it necessary to equip the units of the Armed Forces of Ukraine with promising models of combat armored vehicles with increased levels of mine protection.

Based on the results of the analysis of problems of manufacturing welded armored corps of domestic combat armored vehicles, the study of the structure and properties of welded joints of armored steels of foreign production, the selection and justification of the criteria for the assessment of mine protection with regard to modern medical and technological requirements, units in the design of a combat armored car developed a calculated and experimental method for assessing the stability of combat corps armored vehicles based welds and recommendations for rolled steel arc welding in the manufacture of high hardness buildings armored vehicles with armored steel foreign production.

The practical importance of the research lies in the implementation of results at the enterprises of the industry for improving the welding process of armored combat vehicle hulls and further scientific research in the development of tactical and technical tasks for research and design support for the creation of new models of combat armored vehicles and modern armored vehicles The Armed Forces of Ukraine.

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EVALUATION OF THE EFFECTIVENESS OF MOBILE MOBILITY OPERATIONS BY USING THE MASS-SERVICE THEORY

The experience of modern military conflicts has shown that automated and robotized means of fire, in particular, mobile combat robots (MCR), play an important role in deterring the enemy's firearms. MCR is a ground-based autonomous, remotely controlled, fire-fighting melee weapon that implements the principle of "see-shoot" based on the decision of the human operator. Among such combat features of the MCR as fire efficiency, security and maneuverability in its first place, the importance of its fire efficiency, that is, the ability to strike various goals.

We describe the effectiveness of using MCR using the theory of mass service. An MCR military unit will be considered a Mass Service System (MSS) with service failures, which fulfills claims for the destruction of targets. By signs of such a MSS can be attributed to a class of systems with a queue (goals more than robots in the division, goals in the battlefield do not disappear, and waiting for their queue for destruction). The goal is served by the newly released MCR. The goal waiting time is limited, and goal maintenance is not a priority, that is, random. Although in some cases, priority cases should be considered. The MSS belongs to the open– the flow of applications does not depend on the state of the MCR itself (how much the MCR is employed).

The research determined: absolute capacity (efficiency) of the MCR as a military unit, that is, the average number of goals destroyed per unit time; the relative capacity (efficiency) of the MCR, or the average share of the inbound targets served by the system, will be subjected to a strike; the likelihood of a refusal, or the fact that the target in a battle collision will not be destroyed; the average number of involved MCR.

Two variants were accepted for calculations: the number of MCR in the military unit is three and five machines. Different output parameters for calculation were considered. It was also assumed that the target was not destroyed (it was rejected) if at the time of detection all the MCR units were occupied.

Based on the studies conducted, the boundaries of the possible use of an MCR group as a military unit were outlined. Determined load of each machine and, accordingly, the efficiency of the unit as a whole. On the basis of the conducted analysis, variants of increasing the efficiency of the use of machines and military units in general are calculated.

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ON THE ESTABLISHMENT OF A UNIFORM SYSTEM OF ANALYSIS OF ERRORS OF RADIO-ELECTRONIC EQUIPMENT

The issue of standardization of radio-electronic weapons and electronic component base (ECB) in the Ministry of Defense of Ukraine has not been raised since independence, although this area of research is an important element of the military-technical policy that the Ministry of Defense of Ukraine should improve in the field of quality, combat capabilities and efficiency by creating a system of military regulatory documents that regulate the requirements for the unification, reliability and stability of radioelectrics nnoyi military equipment (RNME), ECB materials and external factors affecting and methods for quality assurance and control EKB and materials.

At present, it is of great importance to develop and refine the methodology for ensuring the reliability (reliability, failure, maintenance, durability and preservation) of the RNME and its ECB components.

It is necessary to create a structure that will be tasked with investigating the reliability and analysis of the causes of RNME failures, which is used in all types of Armed Forces of Ukraine and troop deliveries at all stages of their life cycle, as well as a thorough analysis of the causes of failures and defects of the ECB. In the future, the structure should become one of the scientific, methodological and organizational center for the development of the theory and practice of ensuring the reliability of the RNME and its component ECB. Also, in this structure should develop a methodology and methods of carrying out work on the reliability and analysis of the causes of failures of the equipment and the ECB in accordance with changes in the circuitry, equipment design and technology of its manufacture. In order to resolve the disputes between the developers and manufacturers of the equipment and the developers and manufacturers of the ECB using the methods and techniques for the analysis of the causes of the failures of the RNME and the ECB, it is necessary to create a single system of analysis of the failures of the RNME and the ECB, which consists of branch departments of analysis of failures at the head with the “Interagency Department of Investigation of Reliability and Failure Analysis of RNME and its ECB Components”.

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ESTIMATION OF TARGETS LINE DETECTION OF RADIO ENGINEERING TROOPS RADAR ON MISSILE DIRECTIONS

The line radar detection is understood as the position of the conditional surface in the airspace where air targets are detected by the radar with given indicators. It also provides getting other necessary information about air targets. The line deleting depending on a combination of factors and the nature of the air enemy actions (type, speed and altitude, direction and flight modes of attack equipment, options for interference) are important indicators that determine the information capabilities of individual radars and groups of radio engineering troops.

The method for estimation of line detection is considered in relation to the class of high-speed and low-altitude (flying around the terrain) of aircrafts (cruise missiles) whose echo signals in the radar are observed against the background of interfering reflections from the underlying surface, hydrometeors and goal-like reflections of angel-echo type. It is assumed that the track of targets entering the detection zone of the radar from missile direction are determined based on the configuration of the terrain. Radar parameters, interference characteristics and detection zones (in the “traditional” sense of detection range) are known.

The line detection targets acting from a specific direction is determined by a set of points characterizing the so-called “limit detection range” (or tracking) and recognition of individual targets. The recognition is understood as estimating the motion parameters of a target with a quality sufficient to reliably distinguish target marks against an angel-echo type of noise. The maximum range (described in detail in well-known works) is defined as the average value of the range for the first time detected mark (or group of marks) of a target that approaches the radar at a given speed of movement. The increment of the maximum range is also estimated due to subthreshold (multi-threshold) processing, multi-radar signal processing of several radars in the radio engineering troops deployment.

The estimation of the detection limit (tracking) allows to take into account the effect of consistent surveillance in the radar of all target marks taking into account its speed. Meanwhile the often used (“traditional”) concept of maximum detection range characterizes the result of only one-time interaction of the radar with the target without taking into account the speed. It can lead to incorrect estimates.

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REFERENCES AND TESTING OF SAMPLES OF ARMS AND MILITARY EQUIPMENT IN THE PERFORMANCE OF RENEWAL MEDIUM AND CAPITAL REPAIRS

When performing repair, medium or major repairs of a sample of weapons and military equipment (WME), the following works are performed: defecting, combat damage repair, restoration of performance, proofing and testing. Preliminary work is carried out at the final stage of repair. In order to identify and correct hidden defects, the repair facility operates during the established operating time in conditions and modes close to the operational ones.

During the period of completion of the work is carried out the accretion of components of the sample WME, detection and gradual elimination of hidden defects, while increasing the reliability of the components of the sample WME. The life time of the sample of the WME sample is considered to be over when the magnitude of the failure flow parameter reaches the level required for the operation of the WME sample.

One of the most effective ways of detecting hidden defects is to carry out a technological test run of military-type military vehicles with repaired combat damage and restored performance, in conditions close to actual operation or more severe. After completion of the work-up, the operation of the WME sample must be ensured within a fixed period, which is much less than the repair, inter-repair or after repair life. To identify the hidden defects of the products and the causes of their occurrence, enterprises organize a technological run, which is a special test. Technological breakdown, as a rule, is an integral part of the technological process of repair on a technical condition and covers all restorative products.

During the repair, medium or major repairs of WME samples, hidden defects, which were not found during the elimination of combat damage, or defects that appeared during the repair operations in the WME samples, are revealed. In this regard, after the combat damage is eliminated, repair work is carried out during which these defects are detected and eliminated, resulting in the level of failure of the samples of the WME increases.

In order to determine a reasonable period of completion of the works and tests of the WME sample, a model of dependence of the parameter of the flow of failures from the development should be constructed and a model of change of the total economic costs for the completion of the WME samples and tests.

To solve the problems of constructing a model of change in the integrity of the reference works and tests, and to justify the rational duration of the proofing works in the course of restoration, medium or major repairs of samples of WME is relevant.

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INFLUENCE OF STABILITY OF THE RESERVED STEEL ON PROTECTIVE STABILITY OF COMBINED BURNERS

An urgent task, in modern conditions, is the development of reliable bullet-proof protective structures for the protection of light-armored machinery and the determination of the impact of the strength of armored steel on the anticellular resistance of protective coatings.

Impulse action on the obstacle of high-speed macro and micro-impactors is characterized by various deformation processes, dynamic aspects of the strength of obstacles.

The most dangerous striking factors during combat operations for armored vehicles are bullets, splinters and shock waves from close explosion charges of explosives.

The armor structure directly affects the breaking capacity of the ball core. Great influence on the breakthrough have the configuration and size of the main part of the core. The armored core is made of high quality instrumental carbon and alloy steel with a hardness of 64-67 HRC, or sintered solid alloys 87-90 HRC. Interaction of the core (ball) with an obstacle begins with the phase of a shock wave, which is characterized by the presence of shock waves and rarefaction waves both in the obstacle and in the core.

There are three types of interruptions to breaking obstacles that do not collapse: knocking off the jam from the obstacle; plastic expansion of the hole with a predominantly radial cross-section of the material obstacles; plastic deformation of the obstacle with the formation of the rear outgrowth and its subsequent destruction, such as the cutting of the plug or the formation of a petal hole or plastic bending of the edges. The obstacle can be deformed with the formation of the rear outboard before cutting off the stopper. Knocking the plugs, as a rule, precede the deepening of the core of the ball in an obstacle to a certain depth.

Increased strength leads to a decrease in the depth of the bulge, the appearance and thickness of the barricade of the obstacle. Braking of a ball at a breakthrough obstacle is carried out due to the resistance of the steel armor and the thickness of the not pierced area. Thus, the factors contributing to the anticorrosion resistance of steel armor are: the destruction of obstacles (in part of the bullet) and the formation of release, the resistance of the back of the material to the barrier jamming plug.

The deformation of the rear layers of the obstacle occurs when the armor-piercing balls are activated, which leads to the formation of chips or emerging with a broken crack. The resistance of the cut of the plug depends on the thickness of the broken area of the obstacle and the strength characteristics of its material.

Strength properties of steel armor are beginning to make a significant impact on the resistance only in the rear layers of the obstacle. The higher the strength of the armor material, the less thickness is needed to prevent obstacles from breaking.

To increase the anticorrosion resistance of armored equipment protection, it is advisable to use armored steel of high strength with a relatively small thickness on the rear parts of the combined armor.

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ON THE IMPLEMENTATION OF RESEARCH AND DEVELOPMENT WORKS

The modernization of armaments and military equipment is carried out by performing research and development work in accordance with the needs and priorities identified by the General Staff of the Armed Forces of Ukraine.

Research and development work is carried out on the basis of state contracts concluded between the Ministry of Defense, as a state customer, and business entities.

Before carrying out the research and development work, the necessary research may be carried out, the purpose of which is to substantiate the possibility and feasibility, to search for scientific and technical ways of modernization of arms and military equipment.

To perform research and development work requires:

- joint decision of the Customer and the contractor to open the research and development work, which is approved by the Minister of Defense of Ukraine in accordance with GOST B 15.201;
- execution of an advance project for the implementation of research and design work in accordance with GOST B 15.102 and GOST B 15.103;
- development of a tactical and technical task for the execution of the research and design work (and its components) in accordance with GOST B 15.201;
- development of sketch and technical projects in accordance with GOST B 15.203 and GOST B 15.204;

development of the Program and methods of state tests. Conducting state tests of the prototype. Correction of the working design documentation on the results of state tests of the prototype in accordance with GOST B 15.210 and GOST B 15.211.

The design work (stage, sub-stage of the design work) is considered completed after approval of the act of acceptance of the design work.

The financial support for the closure of work in progress is carried out in accordance with the legislation of Ukraine.

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THE ACQUISITION & TARGETING FACILITIES FOR COUNTER-ROCKETS, ARTILLERY AND MORTAR SYSTEMS AS PERSPECTIVE FIELD OF DEVELOPMENT OF RADAR WEAPONS OF AIR DEFENSE OF GROUND FORCES

In the current conditions of the Joint Forces (JFO) operation, the actual threat is the single enemy shelling (mortar, artillery, rocket) of the areas of troops location and settlements, important military and civilian objects. It is reported that such shelling has usually terroristic character. The enemy makes firing by using civilian vehicles and from settlements or places of gathering of civilian or from critical infrastructures in order to provoke a fire at response. A complexity of terrorists separating, risks of violating international humanitarian law and causing of collateral damages to the civilian population entails limitations of symmetrical measures as use of the counterbattery firing of the Ground Forces (GF) of Armed Forces of Ukraine. Therefore, the report considers a new approach to counteracting such shellings, which envisages, among other measures, the destruction of missiles, shells and enemy mortars by air defence fire.

The report reveals the essence of the concept of counteraction to single missile, artillery and mortar shells, which was implemented in advanced NATO countries, called as C-RAM (Counter - Rockets, Artillery and Mortar) Concept. The results of the comparative analysis of C-RAM tasks with counter-measures to unmanned aerial vehicles (UAVs) are presented. The similarity of the C-RAM Concept tasks with the tasks that solved by air defense troops of GF in JFO is determined.

The characteristics of the existing C-RAM weapons are given, the main trends of their development are determined. Particular attention was paid to the features of the detection, classification and tracking of RAM targets and UAVs, which should ensure operation in a difficult interference environment, with strong requirements for throughput and small values of scattering surface of targets.

Cognitive radars (CogRa) based on active phased array antennas can satisfy these requirements. The CogRa is a new direction to improve the capabilities of radars by smart adaptation operating modes and parameters to suit the environmental characteristics and new knowledge gained during the functioning. In the report considered following aspects. There are essence of Matched Illumination - which is to maximize the radar quality indicators by adaptation of the probing signals and this processing algorithm to the characteristics of the target and radar channel, the Radar Resource-Management and Optimization Technologies is to maximize quality metrics by optimally distribution of power resources and radar searching efforts in and between the operational modes.

It is shown that the use of these technologies, together with Deep Learning algorithms, enables the processing of large data sets in real-time and the formation of feedback circuits at different hierarchical levels of functional CogRa subsystems and the choice of optimal control policy.

The perspective directions of development of methods of analysis and synthesis of functionally necessary components of CogRa for their using as acquisition and targeting devices for fight against missiles, shells, mines and unmanned aerial vehicles of the enemy are also presented.

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PERSPECTIVE WAYS OF INDICATION SYSTEM MODERNIZATION OF SURFACE-TO AIR MISSILE COMPLEXES MEANS

The element base replacement is a well-known trend in the modernization of surface-to-air missile complexes (SAMC) and their components. A promising area is display system units replacement, here monochrome electron beam tubes are widely used as indicators, with modern multifunctional indicators. The urgency of this issue is due to the obsolescence of electron beam tubes and associated radioelectronic devices (deflection systems, specialized high-voltage transformers, voltage multipliers, etc.), their decommissioning, the lack of replenishment of their spare parts. In addition, SAMC indicators, as rules, are only used in combat operations (display of primary or secondary radar information, information on the number and type of missiles, etc.) and when performing some adjustments to the SAMC functional systems during its maintenance.

The modern technologies development makes it possible to significantly expand the indicator systems functionality. First of all, it is to improve the displayed information perception during combat work and to display additional information on the indicator without changing its geometric dimensions due to the use of color displays. In addition, the use of these indicators is possible, provided that there is no need for combat work as:

– monitor of the optical-electronic surveillance system (for the detection of unmanned aerial vehicles, ground protection of the battalion (battery) positions), which will allow to create the main (additional) appropriate observation point in a camouflaged combat vehicle;

– displaying means of interactive electronic operational documentation, which will improve the information support of the maintaining processes a combat vehicle in a capable state, as well as mastering its construction and use for its intended purpose;

– tactical calculation module with the help of a complex of specialized information and calculation tasks, which will improve the quality and efficiency of decision making by officials.

Upgraded device generalized structure is proposed, which includes both hardware and software components. The device hardware includes input signal processing modules, microprocessor module, microcomputer module, display, controls. The software includes modules for processing signals from the outputs of the receiving radar and optical devices, signals for the antennas angular position, signals from the synchronization and tracking systems, as well as a module for storing, processing and preparing them for display, specialized software for displaying operational documentation and calculations.

The implementation of this approach, in addition to the main positive effect will allow to:

– reduce the adjustments number of the indication systems units , which will reduce the operations number during the maintenance and, as a consequence, the duration of their implementation;

– reduce the elements nomenclature of spare parts kits, due to the use in the same blocks of the same hardware, i.e. one device instead of dozens of types of elements (deviating systems, specialized high-voltage transformers, voltage multipliers, etc.);

– improve the trouble-free performance of the display unit, due to the greater reliability of modern devices.

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WAYS TO IMPROVE THE EFFICIENCY OF THE EXISTING MEANS OF FIRE DESTRUCTION BY THE CREATION OF UNMANNED AERIAL RECONNAISSANCE SYSTEMS

The analysis of military conflicts of the last decades shows that their most characteristic feature is transition from" contact "forms of military operations in which the main role is given to blows of several ground kinds of groups of troops, in so-called" contactless", or reconnaissance-fire forms in which the deep fire defeat plays an increasing role. It is to such types of combat operations should prepare the system of fire destruction of the enemy.

Currently, missile troops and artillery are mostly ready to perform tasks in promising forms of combat. Tactical and technical characteristics of samples of missile and artillery systems on such indicators as reliability and maneuverability, generally meet the requirements, but their firing range requires increasing, the processes of command and fire - automation, and the efficiency of exploration and use of certain types of ammunition (primarily precision) - increase.

Prospects for the development of artillery armament currently associated with the implementation of the modern concept of fire damage to the enemy in operations by the method of reconnaissance and fire actions. The possibilities of using artillery armament in the mode of reconnaissance and fire actions with the implementation of modern methods of zonal-object and structural destruction of enemy groups are currently limited. The reason for this is the shortcomings that became evident in recent years and existing in the army, namely a significant number of obsolete models, inadequate reconnaissance, a primitive degree of automation control units of artillery.

The elimination of these shortcomings in the future makes it possible to gradually develop field artillery in a qualitatively new state, which allows the use of missile and artillery formations in the contour of the reconnaissance and fire system, covering all combined arms levels from the battalion to the operational command inclusive. Creation of this system will allow to realize a number of qualitatively new principles, such as" reconnaissance - strike - maneuver","shot (volley, launch) - destruction of the target".

Currently, work is underway to build (upgrade) some missile and artillery systems and control systems. As a result of these activities, it is expected to focus on solving such problems as improving the range and accuracy of shooting day and night and from closed firing positions, automation of control processes.

The purpose of combat use of Land forces and field artillery tasks can be performed only if timely and high-quality targeting. This requires advanced acquisition of intelligence systems, complexes and means of exploration and processing in the appropriate automation control.

Based on the above priority directions of development of weapons systems and the requirements to the subsystem of intelligence, you can define the following main directions of improvement of the means of artillery reconnaissance and target designation in the interests of reconnaissance and fire action field artillery: improvement of the circuitry, methods of digital processing of intelligence information; the introduction of new information technologies; the creation of reconnaissance using multiple detection channels; increase stealth reconnaissance. For all means of ground artillery reconnaissance actual problems are the automation of the processes of reconnaissance and transmission of intelligence, as well as the reduction of mass and dimensional characteristics.

The perspective direction of improvement of means of investigation is placement of the prospecting equipment on air carriers, such as complexes of air investigation with unmanned aerial vehicles, tethered balloons (helicopter platforms). This will lead to a significant increase in the range of exploration: the plane is revised and the weakening of the impact of terrain on the technical capabilities of reconnaissance equipment. At the same time, almost all intelligence objects in the tactical (and even operational-tactical) link will be in the line of sight. The creation of complexes of artillery reconnaissance with UAVs will allow in real time to solve the problem for exploration (additional exploration), targeting enemy targets and maintain the fire of artillery and to deliver video information about enemy targets for an actual evaluation of the application of means of destruction that are currently not possible.

Air-based intelligence and information systems should perform direct or inverse tasks. In the first case, the complex is in the mode of barrage, tied navigation AIDS to the earth's surface, identifies potential targets and gives targeting weapons, in the second case-the UAV program method should be determined by other means the location of the potential target and, after detection, carries out its reconnaissance and illumination.

To perform these tasks, modern intelligence and information systems based on UAVs have an information and computing system, which is a set of information sensors and calculators with the appropriate software, as well as a set of modes of their operation, has a GLONASS/GPS binding and a reference model description of scenes of observation of the earth's surface (in the case of the use of "machine vision" technology) and ensures compliance with a wide range of purpose. Note that the methods of the theory of image processing and pattern recognition in the construction of Autonomous reconnaissance systems is an alternative to GLONASS / GPS technologies (and in some cases, their complement)in the formation of the appearance of on-Board high-precision integrated navigation systems and guidance of unmanned aerial vehicles, primarily because of the very great dependence of satellite navigation systems

The expansion of information capabilities is due to the ability of sensors to receive more information from the data received, while improving the reliability, accuracy, resolution, noise immunity of the information and computer system. Ways to expand information capabilities is the use of "machine vision" technology, integration (aggregation) of data coming from sensors of different physical nature, as well as one physical nature that operate in different frequency ranges.

Note that in order to control the UAV in automatic mode during the flight, it is necessary to continuously carry out high-precision (units of meters) binding of the air platform to the topographic coordinates of the terrain. This can be implemented, for example,by including in the complex of optical and infrared sensors and onboard radar millimeter range in the presence of on-Board computer memory digital maps.

The information from the onboard radar can be directly used in the automatic control loop and, in addition, it allows for a low-altitude flight in the absence of GNSS data through the use of correlation-extreme navigation algorithms. An alternative option may be the use of a laser locator for this purpose.

Analysis of the dynamics of the system in a UAV flight is a very difficult task. The difficulty lies, first, in the absence of mathematical descriptions of the effects of overload on the accuracy of measurement and information Executive equipment; secondly, the need to ensure high accuracy navigation system and target acquisition under conditions of prolonged flight, complex pereskokova situation; third, the practical difficulty of conducting experiments to obtain such models.

The application of various compensation methods gives satisfactory results in ground conditions. However, in flight, under the action of positive overloads, compensation for known models may be insufficient. To prevent such phenomena, it is necessary to synthesize appropriate integrated guidance and targeting systems of diverse nature.

The implementation of this can significantly improve the efficiency of the existing means of fire damage, especially those where precision-guided munitions with laser illumination are used.

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PROBLEMS OF NORMATIVE-TECHNICAL & MAINTENANCE DOCUMENTATION FOR ARMAMENT & MILITARY EQUIPMENT IN MODERN CONDITIONS

The changes in military and political situation and safety strategies around Ukraine and challenge for it national safety force the state administration and command of AF of Ukraine to determine quickly the priority directions for military-technical and military industrial policy and to reform an activity and functioning of defense-industrial complex and different forms of incorporation repair enterprises newly.

Unification of the basic type battle machines is carrying out with accelerated course taking into account structure modularity, improving the basic battle abilities (modernization) and with optimal combining of robotics with run its course elements of armament and military equipment. Military-technical assistance of other states with armament and military equipment (AME) is taken into attention. Taking into account all circumstances, tasks, conditions of battle actions of United forces operations, the new examples of Ukrainian AME have used up its inter-maintenance resource during 1-3 years and demand carrying out the relevant kind maintenance. And thanks only to professional actions of repair bodies of military units, centers, mobile repair teams, industrial repair enterprise, which are carrying out the relevant kind maintenance, the military equipment is in military battle readiness and technically acting status.

In modern conditions and absence of relevant normative-technical and maintenance documentation (NT&RD) for AME (supplies as assistance of other states, Soviet period equipment, new samples or modified) the technical state of some AME samples has demands the additional maintenance works, which are not provided by relevant maintenance rules and works deal with prolongation of prescribed indexes (inter-maintenance resource, firing life etc.). But implementation of these works on national enterprises in modern conditions without full volume of NT&RD is very complicated and carrying out of technical service and maintenance of foreign AME and its elements, supplied and accepted to AF of Ukraine without NT&RD is impossible principally.

Such way, there is problem deals with necessity of development (correction) of NT&RD for AME samples, which are in operational service of AF of Ukraine, which are designing by Ukrainian industry enterprises thanks to their money or money of other states.

Order of designing and formation of NT&RD for AME samples is provided by set of national standards of United system of technological documentation (ESTD), national (DSTU) and acting international (GOST, further – Standards in text).

Taking into account all above mentioned, there is necessary to foresee possibility of putting into Contracts a separate item deals with carrying out of necessary SRPV standards or to foresee a possibility to sign the addendums to state contracts on carrying out of separate tasks in stage of capital maintenance of AME (execution of author and technical supervision from side of enterprises, prolongation of resource of AME samples, issuing of documentation, bulletins concerning to increasing of reliability, preparing of maintenance production etc.) at signing of the state Contracts with enterprises of defense-industrial sector on execution of research and experimental works on maintenance of products, execution of works (services, maintenance) for state defense order. SRPV standards system, which is based on the standards of former USSR, would be re-developed in directive terms to meet an Actions plan concerning to implementation of defense reform approved on 15.08.2016 by Defense ministry of Ukraine.

If today acting "Conception on creation of national system of designing and production of armament, military and special equipment" would be re-developed, then there is necessary to consider in new draft the provisions deal with maintenance documentation, namely:

- development of the documentation for military (ordinary), medium and capital maintenance;
- order of the works implementation on elimination of the structural defects with obligatory correction of maintenance documentation;
- on legislation level to ensure the conditions deal with accessibility for analysis by client of maintenance documentation, which is developed by state enterprises or other incorporation with involving of own resources;
- to create the "transparency-algorithms" for buying of repair parts (electro-, radio-components) by state enterprises and firms independently from incorporation forms.

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CORROSION RESISTANCE OF ANTI-MINE SHIELDS MATERIALS AND INTERNAL FRAGMENT PROTECTION OF ARMORED COMBAT VEHICLE

For the parts of anti-mine shields and internal fragment protection of the armored combat vehicle (ACV) is promising to use the Al-Mg alloys system.

Research findings of the national experts show that protective properties of anti-mine shields made of Al-Mg alloys system improve with increasing of plasticity and impact toughness as well as corresponding decreasing of durability. In order to increase the plasticity and impact toughness and to equalize the values of the materials physical and mechanical properties along the rolling direction of the sheets (plates) and perpendicular to this direction, methods of heat treatment of the parts made of Al-Mg alloys system have been proposed. They consist of heating to a temperature higher than the traditional annealing temperature and accelerated cooling in different environments. After such treatment, the value of impact toughness and elongation is significantly increased with a decreasing of plasticity limit with almost no decreasing of tensile strength. Taking into account the operating conditions of the ACV, the properties of the Al-Mg system alloys were determined after heating to 90°C and 200°C. Materials physical and mechanical properties of the parts subjected to rapid cooling from temperatures exceeding the annealing temperature after heating to 90°C and 200°C and slow cooling in the air were better than those of the annealed parts.

Corrosive effect on ACV constructions is various due to the wide range of operating conditions. Aluminum alloys of the Al-Mg system have a sufficiently high resistance to the different types of corrosion under any treatment conditions (hardening with different degrees of deformation, annealing). According to the modern concepts, the most corrosion-resistant parts have annealing at 320...330°C. Therefore, samples of material of the parts subjected to hardening, annealing, heating and rapid cooling under different modes were tested for the resistance to corrosion under humid tropical climate and marine corrosion. The humid tropical climate was modeled by the standard method: 50°C temperature and periodic water spraying. Marine corrosion was modeled by repetitive immersion of the samples in NaCl solution (10%) and subsequent drying. The test was carried out in the summer at temperatures of 30…35°C in the daytime and 20…25°C at night. The test period was 10 days. All tested samples showed satisfactory corrosion resistance. Thus, it is possible to choose the treatment method to ensure the anti-mine and anti-fragment resistance of the ACV without the risk of protective properties reducing under the influence of corrosion.

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THE METHODICAL BASIS OF THE INVESTIGATION OF THE INFLUENCE OF ERRORS IN PREPARATION TO SHOTGUN WEAPONS

The causes that cause scattering are eliminated, so scattering cannot be eliminated. However, knowing the causes of scattering, it is possible to reduce the impact of each of them and thereby increase the accuracy of firing. As you know, the reduction of scattering is achieved by the proper preparation of weapons and ammunition for firing, accurate alignment of aiming and bringing weapons to normal combat, the selection of shots by type of powder charge, the shape and weight of the bullet, skillful application of firing rules and the implementation of targeting techniques.

Shooting targets for small arms are known to be significantly influenced by firing conditions (meteorological, ballistic and topographic). Their deviation from normal conditions leads to a deviation of the midpoint of the target from the center of the target. However, such deviations are systematic and taken into account when preparing the initial data for firing. Meteorological deviations include the deviation of atmospheric (barometric) pressure on the weapon horizon from 750 mm. Hg Art., deviation of air temperature on the horizon of the weapon from 150C, deviation of relative humidity from 50%, presence of wind.

The ballistic deviations indicated in the firing tables include deflection of weight and shape of the bullet, the initial velocity of the bullet, the angle of departure of the bullet, the temperature of the charge from 150C, the deviation of the position of the front sight from the position corresponding to the normal weapon combat, and exceeding or reducing the target location relative to the horizon. weapons.

The main factors that reduce the effectiveness of firing are errors in the preparation of firing (errors in aiming, errors in the determination of corrections to meteorological, ballistic and topographic conditions of firing and range to the target) and firing errors (errors in aiming and weapons at firing and errors in firing, causing the natural dispersion of bullets). They are accidental, cannot be taken into account, and therefore no early amendment can be made to eliminate them. At the same time, the errors of preparation of firing can be reduced by the use of measuring equipment.

The magnitude of the error in preparation for firing, which is determined by measuring without target range and side wind speeds, significantly reduces the efficiency of firing small arms by the criterion of hitting the target from the first shot by 33 ... 50%. The use of instruments to determine the target range (laser rangefinders) and crosswind velocity (meteorological stations) will allow effective rifle firing at a level determined by its tactical and technical characteristics.

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ARMOR-PIERCING CORES FROM HARD ALLOY WITH SUPER FINE-GRAINED STRUCTURE FOR SMALL ARMS

The bullets with core from hard VK8 alloy with super fine-grained structure made by original technology developed in Igor Sikorsky Kyiv Polytechnic Institute make a hole in the Quardian 500 (Belgium) armor with thickness of 15 mm and not destroyed (the bullets with caliber of 7.62 mm, the distance of 50 m). It is proved that according to the new technology the cores of all calibers of small arms and artillery ammunition can be manufactured on an industrial scale.

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ANALYSIS OF DEVELOPMENT OF ACTIVE PROTECTION COMPLEXES OF LIGHT-ARMED VEHICLES

Active defense is a special missile defense system located on the armed fating vehicles (AFV), combined with a radar system of local action. When detecting an approach to the BBM, the impact vehicle (projectile, grenades, etc.) is commanded to shoot a charge, which, when approaching the projectile, explodes, forming a cloud of fragments that destroy or greatly impair the effect of the munition. There are also systems with non-firing protective charges (APS) "Zaslon" (Ukraine).

Global trends in the development of APS provide their compliance with the following requirements:

- providing circular protection against damage to all existing types of antitank weapon (ATW), including the upper projection;
- "invisibility" for radio intelligence and security;
- providing electromagnetic compatibility, both with the equipment of the carrier and in the unit on the battlefield;
- the smallest overall dimensions;
- ability to combine with dynamic protection (DP) and maximum unification for installation on existing and prospective AFV.

Advanced protection systems face an even more difficult task - intercepting high-speed permeable kinetic and cumulative ammunition with an approach speed of 2500 to 3000 m/s.

This means that all potentially dangerous projectiles / rockets / rocket-propelled grenades flying above the tower of the fighting machine below the specified height, must necessarily be intercepted on approaching the machine.

Based on the analysis of modern APS, which can be installed on the LBM, we can conclude that only some systems, such as "Shuttle", "Arena", "Trophy" in their technical characteristics are most close to the requirements of modernity and ready for combat deployment in the coming period.

As practice shows, not even the most sophisticated type of DP is capable of independently guaranteeing the protection of AFV against the entire PTS spectrum with equal efficiency. In addition, for structural reasons, it is impossible to ensure complete overlap of the frontal and airborne projections of the AFV DP, and these disadvantages neutralize active protection.

Active protection is a future-oriented method of enhancing the viability of LAV. The introduction of APS will significantly reduce the effectiveness of existing and developing PTKR and unmanaged anti-tank vehicles of mechanized units and will put before the developers of ATW a number of serious tasks, the cost of which can significantly exceed the cost of equipping the AFV with APS data.

The modern experience of combat use of LAV clearly demonstrates the benefit of rapid implementation of measures to equip them with complex means of active and dynamic protection, along with improving the means of visibility reduction.

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EVALUATION OF THE INFLUENCE OF THE DRIVERS ON THE DYNAMICS OF THE GYROSOCOPIC SYSTEM OF STABILIZATION AND GUIDANCE

To stabilize the optical line of vision on aircraft, ships, armored objects, as a rule, use electric drives, which carry the movement of the frames of the cardan suspension, in which established optical device on the corps of corresponding object, so that the position of the optical line of vision reproduced direction of the line of vision, which sets. To measure the absolute angular velocity and rotation angles of the optical line of vision in the circuit feedback system stabilization and targeting uses gyroscopic sensors of angular velocity.

As an information-measuring device, the stabilization and guidance system performs two functions: it models the coordinate system associated with the optical line of vision and measures the bearing of the optical line of vision relative to the corps of the object. The accuracy of the entire overview sighting complex depends to a large extent on the error of determining the source information in the form of angles and angular velocities of the bearings of the optical line of vision.

On the example of the azimuthal channel of the stabilization and guidance system, was conducted the research of absolute angular velocities, bearing angles and stabilization errors and guidance of the optical line of vision, taking into account the electromagnetic processes occurring in electric drives of direct and alternating current.

Taking into account the processes in electric drives, was carried out the synthesis of correction devices and the analysis of the dynamics of the stabilization and guidance system with subordinate regulation and indirect measurement sets the effect, which allows to improve the accuracy of the optical line of vision to 0.5 angular./min.

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USING THE BIFURCATION THEORY APPROACHES TO INCREASE THE FORECASTING LEVEL OF MILITARY FORMING OPPORTUNITIES IN THE PROCESS OF FIRE DAMAGE

The results of the multifactorial analysis of the organization of military use of military formations in armed conflicts in the last time indicate that one of the main problems of studying the peculiarities of the military use of military formations is to determine the predicted dynamics of changes in the level of implementation of the capabilities of military formation, this adversely affects the level of combat capability of military formations under conditions of fire influence. Thus, the approach widely used to determine the predicted dynamics of change in the level of implementation of military capabilities through the expected level of irreversible losses of the enemy. Moreover, it should be noted that the level of such losses is determined by indirect dependencies, in particular due to the level of ammunition spending. Even considering the general procedure for determining the level of combat capability due to the cost of ammunition, it can be noted that there will be two groups of significant errors. In particular, such errors associated with a relatively large range of values of the level of irreversible losses at the same rate of ammunition, as well as errors in determining the limit values of the implementation level of military formation capabilities.

At the same time, modern military formations are characterized by saturation of different purpose and structure of elements that have different qualitative influence on the level of realization of possibilities of military formation. For example, the failure of the communication node (the group of nodes), which by the number of personnel and equipment may be less than 5% of the regular strength of the military formation, in most cases will lead to the disruption of the organization of military use of military formation. The results of the analysis of the reasons for the success of the parties in recent armed conflicts indicate that the party that was first struck by the so-called centers of operational (combat) stability (command posts, ground aviation control centers, elements of intelligence systems, air defense, and rebels etc.), whose functional importance is large. The degree of defeat of these elements could reach 20-30% in suppression and 50-60% in destruction.

Thus, in the practice of organizing the enemy's fire damage as one of the elements of the military use of military formations, there was an urgent need to determine the dynamics of change in the level of implementation of the capabilities of the military formation, which determines the level of combat capability of military formations under conditions of fire influence.

Existing approaches to determining the dynamics of change in the level of realization of the possibilities of military formation under conditions of fire influence do not allow to determine it with sufficient accuracy for specific conditions, which accordingly leads to significant inaccuracies in the organization of fire damage (errors in determining the limit values of qualitative change in the level of combat capability are imposed on errors in determined the degree of fire damage (number of tasks), which in turn is superimposed on the errors of determining the forces and means necessary for the Reference tasks, and this in turn applied to the error of identifying the needs of ammunition).

It is known that a qualitative change in the level of realization of the possibilities of military formation at marginal values is characterized by significant changes in the functioning of military formation with relatively small external influences (in particular fire). Thus, it can be argued that when reaching the limit of the level of realization of the capabilities of military formation, it is difficult to predict its further behavior. The level of realization of opportunities may decrease more slowly if the level of synergy of individual elements is higher than that of military formation as a whole, and more rapidly when vice versa. In this case, it may be argued that the process of realizing the possibilities of military formation in conditions of fire influence when reaching the limit value of the level of combat capability is inherent bifurcation. Thus, in order to determine the level of realization of the capabilities of military formations and the dynamics of its change in the process of fire damage, it is proposed to consider the possibility of applying the approaches of the theory of bifurcation as being appropriate to the conditions of the process being investigated.

Thus, the application of the approaches of the theory of bifurcations will determine the dynamics of the level of realization of the possibilities of military formation in the process of fire damage, which will allow for the conditions for changing the organizational structure to increase the stability of the functional links of the components of military formation when reaching the area close to the point of bifurcation. Also, the application of the approaches of the theory of bifurcations, in particular the constant Feigenbaum, will determine the following points of bifurcation of the function of the indicator of the realization of the possibilities of military formation in the process of fire damage, which will increase the time of the functioning of military formation.

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WAYS AND PROBLEMS OF INTRODUCTION OF NATO IFF SYSTEM MEANS TO THE ARMED FORCES OF UKRAINE

Implementation of interrogators and responders of the NATO IFF system Mk XA used in many non-aligned states is called to improve the control of airspace of Ukraine and to prevent “friendly fire” during international military co-operation.

The analysis of the principles of the construction and application of radar detection systems of Ukraine and NATO shows that these systems are technically and systematically incompatible. Technical incompatibility consists in the first place in the difference in the frequency of signals in 1.5 times. It prevents the use of single generators, radiation and signal reception. Different principles and capabilities of identification implemented in systems require different technical implementation display of the results of identification, automatic decision making. System incompatibility consists of different principles of general and individual identification of air, surface and ground objects and in the application of modes and identification codes. Therefore, it is possible only an independent parallel to the existing means of identification – interrogators and responders – and using elements of the Mk XA system.

A simple replacement of equipment of the 3rd band of the “Parol” system on the equipment of the Mk XA system does not solve the problem. Necessary substantial revisions of the “carriers” of interrogators and responders on many samples of existing weapons the introduction of Mk XA interrogators is even technically impossible because the frequency of the third band differs from the frequencies Mk XA by approximately 1.6 times and through different identification principles.

During the modernization of interrogators and respondents of the system "Parol" (VII band) on the block-modular principle there is creation of complex means having the elements of the interrogator (respondent) of the Mk XA system. It allows to introduce the means of the system Mk XA there and then where and when it is necessary and technically possible. But there is also need in substantial revisions of the “carriers” of the interrogators and responders.

During the implementation of the elements of the Mk XA system by installing complex interrogators and responders, it is necessary to complete the means (radar, anti-aircraft missile complex, aircraft) which involves conjugation in the part of control, processing, display, transmission and use of information.

For some or many weapons systems this may be technically impossible. In such cases, the prevention of false fire exposure may be provided by operational alerts from radar reconnaissance facilities equipped with the Mk XA interrogators.

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INTELLIGENT SYSTEM OF ELECTRICITY SUPPLY TO MILITARY EQUIPMENT IN FIELD CONDITIONS

The power supply of military equipment in field conditions is very important in the military actions in case of damage to stationary electricity networks. The use of diesel generators creates a noise that disguises troops, which allows the enemy to identify the masked positions of Ukrainian troops.

In order to provide power supply for military equipment in field conditions, the authors offer an intelligent power system consisting of solar panels, super-capacitors, accumulators, a device for tracking the position of the sun and a maximum power point tracking device for each solar panel.

An important element of the intelligent power supply system for military equipment in the field is a diagnostic unit for each solar panel, each cell of the supercapacitor unit and each cell of the battery. The peculiar feature of this device is the proposed new diagnostic algorithms based on the fractional number theory, impedance spectroscopy and elements of the theory of artificial intelligence.

A common feature of all components of the intelligent power supply system for military equipment in field conditions is that they all consist of serially connected cells, whose work depends on their internal complex resistance. For example, the solar panel consists of serially connected photocells, the supercapacitor battery consists of serially connected supercapacitor cells, and the rechargeable battery consists of a series of connected galvanic cells.

The use of smart Internet technology allows you to use the individual IP address of each solar cell, each supercapacitor battery and each battery. This allows for remote diagnostics of each of the serially connected photocells in the solar panel, each of the serially connected supercapacitor cells and each of the series of connected galvanic cells in the rechargeable battery. The received information is remotely transmitted to the laptop, processed and depending on the results of the diagnosis, control signals are generated to ensure the maximum efficiency of the system and its maximum efficiency and can be applied in the units of the armed forces, command posts, the rear units of the security, which will significantly increase their energy independence in field conditions and in military actions.

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DEVELOPMENT OF SCIENTIFIC BASES OF STRUCTURAL MATERIALS AND COATINGS, EFFECTIVELY ABSORBING ELECTROMAGNETIC ERADIATION IN SPECIFIED SPECTRAL DIAPASONS

The purpose of the work is development of scientific bases of new materials and coatings promising for practical use and introduction into manufacture, minimizing the visibility in the radar and infrared ranges of the spectrum, production of experimental samples, study of their physical and chemical properties and operational parameters.

The objects of study are structural radioabsorbing materials, painted antiradar coatings, nanosystems and fillers which interact actively with electromagnetic eradiation in a wide range of the electromagnetic spectrum.

Research methods include X-ray phase analysis, electron and optical microscopy, differential thermal analysis, measuring of magnetic, electrical, electrophysic and optical characteristics, climatic tests, theoretical calculations, etc.

Research content consisted of: synthesis of ultrafine and nanosized components with given dielectrical and magnetic losses, creation of matrix-dispersed and film systems based on them, which interact effectively with electromagnetic eradiation in promising spectral ranges, study of their physico-chemical and dynamic properties, determination of optimal composition, research into the operational characteristics of radioabsorbing materials and coatings as well as influence of operational conditions, etc. on their parameters; scientific substantiation of new promising ways for obtaining of radioabsorbing materials with predetermined electrodynamic parameters and the possibility of high-adhesive deposition onto metal and non-metal surfaces, using technologies of painting and gluing of tiles, creation of experimental samples of radioabsorbing materials for a decrease in radar visibility and wide functional destination; development of techniques and technologies for production of new non-combustible / low-combustible materials and coatings which are ecologically safe and promising for introduction into manufacture from environmentally friendly and economically accessible components.

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WAYS OF DEVELOPMENT OF BASIC WHEEL AND TRACK PLATFORM

The analysis of the loss of weapons and military equipment (WME) in the Joint Force operation indicates a significant burden on the WME reconstruction system. These circumstances are conditioned by the large nomenclature of WME samples that were in service with the Armed Forces (AF) of Ukraine until 2014 and an increase in the nomenclature - after the adoption of new and modernized WME samples.

In addition, an increase in the WME nomenclature accordingly leads to an increase in the inventory of material and technical equipment (MTE) needed to repair the WME samples that have received operational or combat damage. These circumstances undoubtedly affect the logistics system of the Armed Forces of Ukraine, one of the functions of which is the subsystem of recovery, the functioning of which depends directly on the subsystem of provision of MTE. Processing information of the MTE subsystem regarding the need for military units (units) in the MTE, determining the storage locations of MTE in need, determining the transport to which they are to be served leads to an increase in the time of their submission to military units (units). And the wide nomenclature of WME, respectively, for their restoration of MTE virtually makes it impossible to submit to the designated place and in due time the necessary MTE.

Thus, in order to reduce the burden on the logistics system of the Armed Forces of Ukraine and its corresponding subsystems for the renewal of military-industrial complex and provision of MTE, it is necessary to find new and effective ways of creating basic wheel and track platforms. These platforms must be unified and allow for the installation of firefighting equipment and special equipment on their basis, depending on the specifics and tasks of the troop and services.

To solve this problem, a basic wheel and crawler platform of modular type is proposed. These base platforms should provide for the possibility of accommodating a crew or remote control, quick replacement of damaged units and units, the ability to install different types of firearms or special equipment, etc. Accordingly, the platform data must include a crew or remote control module, a power unit, a transmission module, a chassis module, and the platform body must include cells for mounting the said modules.

Thus, the creation of these platforms will allow to unify the base platforms for the installation of firearms and special equipment, simplify the design, allow for rapid change of purpose of the base platforms, reduce the time and amount of repair due to the modular repair method, and provide modular configuration, the possibility of upgrading by replacing modules, convenient transportation with different modes of transport, etc.

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APPLICATION OF IMAGE SEGMENTATION METHOD FOR DETERMINATION OF POSITION OF SIGHT VIEWING LINE“RETICULE” TYPE

Process of sight reticle (SR) coordinates determination should be automated with purpose to minimization an error, when visual superposition of SR with viewing sign of measuring optical-electronic complex (OEC) collimation channel. There is drawn analytic correspondence between deviation of control sight viewing line (VL), conditioned by operator error during visual superposition, and laser spot in coordinate system of the OEC relevant digital photo-detectors (DPD).

Two congruencies are drawn, when there is misalignment between sight VL and laser beam axis. These congruencies are violated, when there is deviation of sight VL. Then difference its left and right parts will determinate a value of VL deviation relatively to laser beam in both planes.

Let we consider method of SR displacement value determination on simplified model using the image segmentation method.

There is resulting from analysis of DPD area, where SR image has been formed, that SR reticule is dividing an area of viewing sign image by four rectangles.

The linear value of VL displacement in areas of relevant DPDs depends on coordinates of both rectangles and laser spot centers. The linear displacements are converting into angular values, taking into account the DSDs pixels dimensions, objectives focus of both ocular and OEC collimator channel cameras and sight magnification.

Assessment of error of VL position determination of sight under control together with weapon gives result 4,7" - 5,9" for different kinds of OEC, if a considered method is using for determination of coordinates of SR reticule.

The following conclusion may be done on base of results on calculation of error of VL angle displacement determination, if automation control method is applied:

- using of automated method for control of the sights VLs during tests permits to increase an accuracy of measurements by 1,6 - 2,1 times in comparison with non-automated method;
- using of the OEC with additional reflector permits to increase accuracy on 1,2" - 1,4".

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METHOD FOR SIGHT VIEWING LINE CONTROL DURING VERIFICATION FIRE PROCESS

Verification fire is carrying out according to following methodology:

a) measuring optical-electron complex (OEC) is preparing for operation in accordance with it operation documentation;

b) weapon equipped with sight is preparing for normal fire in accordance with it operation documentation;

c) sight under control is dismounting from weapon and installing on mounting seat of zero-collimator five times with determination of viewing line (VL) position in both coordinates (horizon, vertical);

d) average values of VL coordinates determined by zero-collimator are calculating;

e) sight under control is dismounting from mounting seat of zero-collimator and installing on weapon again;

f) series from 10 shots to breast target installed in distance 100 m from shooter is carrying out with further determination of dispersion center (DC) position relatively to sighting dot in both coordinates (horizon, vertical);

g) weapon equipped with sight is fastening into special fixture PS-51 type;

h) barrel collimator 1P6 type is installing 5 times into weapon barrel and VL position is determining in both coordinates (horizon, vertical);

i) average values of VL coordinates are determining by means of barrel collimator;

j) weapon equipped with sight is installing on OEC supports;

k) laser is installing upon weapon barrel and switch on it power supply;

l) sighting sign of sight under control is adjusting 5 times with viewing sign of OEC collimation –measuring channel by changing of weapon angle position;

m) coordinates of laser spot, sighting reticle and control dot are storing in PC memory with application of special software;

n) angles between laser beam axis in horizontal and vertical planes corresponding to initial position of VL are calculating;

o) average values of VL coordinates are calculating;

p) laser is dismounting from weapon, weapon is dismounting from supports and 5 series (10 shots in every series) to breast target installed in distance 100 m from shooter is carrying out;

q) DC position relatively to sighting dot is determining in both coordinates (horizon, vertical);

r) weapon equipped with sight is fastening again into special fixture PS-51 type;

s) barrel collimator 1P6 type is installing again 5 times into weapon barrel and VL position is determining in both coordinates (horizon, vertical);

t) average values of VL coordinates of sight under control determined by barrel collimator are calculating;

u) weapon equipped with sight is installing again on OEC supports;

v) laser with weapon is installing again on assigned place in reverse order;

w) values of laser spot, sighting reticle and control dot coordinates are determining duplicating items (l)…(n);

x) average values of VL coordinates are calculating;

z) sight under control is dismounting again from weapon and installing on mounting seat of zero-collimator five times with determination of viewing line (VL) position in both coordinates (horizon, vertical);

y) average values of VL coordinates determined by zero-collimator and values of VL controlled sight displacement are calculating for every method.

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OPTICAL-ELECTRONIC COMPLEXES FOR CONTROL OF OPTICAL SIGHTS VIEWING LINE POSITION

A value of accessible deviation of viewing line (VL) – one of important characteristics sighting technique is 54" for weapon of high accuracy. From metrological point of view, an accessible boundary of measurements should be equal (0,2…0,3) from boundary of symmetrical tolerance for important parameter under measuring. Such way, maximal value of accessible error of the optical-electronic complexes (OEC) for VL position control of modern sights should not excess 10…16".

On base of analytic survey results of existing technical means and methodic for VL position control, its accuracy calculation results we can draw conclusion – they do not meet the abovementioned accuracy. We can formulate other demands to such OEC:

- measurement diapason for measuring of angles should ensure possibility to assess a VL deviation within all diapason of sighting angles;
- absence of necessity to re-set a sight on weapon mounting support during it control;
- decreasing or full absence of dependence of measurement results from operator qualification;
- automation of measurement process with possibility to safe the measurement results for further its analysis and processing;
- safety for operating personnel and for weapon technical state, relative operation simplicity.

To meet these demands – OEC should be designed on base of modern element base: laser for identification of weapon barrel channel and digital photo-detector for identification of laser axis and sight VL.

Five variants of OEC designing are considering in presentation:

- with integrated collimation and receiving channels on base of direct laser emission;
- with distributed collimation and receiving channels on base of direct laser emission;
- with integrated collimation and receiving channels with application of reflector;
- with distributed collimation and receiving channels with application of reflector;
- with application of laser cartridge for control of the sights of ground unmanned complex battle modules.

Accuracy calculations for these schemes have shown they meet requirements to OEC but without sufficient metrological margin.

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CURRENT STATE OF MILITARY EQUIPMENT IR CONCEALMENT ANALYSYS

In modern conditions of warfare, the task of hiding objects of military equipment of optoelectronic intelligence (OE) reconnaissance, operating in the infrared (IR) range of wave, is particularly relevant.

Modern day IR reconnaissance make it possible to detect objects of military equipment of a wide range with a high probability. Military experts note that the percentage of identified targets in the optical-visual reconnaissance equipment during the day and night is approximately identical. In this regard, it is obvious that the problematic issues of reliable camouflage of military equipment of reconnaissance in the IR range require an appropriate solution.

It is possible to counteract an enemy’s IR reconnaissance quite successfully by using passive and active methods and means of hiding and thermal imitation of military equipment.

To conceal objects of military equipment in the IR wavelength range, a set of measures should be implemented to compensate for the thermal contrast between the object and its surrounding background, and to simulate them, by reproducing thermal contrast on the surface of an incorrect thermal target, it corresponds to a real-life model of military equipment.

Passive methods and means of concealment and imitation are well known, described in detail in many sources and are widely used in the armies of the leading countries of the world. Basically, this is the use of materials of different types in design and composition, deform and reduce the thermal signature of the object; enamels and varnishes for painting equipment, with a reflection coefficient, lies in the range of 10 - 40%; foaming and porous materials applied to the surface of objects.

In addition, various heat-scattering and heat-reflecting coatings and materials, usually consisting of several layers, are widely represented.

Also, modern nano-structural materials, for example, electromagnetic wave absorbers made in the form of oxide polymer (ceramic) microspheres based on lead or small carbon tubes oriented vertically, have great potential for masking military equipment. According to the authors of these developments, the use of various options for such materials achieves a reduction in the detection range of objects 3 times.

The most promising direction for the development of concealment and imitation of objective equipment in the infrared wavelength range, according to experts, is the creation and use of materials and coatings with controlled thermal radiation.

The five most famous companies that have achieved significant results are the Israeli "Eltics", which developed the camouflage system "BlackFox"; Swedish "Saab Barracuda", which created the eponymous mobile camouflage system; British "BAE Systems", which launched the production of the system of hiding the thermal radiation of the objects "Adaptiv"; American "AAE Tacticam", which has developed adaptive coatings and special camouflage panels.

Based on the above means of concealment and thermal imitation should satisfy the following basic requirements:

have multispectral functionality;

match the capabilities of the spatial and energy resolution of the reconnaissance IR range;

have the ability to control radiation sources in a wide temperature range, low energy costs;

universality of application at various objects of military equipment.

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INFANTRY SMALL ARMS DEVELOPMENT TENDENCIES

Many countries' armed forces are exploring the need for next-generation small arms, which suits best for effective missions across the future "operational space" spectrum.

Procurement programs have been implemented in the world over the last four years, and demand for small arms has been identified and illustrates specific trends in small arms development.

In September 2016 the French Army announced a contract with Heckler & Koch worth EUR 168 million, replacing regular assault rifles FAMAS F1 with HK416F 5.56x45 mm rifles. The possibility of replacing the FRF2 sniper rifle with a self-loading rifle in 7.62 caliber and a Minimi machine gun in 5.56 caliber with 7.62 Lightweight Machine Guns (LMGs) is also being considered.

In April 2017 the German Armed Forces issued a request for the System Sturmgewehr Bundeswehr program proposals, which required the replacement of H&K G36 5.56x45 mm assault rifles with the same caliber system. According to the official documents, up to 120,000 rifles will be purchased between 2019 and 2026.

In 2016 the Special Operations Forces of the Netherlands decided to replace the HK416 assault rifles in 5.56 mm caliber with SIG Sauer MCX assault rifles in the .300 BLK caliber.

In March 2017 USSOCOM decided to purchase M4A1 assault rifle retrofit kits to use in both 5.56 mm and .300 BLK calibers.

In April 2017 USSOCOM issued a demand request for an Advanced Sniper Rifle (ASR) modern sniper rifle. The new ASR requirement is to find a single sniper weapon that can be converted to any of the three calibers in a minimum time: the .338 NM cartridge along with the more conventional 7.62x51 mm and .300 NM cartridges.

The .338NM cartridge is also gaining popularity in weapons of other types, including the USSOCOM requirement for the Lightweight Medium Machine Gun (LWMMG), which provides the delivery of 5,000 such systems for military testing and evaluation.

The LWMMG Request for Proposals, published in May 2017, envisages the development of a .338 NM medium-ribbon cartridge, which is an easy alternative to .50 BMG (12.7 x 99 mm) large-caliber machine guns.

But the most crucial are the measures announced in early 2019 by the US Army, namely a program to develop a "next-generation squad weapon / NGSW" represented by the NGSW-AR manual machine gun to replace the M249 and the NGSW-R assault rifle to replace the M4, 250,000 weapons under the new 6.5mm or 6.8mm CT (Cased Telescoped) cartridge and the cartridges themselves 150,000,000. At the end of spring 2019 potential contractors for the "next-generation squad weapon" development are suggested to submit applications for 53 NGSW-R and 43 NGSW-AR units and 845,000 test rounds.

A significant difference of the complex is the telescopic cartridge use (the bullet is placed inside the powder charge, the powder charge itself is placed in a plastic sleeve), which provides a 40 percent reduction in weight than the tactical counterparts.

The main purpose of the implementation of this system in the US Armed Forces is to increase the mobility, situational awareness of the military personnel and ensure the defeat of the enemy protected by modern personal protective equipment at distances up to 600 meters.

Based on the above, we can make the following conclusions:

considering that any shift from widespread types of ammunition to existing small arms related to high financial costs, in the short to medium terms, few Western forces will have to move far from existing NATO standards until the moment of successful implementation of the US program of transition to the fundamentally new "weapon-cartridge";

Special Operations Forces of different countries with their special requirements will field alternative ammunition for small arms or new complexes "weapon-cartridge".

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FEATURES OF THE SPECTRUM OF A SIGNAL REFLECTED FROM VORTEX RING

The troposphere is a nonuniform, random, nonstationary medium, the radiophysical properties of which depend on a many number of factors. The most volatile is the lower layer of the troposphere immediately adjacent to the earth's surface (planetary boundary layer, PBL). Depending on the meteorological situation, inhomogeneities of different spatial sizes (layered, pointed) can occur in the PBL. Pointed inhomogeneities, it is necessary to distinguish inhomogeneities with a long lifetime, which can strongly influence the functioning of radio engineering systems (RES) - the so-called dotted-echo (thermals, globules, etc.). The physical basis for the occurrence of such discontinuities is the movement of air, which can become closed (the formation of a vortex, which in turn can evolve into a vortex ring). Tropospheric non-uniformity of the dynamic type in the form of vortex rings (VR) can move in space without breaking up to a distance of about 100 intrinsic diameters and can carry within it a certain amount of foreign matter, the electrical properties of which differ from the properties of the surrounding air. Thus, VRs can act as reflectors of electromagnetic energy. A feature of the VR is the absence of an outer shell in them, which would keep the substance inside, therefore, gradually foreign matter is removed from the vortex ring. That is, with time, when moving in space, the electrical properties of the VR will change. The speed of these changes will be defined as internal (size, state, amount, mass and particle size of foreign matter, ring size and vortex rotation speed), as well as external factors (turbulence, wind speed and direction). The result will be a change in both the amplitude and spectral characteristics of the signals reflected from the VR.

The report provides theoretical estimates of changes in the spectra of signals reflected from VR at different stages of the life of a vortex ring, and the results of experimental studies of this issue.

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THE METHOD OF INCREASING THE EFFICIENCY OF DETECTION OF AIR OBJECTS USING A PASSIVE RECEPTION SYSTEM

It has been established that the main trend in the development of airborne objects is a decrease in their radar visibility. Small values of the effective scattering surface of modern and prospective air objects cause a deterioration in the efficiency of their detection.

The traditional methods of increasing the efficiency of detecting subtle air objects are considered. It has been established that the main disadvantage of using such methods is an increase in the number of radar stations, power consumption and, as a consequence, the cost of creating and maintaining a radar field.

To improve the efficiency of detecting subtle air objects, a method is proposed that is based on the use of a system of passive receivers. The information of such a system of passive receivers, which are located at a certain distance from each other, can be used as an additional one at command posts of radio engineering units, as well as for creating and maintaining a continuous radar field.

Detection of air objects and determining their coordinates is performed by measuring the relative delays of signals from objects. Therefore, you can refuse to review the airspace and use omnidirectional antennas. But it is necessary to scan the entire range of frequencies at which the sources of such information from airborne objects operate.

In the case of pulsed radiation, the time of arrival of the signal at each of the receivers is distinguished. In the case of a continuous signal, it is necessary to use the basic correlation function of the radiation received at individual positions (bases) to measure the delay.

To measure the angular coordinates of air objects in the system of passive receivers, you can use known methods of direction finding, namely: angular, differential and distance measuring, or angular differential and distance measuring.

In further studies, it is necessary to choose a method for determining the coordinates of air objects and consider the main sources of information for the passive system of receivers, their tactical and technical characteristics and determine at what frequencies the receivers of the proposed system should work.

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RESEARCH OF PROCESS OF DEVELOPMENT OF FIRE AT MODEL TESTS OF BECOMING OF MODEL STACK WITH 125 TANNED MM BY OF TANK SHOTS IN THE STATE WOODEN CONTAINER

In the modern terms of conducting OOS in the Lugansk and Donetsk regions on east of Ukraine for all soldiery forming andpower structures new calls require permanent perfection of existing and developments of new methods of defence of these important objects. Organization and conducting of the measures related to safe maintenance of ammunition in soldiery parts of MilitaryPowers of Ukraine taking into account credible threats in relation to realization of assassinations (attacks) on the objectsof saving went out on the first plan. Thus development of receptions and methods of extinguishing of firesdepending on descriptionsof sources of zapalyovannya is important, that characteristically during application by the diversionary groups of opponentof different zapalyovalnih facilities and zapalyovalnoi weapon of different groups, and also through new aspects of theirapplication with the help of shock bezpilotnih aviation complexes. With the purpose of study of this question, creation ofmore effective checking system after providing of vitality and vibouhopogegobezpeci in Military Powers of Ukraine, makingof clear order of estimation of such potentially dangerous objects, timely operative reaction in the case of extraordinarysituations on potentially dangerous military objectives, working of suggestions on the defensive and defence from the zapalyovalnoiweapon of places of saving of ammunition, in that number on the field compositions of placing of armament and live ammunitions, the proper scientific researches were conducted.

In a lecture the results of conducting of the planned fire test are consideredfrom zapalyovannya on a 233 general-military ground (s. New Lyobomirca, Rivnenscoi obl.) of experimental model stack 125mm of the OF tank shots which designs the state depository of the opened saving with such live ammunitions. Scladouvannyaof the state oucouporci was conducted according to a chart which was used during saving of live ammunitions on a ground № 149 technical territory v/ch A1358 with covering. To the place of conducting of experiment from soldiery parts complete setsare delivered 125 mm of the finally unequipped tank shots in the state oucouportsi III category in a quantity 200 complete sets and as sources of zapalyovannya gunpowder of nitroglitserinoviy band to the type of brand NBL-92 (to SPG-9).

To night before conducting of experiment there was a rain, part of wooden oucouporci under live ammunitions were moist.During conducting of experiment there was a sun and windy weather, temperature of air + 9 0C, humidity of air 90%.

The experiment was conducted **in three stages**:

And a stage is establishment of possibility of becoming of the individual state oucouporci (wooden to the box) tanned withthe use of bunch of nitroglitserinovogo band gunpowder of brand NBL-92.

For conducting of experiment the empty oucouporca (wooden container) from the complete set of tank shot and nitroglitserinoviy band gunpowder was used weighing **650** g.

After a zgoryannya gunpowder the decay from which flame appeared gradually began in one place. As a result of combustion of gunpowder during **3** hv. it was observed presence of smoke, and through **5** minutes. appearance of the opened flame. In **10** minutes a box confidently flamed up. Mechanical destruction of box and complete combustion happened through **40** minutes.

Conclusion. It is possible to inflame the state oucouporcou (wooden box) with the use of bunch of nitroglitserinovogo band gunpowder. From one place of decay possible formation of flame. A box fully burns during **40** minutes.

The **II stage** - determination of interval of time after becoming of single wooden box tanned which causes poslidouyochou detonation of metalnogo gunpowder charge G-40 during burning of one state oucouporci (wooden container). An arson was carried out by one bunch of nitroglitserinovogo band gunpowder of brand NBL-92.

For the experiment the state oucouporca (wooden box) was used to which from the complete set of tank shot one metalniy gunpowdercharge G-40 in air-tight metallic toubousi was stopped up.

Through **10** minutes loud detonation of gunpowder charge with a subsequent break and destruction of metallic corps and troop landing of flame of large intensity happened after the arson of box.

Conclusion. Temperatures and quantities of heat which is selected during burning of even one state oucouporci (wooden tothe box), it is enough for warming up of metallic toubousa and display of detonation of metalnogo gunpowder charge G-40 through **10** minutes after an arson.

The III stage. Recreation of the real situation and exposure of threats as a result of fire of model stack 125 mm of the OF not of course equipped tank shots in the state oucouportsi in a quantity **200** complete sets.

For conducting of final stage of experiment was reproduced chart of conclusion of live ammunitions, which was used during heir stationary saving on the ground of the opened saving № 149 (with covering) on technical territory of military part A1358.

On **6** minutes fire test there was appearance of smoke and opened flame. On **10** minutes the first explosion of gunpowder charge G40 with the troop landing of flame happened. The first detonation to directly the shell (loud explosion) happened o 13 god.12 hv. that is through **12** minutes after an arson.

In a period with 13 god. 23 hv. to 14 god. 00 hv. the series of mass explosions of gunpowder charges and shells happened that resulted in complete destruction of stack.

During the explosions there was flying away of shells, wreckages and blazing elements of stack on distance to 100 m. The last explosion was one can hear o 14 god.00 hv. that is the explosions of experimental stack proceeded a **1 hour** after anarson.

On a next day the inspection of place of explosion of stack was carried out with live ammunitions and the following is as a result set:

maximal distance on which flying away of a few live ammunitions happened makes 95м, one of them with burning down of explosive in the place of falling;

the basic quantity of live ammunitions, toubousiv with gunpowder charges and tailings of oucouporci is found in the distance to 60 m.;

with 200 shells was in the not zdetonovanomou state 163 sht. (from them 24 with a vigorivshoyo explosive)is found, the other shells burst during the experiment;

with 200 gunpowder charges in the whole state 45 sht. is found Gunpowder the other charges burst during the experiment. The maximal radius of flying away of metallic oucouporci and elements of gunpowder charges makes to 100 m.;

3 tank shots were not damaged by a fire and explosion in the state oucouportsi.

Live ammunitions (shells and gunpowder charges)which remained not zdetonovanimi after the experiment was collected by subsection of the mine clearing and annihilated by the set order.

Motion of conducting of experimental fire test from zapalyovannya of stack was fixed by means the photo-videosurvey with cvadracoptera and the ground set video cameras.

Conclusion: Thus the conducted experiment confirmed possibility of development of extraordinary situation of similar to the extraordinary events, that happened on arsenals in Balakleya, Kalinivka, Ichnya, as a result of diversionary actions on the grounds of the opened saving of live ammunitions by an arson. **12-15** minutes are control time from the beginning of becoming of stack tanned to the moment of beginning of detonation of tank live ammunitions only. It is that relatively safe interval of time in which subsections of fire guard of arsenal must carry out measures on battle development and liquidation of fire in the place of its origin. Farther a fire becomes uncontrolled and carries a chaotic character.

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DEVELOPMENT OF AUTOMATED CALCULATIONS OF INTRABALLISTIC CHARACTERISTICS

Calculations of intraballistic characteristics (IBC) is an essential component of designing solid propellant rocket motors (SPRM). Presently, the use of the mathematical model method for calculations of SPRM IBC is a challenging and resource-intensive task. For this reason, development of automated calculations is of high priority.

For this purpose the authors have developed software which the user feeds with input data required for calculations, and the developed software performs calculations based on the preprogrammed algorithms. The use of this product makes it possible to increase productivity and efficiency of work, and also to improve accuracy of calculations.

The computational solution to the task was implemented with the use of a built 3D solid propellant grain model and subsequent truncation of the obtained model with determining the surface area at each step. Thereby, burning process was simulated. The basic equation of internal ballistics, namely, the equation of Bori, was applied as the main dependency.

The mathematical model of internal ballistics is implemented in the research software package for numerical computations Scilab. The developed software is a graphical user interface created with help of Scilab GUI Builder. The software consists of four main units: an output data unit (thermodynamic and physical-chemical properties, burning law parameters), a unit of estimates of IBC spreads, a computational unit, a unit of characteristic curves. The results of IBC parameter computations are drawn in the tabular and graphic form.

During trials of the developed software, the achieved results of IBC calculations correlated with experimental data obtained from test bed firing. In consideration of the results of the software computations, which are close to experimental data, the developed software may be recommended for use in IBC calculations for solid propellant rocket motors.

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LASER SYSTEM FOR RECORDING OPTICS

Researchers of the Kharkiv National University of Radioelectronics and developing a laser system for recording optics. Let's consider the principle of recording an optical object with a laser recording system in simplified form: the laser emission from the source (probing beam) enters the sight of the objective lens or another optical device, passing through the diaphragm, which is formed by the parts of the device body itself. In the focal plane of the lens there is an aiming or longitudinal grid. The bulk of incident laser emission passes through a grid, enters the vision field, and then, passing a complex optical system of the eye-lens, enters the receptor apparatus. But some part of the incident laser emission is reflected from the grid and passes through the lens once again and returns to the emission source parallel to the incident emission. Also, some part of the laser emission is reflected from the visual part of the retina and goes through the optical path through the eye system and the optical device, and also returns to the emission source. In this case, if the optometric system uses an infrared camera, then on the computer screen or on the display, it is possible to see an intense glare, thereby recording the optical device, etc. In order for the observer to be unable to see what he has been discovered, detection systems employ near-infrared laser emitters that the human eye does not see. From the above comes a situation in which the optical object - a viewing device or sight acts as a reflector of infrared radiation, and the human eye simply does not perceive it. But there are methods to combat such systems, such as the use of filters that do not transmit IR radiation.

Therefore, the proposed laser system is based on two principles: first, fixing glare from optical devices; second, fixation with the help of a high-sensitive photodiode of low-intensity emission, which in turn complicates the operation of counteraction systems offered for the laser system studying by the authors of this research paper.

A conceptual design of a laser optics recording system was carried out based on the results obtained.

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METHOD OF DETERMINATION OF THE BASIC (OPEN) MILITARY COMPOSITION OF THE OPERATIVE PLANNING OF THE WAR

In modern conditions, the military authorities, which are tasked with determining the composition of troop groups for operations, spend a lot of time to substantiate them. This is due to the fact that the scientific-methodical apparatus used is to take into account the complex character, as well as to allow the determination of such a troop that ensures the achievement of a specific purpose of the operation.

The analysis carried out by the authors of the study shows that at present, the existing scientific and methodical apparatus for substantiating the rational combat composition of the operational grouping of troops needs to be improved.

First of all, it concerns the choice of the basic (reference) version of the combat personnel of the operational grouping of troops. Researchers, as a rule, the choice of the basic (reference) variant of the military composition of the operative grouping of troops in the operation was carried out by choosing the already established grouping of troops (as an example for conducting command-and-staff exercises) or by comparison of combat potentials. This, in turn, makes it impossible to compare the grouping of its troops and enemy forces, taking into account the specifics of the use of shock drugs.

Taking into account the aforementioned, the report developed an improved method for determining the basic (reference) version of the combat composition of the operational grouping of troops, which would improve the methodology of substantiating the rational combat composition of the operational grouping of troops for a defense operation.

The main stages of the implementation of this method are: input of initial data, determination of forces and means of the enemy, calculation of coefficients of reducing the effectiveness of the use of weapons and military equipment, calculation of the effectiveness of fire damage of own troops and the enemy, determination of the basic composition of forces and means of operative grouping of troops.

The results are planned to be used in further research to obtain input data for assessing the predicted efficiency of the operational grouping of troops, and to improve the methodology for justifying the rational combat composition of the operational grouping of troops for a defense operation.

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IMPROVING COOLING EFFICIENCY TRANSMIT/RECEIVE MODULES OF APPA RADAR THROUGH USING HEAT PIPES

Modern radar stations are widely used to obtain high spatial resolution images of the surface of the Earth. This helps to solve problems of weather forecasting, search for natural resources, geological exploration, bioresources assessment, creating topographic maps, monitoring of disasters and environmental pollution, etc. Radar stations also make it possible to detect moving objects on land, on water and in the air, and to determine coordinates and parameters of their movements with high accuracy.

In recent years, active phased array antennas (APAA) have been widely used as antenna systems in order to expand the functionality of radar stations. The APAA technologies are constantly perfected due to advances in solid-state microwave integrated circuit development and design. An APAA includes a large number (from tens to several thousand) of transmit/receive (T/R) modules.

T/R modules in its work allocate a significant amount of heat. The heat generated by the active microwave elements of the output power amplifiers of T/R modules leads to an increase in the temperature of the active elements, a decrease in their reliability, and a decrease in the output power of the signals.

The transition from gallium arsenide to higher-frequency gallium nitride electronic components when designing new and modernizing the already developed T/R modules for APAAs made the problem of increasing the cooling efficiency of active microwave elements of output power amplifiers particularly relevant. Gallium nitride elements are characterized by higher specific and total heat release values. While the power level of gallium arsenide based T/R modules is about 10 W, the values for the modules on gallium nitride reach 15–20 W and more, and the dissipation power density in a GaN-based element base is 5–10 times higher than in GaAs-based devices.

Therefore, in the development of new and modernization of the existing T/R module designs, special attention should be paid to the issues of improving the cooling efficiency of active microwave elements.

In this study, the authors use numerical simulation to study the ways of increasing the air cooling efficiency of a T/R module containing 8 active microwave elements with a heat output power of 28 W each. The microwave elements are assembled on the mounting surface of the module base. The reverse surface of the base contains longitudinal cooling fins. The case of the module is made of aluminum alloy. The finned surface is ventilated by an air flow with an inlet temperature of +40°C. The simulation allowed obtaining the temperature distribution over the mounting surface of the base for three values of the air flow velocity in the interfin channels: 1, 6 and 9 m/s. It is shown that the maximum temperature of the mounting surface in the spots where microwave elements are mounted is 90.1°C at an air flow velocity of 1 m/s. If the air velocity is increased to 6 m/s, the temperature in these areas decreases to 77.1°C, and to 73.0°C at a velocity of 9 m/s.

To make air cooling even more efficient and to reduce the temperature of the mounting surface, a new technical solution based on the use of heat pipes is proposed.

The effective thermal conductivity of heat pipes is orders of magnitude higher than that of such metals as copper and aluminum. Thus, embedding heat pipes into the base of the case allows distributing the local heat flux from microwave transistors over the entire finned heat sink surface with a minimum temperature difference along the length of the fins, regardless of their distance from the heat source, thereby increasing the heat dissipating capacity of the fins and further reducing the temperature in the mounting spots of microwave transistors.

In order to determine the temperature reduction efficiency for the mounting surface of the case base, a numerical simulation of its temperature field was carried out with the same cooling air parameters and geometric characteristics of the case as the basic module design has. To numerically simulate the new design of the T/R module case with heat pipes, the calculated value of the equivalent thermal conductivity of a flat heat pipe was assumed to be 8000 W/(m•°C). The thermal conductivity coefficient of the base material of the module was assumed to be the same as that in the basic case design, i.e., 132 W/(m•°C).

It is shown that the use of 8 flat heat pipes in the design of the T/R module allows reducing the maximum temperature value in the spots with installed microwave elements by another 20.3°C, i.e., to 52.7°C at an air velocity of 9 m/s. At the same time, the non-uniformity of the temperature field of the mounting base decreases significantly (by more than 20°C).

Thus, the use of heat pipes is an effective technical solution when modernizing the radar station with APAA.

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DEVELOPMENT OF SMART TEXTILES FOR COMFORTABILITY INCREASE OF MILITARY PERSONNEL CLOTHING ENSEMBLES

Smart textiles, which has seamless integration with electronic elements such as microcontrollers, sensors and wires, expand the functionality and applications of textile materials. The convergence of textiles and electronics can be relevant for the development of intelligent materials capable of performing a wide range of functions that are in hard but not flexible electronic products.

Worldwide research is being conducted on the use of smart textiles, which can be used to increase the safety and efficiency of military personnel. In extreme environmental conditions and dangerous situations, there is a need for real-time vital signs information to enhance the protection of people that are working in these conditions. Improving the effectiveness of existing specified properties of products that are made of textile materials will have a positive impact on the personnel of the armed forces and emergency response services.

Over the past decade, there has been a growing interest in the integration of electronic sensors and components with textile materials and equipment that are used by military personnel. Smart textiles can react and adapt to environmental conditions. A revolutionary feature of high-tech textiles will be the ability to exchange information. If the clothes will be able to register, analyze, store, send and display data, you can develop a new type of intelligent high-quality clothing. Given the needs of military personnel, such military equipment will become part of a military uniform.

Military outfits can be equipped with the main display, wireless weapons, global positioning systems, chemical and biological threat sensors, batteries, individual physiological status sensors (temperature and relative humidity), combat identifier sensors that are connected to a military personal computer for real-time data acquisition. Wires for data transmission and electricity, as well as antennas for close and remote communications, can be integrated into the clothing and equipment of a military man to reduce the weight and size of the current interface of the electronic system.

The authors have developed a system for remote monitoring of changes in the internal microclimate in the inter-layer clothing space, which can later be used to assess and predict the comfort indicators of military personnel clothing.

The system consists of:

- the Arduino microcontroller, which is used to control and process system data;
- accumulator battery, which is equipped with an intelligent power supply and charging module;
- radio module that is used to transmit data on the VHF radio network (range up to 100 km)
- module microSD card, which is used to backup the received data;
- temperature and relative humidity sensors to obtain data from the inter-layer clothing space of the military personnel and to determine, in the future, the comfort parameters of clothes set that the military personnel is wearing.

The system is integrated into fabrics with cells in a knitted structure. If necessary, the system can be equipped with GSM and WIFI modules. The data obtained from temperature and relative humidity sensors is documented by a microcontroller. The data is stored in flash memory, but during long transportation, they can be transferred to an external memory card. The data is transmitted on demand periodically over a cellular channel or via WiFi access points with open access. If the terminal is located outside the cellular network and WiFi networks, it is proposed to use the VHF radio channel in packet mode to transfer data to the cloud storage. Processing of the data is carried out in real time using the Python programming language and libraries: serial, numpy, matplotlib and drawnow and subsequent storage in the cloud storage.

The obtained data of temperature and relative humidity in the inter-layer clothing space, which indicate that with an increase of physical activity there is an increase in the above-mentioned indicators, but accompanied by a significant decrease of those indicators in the rest periods. These results can be explained by the difference in the partial pressure of water vapor between the layers of clothing and the ambient air, that decreases with the increase of the relative humidity of the environment, and thus evaporation decreases.

To improve the comfort of clothes, it is proposed to make some parts from non-woven materials that have excellent heat-shielding properties, but at the same time, they are distinguished by high air and vapor permeability.

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CAVITATION MAGNETIC FUEL ACTIVATOR

The project relates to the technological use of the phenomenon of hydrodynamic cavitation and can be used in various industries, in particular in processes occurring in a liquid medium, for example, when activating liquids and liquid fuels (gasoline, diesel fuel, kerosene).

The fuel cavitator in the car's power system provides:

- fuel economy;
- increase of engine power;
- reduction of harmful emissions.

The actual problem of increasing the efficiency and ecological compatibility of internal combustion engines can be solved by the use of portable fuel cavitators and fuel activators, whose function is to improve the performance characteristics of fuel for internal combustion engines, with the aim of reducing fuel consumption by 5-20%, increasing environmental friendliness and power engine with hydrodynamic cavitation and magnetic activators.

The proposed cavitation device for fluid treatment allows activating the fluid through hydrodynamic cavitation and magnetic action. The device is capable of operating in a wide range of flow changes and in a wide temperature range and does not require additional electrical energy. The activated liquid fuel has an increased combustion energy. Such fuel can completely be burned out in the ICE chamber with maximum efficiency, does not wash off the oil film from the friction pairs and is not ejected with the exhaust gases into the atmosphere. The emulsion obtained in such a device does not decay for a long time due to intense cavitation mixing at the molecular level.

readiness:

- Laboratory tests of the cavitator have been confirmed
- The patent application for the patent for Ukraine for the invention is filed (Patent for the invention "Cavitation device for liquid processing" No. a 201710288, dated 24.10.2017 Luhovskyi O., Nocnichenko I., Zilinskyi A., Kostiuk D. (Formal examination).

For the further implementation of the project, there is a need for technological equipment and the production of a batch of industrial samples and the conduct of in-depth, full-scale motor research.

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METHOD OF RECOGNITION OF MEAN ELEMENTS OF AIR FIGHTING AGAINST TREATMENT OBJECT OF AIR ATTACK USING THEANT SYSTEM

The method of determination of routes by means of air attack to objects, elimination (purpose) with the use of Ant System for recognition of the protected air enemy is proposed. The method shows the solution constructed in the iterative process by many agents (ants) that interact with each other through the stigmergy while introducing changes to the environment, - namely, the deposition of pheromones on their routes, the higher levels of pheromone is deposited on the best routes.

The research was carried out on the application of the method using the Max-Mini Ant System to simultaneously determine the routes of several groups of means of air attack from different aerodromes to various objects of impact and the breakthrough band of the air defense system, taking into account the influence of the means of attack necessary to destroy the object of impact from given probability. Within the space in which there are fire zones (reconnaissance, suppression) of the means of air defense, the routes of different object of air attack coincided. Relevant, common to all route sections of the site are the best criteria for selecting the routes to overcome the air defense system, which allows, taking into account the existing norms, to determine the position of the breakthrough barrier of the air (passage corridors (breakthrough)) defense system. Conducted research on the performance of the method in a non-stationary environment.

Further research may also be directed to the realization of a three-dimensional search of airborne attack flights in geographical coordinates, taking into account the dimensions of the turning points of the route, in which the means of air attack carry out maneuvers, and the real size and configuration of the prohibited zones, as well as the terrain.

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APPROACH TO AUTOMATION OF THE PROCESS LAUNCHING OF ASSAULT AVIATION TO GROUND TARGETS BASED ON FUZZY NEURAL NETWORKS

The launching of assault aviation to ground targets is a complex, dynamic and non-linear process, the elements of the subject area which consist of many sets of different types of data and have a significant number of causal relationships. This is due to several factors. First, when describing the process of inducing a assault aviation to ground targets, we obtain a system of large dimensions, in which a large number of inputs and outputs. With a large number of inputs and outputs, it is difficult for an expert to describe causal relationships with fuzzy rules. Secondly, in these systems, losing fuzzy sets of fuzzy rules can be obtained, which complicate the sequence of fuzzy output, which, in turn, affects the accuracy of the result. To solve these problems, it is suggested to use fuzzy neural networks. The model for making recommendations on the parameters of the a assault aviation to ground targets on the basis of fuzzy neural networks allows the use of neural network teaching procedures to set the parameters of the antecedents of the rules and functions of fuzzy sets belonging. At the first level, for the purpose of solving the evaluation problems, where the input parameters of the environment are submitted to the input, a hierarchical fuzzy production model is used. At the second level, a fuzzy neural network is used to solve decision-making problems. This hybrid structure allows you to effectively apply fuzzy sets and fuzzy logic, since the disadvantages of hierarchical fuzzy production models are offset by the benefits of fuzzy neural networks and vice versa.

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REGULARITIES OF DRIVER SKILLS FORMATION WHEN DRIVING A COMBAT VEHICLE – AS THE BASIS FOR DEVELOPING REQUIREMENTS TO IRAINING FACILITIES

Skills are allocated to the arbitrary actions of the human-operator, which are realized at the will of a man and under the influence of his consciousness.

But it must be taken into account that correlation of consciousness and moving action is net constant on the different levels of skills development general tendency is that consolidation of skills the degree of direct consciousness participation in the separate movements and operations is reduced, but still stereotyped actions are bring under consciousness constant control. It is explained by the Pavlov`s I.P. doctrine, from which it is known, that the processes of excitation and inhibition are the most essential in the brain cortex activity. In the case of lack of skills the probability of ergonomic failures increases substantially as a result of stress, which is caused by a deficit of time, technical failures, mental disorder, lack or loss of knowledge. Other ergonomic failures can occur as the result of driver`s weakening of attention (mechanic-driver).

They can also arise as the result of excessive strengthening of automaticity without appropriate control or usage of knowledge.

Such failures related to the human factor, manifested themselves in significant delay of the transition process from action algorithm in operational mode to the algorithm of parrying bounce, and also in taking wrong decision. They increase control mistakes, can lead to confusing a given sequence of discrete operations, exclusion of individual actions, substantial parameter deviation from benchmark dependence or required algorithm of actions. The very occurance of situations to which a driver is not ready promotes stress and as a result brakes the stereotype. However, a well – trained driver, who has stable stereotype and strong psychological data, probability of similar phenomena is extremely small.

Many scientists – psychologists in different sheres of military activity researched regularities of skills formation.

Analysis of combat training experience reveals that the same, regularities manifest themselves during the skills formation of combat vehicles driving. That`s why taking regularities into account is an important condition of successful drivers workmanship formation.

The first regularity of skills formation is their inconsistency. During the first classes the skills are formed slowly, then relatively quick upgrade takes place after which increase in productive skill is slowing down again

The second regularity is periodical manifestation of temporary delay in skill productivity gains, and in some cases decrease of the skill, especially during practical driving or during the transition from static simulators to dynamic ones due to the lack of knowledge, skills and methods of further skills improvement or due to the phycological skill reconstruction and adaptation to new conditions.

The third regularity can be considered as dependence of skill formation on exercises purposefulness, objectivity of activity evaluation and acknowledgement of the results by the trainees. The skills are formed effectively when a trainee is aware of the exercise purpose, which skills one must work out at the lesson, ways of their application, their meaning for skillful use of combat vehicle. The training is provided under control and one who trains obtains objective information about the results of their activity from the direct observation during training.

The fourth regularity is dependence of skills formation on individual peculiarities of the trainee.

The fifth regularity is in dependence of skill formation on the number of the exercises performed. Its essence is in the numerous exercise repetition, which promotes forming of skill. Experimental researches testify that quality scores of drivers activity depend on number of trainings during (execution) accomplishment of typical professional activity algorithms.

The sixth regularity proves that the effective-ness of skills formation and their stability depend on the sequence of tacks complication and systematic education.

Thus, the progress in skills formation of combat vehicle driving depends on: possibility of the simulators to provide all the necessary conditions for sequential flow of processes aimed at driving skills formation; possibilities to provide sequential tasks complication, which are carried out a trainee; taking into consideration the structure and regularities of skills formation during training.

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PROSPECTS OF APPLICATION OF FUEL ELEMENTS HOW TO ENERGY SOURCES IN ELECTROMECHANICAL TRANSMISSIONS

The experience of conducting the Joint Forces Operation in eastern Ukraine, the use of coalition forces in Afghanistan and Iraq, as well as the counter-terrorism operation, demonstrates the need to equip units of the Armed Forces of Ukraine and other military formations with special machines with high levels of tactical and tactical mobility.

An analysis of the development trends of combat armored wheeled vehicles (BBKM) shows an effort to achieve high mobility through the use of high efficiency coefficient (GEMT) electromechanical transmission (GEMT),

One of the most promising solutions in the design of automobiles, and in particular BBKM, is to use fuel cells as a source of energy. The fuel cell is an electrochemical generator that provides direct conversion of chemical energy into electrical energy.

Yes, Honda produced a small batch of FCX-V4 cars in 2003 with Ballard-type membrane proton-exchange fuel cells. These fuel cells have an electric power of 78 kW and traction motors of 60 kW and torque of 272 Nm are used to drive the drive wheels. The fuel cell car has a 40% lower mass compared to a conventional car, which greatly improves its dynamic qualities, and the compressed hydrogen supply provides a power reserve of up to 355 km.

Thus, fuel cell power plants may in the future compete with internal combustion engines used as a source of energy for cars and special chassis. First of all, it should be noted the high efficiency of fuel cells, which is depending on the type of 40… 60%. High efficiency makes it possible to produce energy sources with a higher specific energy consumption, thereby reducing their mass and overall dimensions while maintaining power and battery life. In addition, more energy-intensive energy sources can significantly extend the life of existing devices without increasing their size and weight.

Another important advantage of chemical fuel cells is the ability to almost instantly renew their energy, even in the absence of external energy sources: it is sufficient to install a new tank with the used fuel. The use of cost-effective electrodes in the process of reaction allows the creation of fuel cells with a long service life and low total cost.

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WAYS OF IMPROVEMENT STABILIZATION ACCURACY

The works aimed to improve defense capacities of the country are highly relevant. Instrumental weapon stabilizing complex is one of them.

The purpose of this work is to offer substantive ways of increasing the stabilizers accuracy in light armored vehicles (LAV).

Ukraine at the time of restructuring and accession to independence as well as the other republics of the former Soviet Union receives holdings of LAV in the inheritance. Its key part consisted of infantry fighting vehicles (BMP-2) and airborne combat vehicles (BMD), where weapon block (WB) of stabilized homing actuators by means of weapon stabilizer (WS) 2E36 were included.

WS LAV 2E36 of BMP-2 and BMD were initially designed by Kovrovskiy electromechanical plant in the 80's of the last century and has a number of deficiencies such as the components of radio-electric device was out-of-date and had been removed from manufacture, the overall dimensions and mass is big, setting of WS was made using the screwdriver on resistors, located in the hard to access place, rockets only shoot with the switched off stabilizer by using the separate control panel. Over the years the WS has reached the end of their life expectancy. Ukraine didn’t have its own manufacture of WS back then.

In the years since independence the country has established all the conditions to conduct restorative repair and manufacture distinct units and assemblies for WS 2E36, first national analogue WS SWU-500 has been designed and implemented with further upgrading to digital equivalent SWU-500-3D (4D, 4D-01) that was developed, produced, and applied in different LAV's.

Scientific and technological progress within arming systems field requires modernization of components and element base, improvement of tactical and technical attributes (rapid action capability, accuracy).

Rapid action capability is characterized by bandwidth, time of rapid action capability for engines and amplifiers, stress of electric actuators and also time discretion of digital counter of information. Rapid action capability growth of electromechanical gyrotahometers can be achieved only through applying gyrotachometers of compensational type, where gyroscopic torque reimbursement is achieved with special electrical moment sensor – electrical spring.

One of the ways to increase the WS accuracy is to replace traditional electromechanical gyroscopic devices that have analog output, with the modern gyro tachometers (Coriolis vibratory gyroscope (CVG), fiber-optic gyroscopes, micro-electromechanical sensors (MEMS)) with digital output signal and broader bandwidth. Besides the growth of rapid action capacity, they have advantages over electromechanical ones: service life is 15-20 times higher due to the absence of moving parts that can reduce life cycle.

The factor ensuring the increase of rapid action capability and accuracy of stabilization is growth of information processing rate in digital evaluator of control unit and growth of rapid action capability in all constituent parts of executive tract - power amplifier and electric motor.

The way to increase the accuracy of WS is the rejection of traditional scheme of so called "power" stabilization of weapon block LAV, where operator or commander from their control consoles directly execute homing operation of WB and turret, that have big weightes and moments of inertia. In order to decrease the errors of stabilization and to increase accuracy, it is proposed to implement opto-electronic devices of range mapping with stabilized field of view (SFV), that will transmit information through the interface connections in the form of code to the screens of commander and operator. In this case commander and operator will redirect the field of view of the device, where masses and moments of inertia are tenth times less in comparison with turret and weapon block. Turret and weapon block control in this machines will be made using signals from angle sensor, that is located in the device with SFV.

This schematic and technical solution is directed on reducing amplitudes and angular rates oscillations in aim field of view – field of view stabilization or "independent" stabilization. Nearly all LAV (except BMP-3) was built using scheme of "dependent" field of view stabilization, this means that scheme envisages "rigid" connection between aim field of view and weapon stabilizer, which greatly improve fields of view observing conditions through this "rigid" connection. This positive effect from "rigid" connection between aim and weapon block leads to many errors in WS – fluctuations of sight mark within madial error of stabilization relative to the direction of the target. Therefore, to hit a target with significantly higher probability operator (commander) need to locate sight mark as close as possible to the aim during continuous movement of the vehicle and wait when sight mark and aim would be joint (by oscillations of armoured fighting vehicle frame) and to shoot with some prejudice. In stabilizers with "independent" stabilization the shot at target is executed only when aim gets into fighting range. The information about aim entering the fighting range would be displayed on the screens of operator (commander).

Expression "one shot one hitten target" – is widely used in heavy armoured vehicles, where devices with stabilized field of view are applied, so it will be relevant to light armoured vehicles as well.

So the concomitant increase of price will be justified by this.

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DEVELOPMENT OF PROPOSALS TO SUBSTANTIATE THE RATIONAL STRUCTURE OF THE PROMISING SUBSYSTEM OF FIRE DESTRUCTION OF UNMANNED AERIAL VEHICLES

Analysis of the applying of unmanned aerial vehicles (UAV) in areas bordering on the Russian Federation and in the zone of the antiterrorist operation (ATO) and operation of the combined forces (OCF) in the Luhansk and Donetsk regions indicates a significant increase in the role of the UAV in modern armed conflicts. The combat capabilities of anti-aircraft missile units for UAV firing in an ATO (OCF) do not ensure the effective fulfillment of tasks to cover objects and troops.

One of the possible ways to solve this problem is the creation of a promising subsystem for fire destruction of a UAV, which is designed to cover military groups, stationary command and control posts, headquarters, military bases, administrative centers and industrial facilities, as well as other government facilities from exposure to small-sized UAVs.

The structure of the subsystem of fire destruction of the UAV is proposed to include means of reconnaissance, control, communications and fire with rocket and cannon channels.

The report reveals that a feature of building a cannon channel of fire weapons is the creation of a high-precision fuze, which provides for the detonation of projectiles directly near the target by programming the fuse when the projectile passes the muzzle.

Also, the proposed subsystem of fire destruction of the UAV has high reconnaissance, maneuverability and the ability to switch to readiness, which allows to destroy the enemy UAV more effectively.

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METHOD FOR SELECTING LEAST SIGNIFICANT INDICATORS IN COMPARATIVE ANALYSIS OF COMPLEX WEAPON SYSTEMS AND MILITARY EQUIPMENT

As follows from the description of the problem of multicriteria comparative analysis as a multilevel hierarchical structure, after selecting the objects of analysis and determining the purpose of the analysis, single (partial) indicators are defined that describe the properties of the objects selected for analysis (alternatives).

The nomenclature (number) of indicators can be determined by peer review methods, either individually (based on the experience of the surveyor) or collectively (by a team of experts).

It should be noted that when performing a comparative analysis of complex technical systems, described by dozens of parameters, for a more complete and adequate description of their properties can be used in a large number of partial indicators. This leads to a significant increase in the number of paired comparisons, with the analysis procedure becoming extra-laborious for the expert. As you know, all methods of expert evaluation are inherent errors in the analysis, due to the characteristics of the experts themselves (knowledge, experience, intuition, etc.). Then, the more references to the expert (the more paired comparisons), the more mistakes are made in determining the weight (importance) of the partial indicators, which, in turn, can lead to serious mistakes in determining the advantage of one analyzed alternative over the other. Therefore, in such cases, when conducting comparative analysis, there is a need to reduce the number of calls to the expert, and therefore reduce the number of paired comparisons.

One way to reduce the number of paired comparisons is to select the least significant indicators to exclude them from paired comparisons, which reduces the risk of gross errors in the analysis.

In practice, there are quite often cases where the indicators characterizing the main properties for the intended alternatives are practically the same. For example, the penetration rate for modern anti-tank guided missiles of one generation, the caliber of artillery systems in one tactical link, the maximum speed and combat mass of the same type of armored vehicles, etc. in their values are little different from each other. In this case, such important indicators that characterize the sample of the complex weapon systems and military equipment in terms of technical excellence, when compared with similar alternatives, become uninformative and insignificant. Therefore, the alternatives chosen will not differ from each other in such indicators and, by conducting a comparative assessment, one cannot decide on the preference of one or another system (alternative) in these indicators, since they are practically identical.

Thus, the essence of the proposed method is to find such indicators and exclude them from pairwise comparisons.

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REQUIREMENTS FOR PNEUMATIC TIRES FOR MILITARY VEHICLES

Providing the ability to move military-grade wheeled vehicles (MGWV) on affected (without excessive air pressure) tires is an integral part of the range of measures to enhance the security and vitality of the sample as a whole.

Therefore, the main requirement for a pneumatic tire and (or) other elements of a wheel propulsion, in case of their defeat by means of enemy fire, is to ensure the possibility of continuing the movement at the maximum possible speed for the maximum distance (until the complete (critical) destruction or ignition of the tire.

At present, in Ukraine there are no unified (standardized) requirements for pneumatic tires intended for the MGWV. Indicators of one-off movement without excess air pressure in the tires are determined for each sample individually, which, accordingly, reduces the level of their unification and leads to an increase in the life cycle of the sample.

Unlike in Ukraine, in the European countries and in the USA, the requirements for pneumatic tires for MGWV are regulated by the relevant regulatory and technical documents. In February 1997, the FINABEL Agreement No. A.20.A (20.A.5) was adopted by the countries that are part of the Center for the interoperability of the armies of Europe. "Pneumatic Combat Tire", which defines the general characteristics, performance requirements after defeat, test conditions and the order of penetration of the test tire.

According to the Agreement, the term "Pneumatic Combat Tire", "Combat Tire" includes a tire sheath, a tire in conjunction with a camera, or a runflat insert mounted on a wheel inside a tire. The term "Penetration" includes damage to a tire obtained during a fight, after which the vehicle must be able to continue to travel in the conditions established.

Vehicle having two or more penetrate tires must provide:

a) 100 km distance without breaking up and tire firing and without seriously affecting control, maneuverability, stability, braking and maintaining speed in accordance with the following conditions:

3 km with a maximum rescue speed of a maximum of 90 km/hr, 22 km with a speed of 50 km/hr and 75 km with a speed of 25 km/hr;

The route is laid in 8-shape on asphalt or concrete pavement with curves with radii of approximately 25 and 100 meters. The vehicle must move in a circle.

b) off-road traffic for 2 hours at a speed of approximately 30 km/hr without breaking up and the tire burning.

The damage is carried out by a bullet 7.62 mm, from a distance of 50 m. In this case, 5 shots are made in the side and 2 in the tire tread.

However, FINABEL Agreement No. A.20.A (20.A.5) does not establish criteria (order) for selecting a wheel drive structure depending on the intended purpose of the sample.

Thus, given the growing role of wheeled vehicles and building on the experience of European countries and the US, there is a need to:

development and introduction of regulatory and technical documentation in Ukraine, which regulates the requirements for pneumatic tires (wheel propulsion) of the MGWV, which will allow to determine and ensure the appropriate level of protection and durability of the MGWV samples, will improve their unification and reduce the life cycle cost.

development of a methodology for justifying the parameters of a wheel propulsion, which will allow to choose the most rational design, depending on the type and purpose of the sample MGWV.

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PROSPECTS FOR DEVELOPMENT OF AUTONOMOUS WEAPON SYSTEMS WITH CONSIDERATION TO THE REQUIREMENTS OF INTERNATIONAL HUMANITARIAN LAW

In military conflicts of the late twentieth and beginning of twenty first centuries, autonomous weapon systems of various purposes were widely used, leading to automation of combat operations.

Experts of Geneva international meeting dedicated combat robot systems, 13-16 May 2014, proposed to consider autonomous weapon systems, as systems which can independently, without human intervention and control, perform the following functions: search, detection, identification and target engagement.

Autonomous weapon systems have a number of advantages that stimulate their development: they can more effectively strike enemy objects, perform tasks of operational support, reduce the risk of human error in the decision making, save the human life, provide technical simplicity of design, increase the ability to use in complex conditions, make a cheaper escort. According to the International Committee for Robot Arms Control data, about 40 countries, including the US, China, Russian Federation, Great Britain, France, China, Israel, South Korea, develop weapon systems that can fight without human involvement.

The actions of mentioned systems must comply with the principles of International Humanitarian Law, such as distinction and proportionality.

The principle of distinction involves identification of the military and civilian objects, own and the enemy forces, children and women protection, cultural values, proper situation assessment and decision making, including the use of weapons.

The principle of proportionality prohibits hostilities that could damage civilians and cause civilian casualties that would be excessive to achieve direct military advantage.

According to leading foreign experts' estimate, the use of autonomous systems will completely change the ways and methods of warfare, which is not regulated by international law. Specifically, the new types of weapon prohibited by Law of Armed Conflict, formulated in the Geneva Conventions of 12 August 1949 and the first Additional Protocol to these conventions. The first norm denies the right of the parties to choose weapons which are not unrestricted, the second - prohibits weapons that may cause excessive damage or suffering.

Today, there is no mechanism for assessing the selectivity of weapon systems at the international level. Therefore, the search for ways to bring the development of autonomous weapons systems to the norms of International Humanitarian Law continues. Only the United States and the United Kingdom asserted official position on the development of such weapons. In particular United States, to conform the development of autonomous weapon systems to the International Humanitarian Law, approved the Ministry of Defense Directive № 3000.09, 2012, which obliges to use it only under the control of the operator.

The experts' repeated attempts at the UN level in 2013, to negotiate on absolute prohibition the use of autonomous weapon systems have failed in the format of the Inhuman Weapons Convention. Only 26 countries supported prohibition of autonomous weapons.

For Ukraine, the implemntation of autonomous weapon systems is a matter of protecting vital national interests. According to the Cabinet of Ministers of Ukraine Decree of 14 June, 2017, No. 398, in Ukraine envisaged the creation of ground and air launched robot systems, among which priority is given to the unified unmanned aerial systems of various purpose (including combat) tactical and operational-tactical level.

It is proposed to address potential challenges to the development of autonomous weapon systems in Ukraine, taking into account the requirements of international humanitarian law, by temporarily introducing into national law norms to restrict the use of these weapon only under the control of the operator.

Thus the problematic issues that need to be addressed first and foremost for the further development of autonomous weapon systems are:

establishment of a legal mechanism at the international level that would regulate the implementation of a review mechanism on the use of autonomous weapon systems in order to comply with the requirements of International Humanitarian Law;

elimination the lag of the legal framework from the movement of technological progress, in particular, from enhancing the autonomy of the weapon and its transition to independent decision-making, wich must be done by human.

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NEW PROTECTIVE COATINGS FOR PROTECTION OF STRUCTURES AND OBJECTS EXPLOITED UNDER SPECIFIC CONDITIONS

In order to obtain new technologies for the protection of various types' structures from destruction under the influence of biotic, abiotic, technogenic, as well as dynamic destructive factors of the environment, a method for obtaining polymer composite materials (PCM) based on polyurethanes (PU) of different composition and structure and epoxy polyurethanes (EpPU) for use them as multi-functional protective coatings has been developed.

PU based PCM with the ratio of BPU: LPU = (70-50): (30-50); PU based PCM with the content of organometallic modifiers (MeOM): NiOM, CuOM and ZnOM; PCM based on EpPU, modified PU, EpPU LPU_{100}, EpPU/$SPU_{70:\,30}$ with the content of modifiers NiOM, CuOM and ZnOM of (0,06-0,20%) and PCM with the use of renewable raw materials - castor oil (CO) based PU: PU_{CO} and EpPU/ PU_{CO}, PU_{CO}/MeOM (MeOM: NiOM, ZnOM and CuOM (0.6-3.0%)) have been created.

PU based PCM have high adhesion/cohesion indices of 29.0-36.5/40.0-43.6 MPa, respectively, and are characterized by high elasticity. The introduction into the PCM structure of the MeOM leads to the increase of their adhesion/cohesion properties up to 35.7-37.0 42.8-43.9 MPa.

The modification of EpPU with $BPU_{70:\,30}$ and LPU_{100} polyurethanes leads to the increase of adhesion/cohesion strength in 1.23/1.43 and 1.20/1.25 times, respectively, as compared to the original epoxy composition.

By adjusting the composition of the PCM, the EpPU compositions with a given hardening rate have been created; hardening rate is about: 2-5 hours.

PCMs based on LPU/BPU and EpPU and PCM with NiOM, CuOM, ZnOM modifiers are salt fog and saline solutions resistant, they are stable to the action of special reagents at low temperatures, as well as chemical, bio-, light and wear-resistant .

The index of waterproofness of concrete, w, is increased with application of protective coating on the basis of PCM from 4 to 12-15.

Protective non-slip coatings of two types - rigid and elastic for metal and concrete structures have been created on the basis of PCM (LPU/BPU). The coefficient of friction of sliding of such protective coatings is adjustable within the range of 0,5-0,9 (dry, moist, or oiled surface).

All samples of PU and EpPU based PCM comprising CuOM and ZnOM possess fungicidal properties in relation to the most active biodestructors, and their fungicidity is estimated with the highest score of 0 points.

The results of the study of the effect of complex atmospheric factor (UV and IR radiation, hight temperature and humidity) on the MAC have shown that all PCM samples are resistant to destructive factors.

The results of the salt mist and seawater effect study on the PCM stability have shown that all samples (metal and concrete) covered with PCM based on $BPU_{70/30}$, PCM based on $BPU_{70/30}$/NiOM and PCM based on $BPU_{70/30}$/PNS (non-slip coating) after being kept in seawater for 60 days have no damage - there are no changes on the surface of the samples and coating.

Concrete elements protected by PCM based on $BPU_{70/30}$ and PCM based on $BPU_{70/30}$/NiOM, after 50 cycles of "freezing/defrosting" in seawater, have no damage, no changes on the surface of the samples and on the surface of the coating At the same time, unprotected concrete samples after 30 cycles of "freezing-defrosting" in seawater have collapsed.

The long-term (summer-autumn-winter-spring) stability tests under the atmospheric conditions of experimental protective PU-coatings and protective/ non-slip coatings on concrete (LDS-2, DP-410, Kiev civil aviation factory), as well as experimental PU and EpPU based protective coatings on the ferroconcrete pontoon dock (DKZ "Palada", Kherson, external beam fender) confirmed their high protective efficiency against destructive factors.

Long-term field trials of PCM as protective/non-slip coatings of concrete structures and protective (including fireproof) coatings of wooden constructions on the objects of the Ukrainian armed forces; rigid and elastic protective/non-slip coatings of metal constructions on the objects of the Ukrainian Navy Armed Forces have begun (July).

On the basis of EpPU, together with the scientists of the ISC NASU, a corrosion-resistant nanocomposite radio-absorbing coating was created, which provides effective protection of objects from electromagnetic radiation. The absorption of radiation in the range of 25-38 GHz is 8-16 dB.

The use of the PCMs as: 1) multifunctional protective coatings of surfaces and different types' objects and configurations: decks and superstructures of ships and / or ferroconcrete pontoons and metal towers of floating docks, which have high adhesion, operating parameters and non-slip properties;

2) special protective coatings for metal, ferroconcrete and others surfaces guarantees: a) reliable prolonged operation of metal, ferroconcrete and wooden constructions, buildings and structures in the conditions of dynamic, abiotic, biotic and technogenic loads; б) safe operation of the objects under specific operating conditions; b) the practical exclusion of the destruction of protected concrete surfaces from the changing effect of positive and negative temperatures and the duration of their operation, and d) in general, increasing the safety and operation life of structures and objects.

The organization of PCM is possible on active (or reconstructed) chemical production using standard chemical equipment.

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RESEARCH BY MONTE-CARLO METHOD OF THE INFLUENCE OF BALLISTIC FACTORS ON THE DISPERSION OF DISPERSION OF PROJECTILES

The influence of random deviations of ballistic indicators, such as mass, initial velocity of the projectile and aiming angle, on the dispersion of the projectiles by statistical modeling methods (Monte Carlo method) in the computational experiment is investigated. The essence of the computational experiment is to obtain a large number of implementations of the stochastic projectile flight process, the probabilistic characteristics of which are similar to the parameters of the problem.

The paper used a computer-based ballistic model, which is represented by a system of equations in vector form

$$m\frac{d\vec{u}}{dt} = \overrightarrow{GF} + \overrightarrow{DF} + \overrightarrow{LF} + \overrightarrow{MF} + \overrightarrow{CF}\ , \tag{1}$$

$$\frac{d\vec{X}}{dt} = \vec{u}\ , \tag{2}$$

$$\overleftarrow{u_0}(0) = (u_0\cos\theta_0, u_0\sin\theta_0, 0), \tag{3}$$

$$x(\theta_0;T) = L,\ y(\theta_0;T) = H,\ z(\theta_0,0) = 0, \tag{4}$$

where $\overleftarrow{u}$ - the velocity vector of the projectile, m - the mass of the projectile, $\overleftarrow{GF}$, $\overleftarrow{DF}$, $\overleftarrow{LF}$, $\overleftarrow{MF}$, $\overleftarrow{CF}$ - acceleration caused by gravity, air drag, lift component, Magnus and Coriolis force, $\overleftarrow{X}(t) = (x(t), y(t), z(t))$ - projectile coordinates, θ_0 - tangent angle, L - distance to the target, H - the relative height of the target site, T - projectile flight time.

Model parameters were determined for a 30-mm gun by comparison with the range-table.

Random values were generated for each of the selected ballistic indicators (projectile mass, initial projectile velocity, and tangent angle) as

$$m_i^* = m\left(1+\delta\cdot\xi_i\right), i=\overline{1,N},\ \ u_{0k}^* = u_0\left(1+\delta\cdot\xi_k\right), k=\overline{1,N},\ \theta_{0n}^* = \theta_0\left(1+\delta\cdot\xi_n\right), n=\overline{1,N},$$

where ξ_i - a normally distributed random variable with zero mathematical expectation and a variance equal to 1, δ - the proportion of deviation from the mean that took 0.001, 0.005, 0.01, 0.02 in different series of computational experiments. For the generated random values of the studied ballistic indicators, system (1) - (4)

was solved for different firing range with an interval of 200 m. The average hit point and the root mean square deviation were calculated for each range.

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RESEARCH OF NEW TECHNICAL FABRICS IN THE MANUFACTURE OF INTERNAL HEAT PROTECTIVE COATING OF SOLID-FUEL ROCKET ENGINES

An important component of marching engines (MD) of solid fuel rocket systems is the internal heat-shielding coating (VTZP). One of the structural elements of VTZP are fabric reinforcing covers. Previously, such covers were made of TKET TU 17 RSFSR 62-5969-78 (TKET) fabric.

In accordance with the import substitution program, according to the technical specifications of SE Yuzhnoye, a manufacturing technology was developed and a batch of domestic PVP fabric TU U 13.9-16287311-162-2016 (hereinafter referred to as PVP) was developed, which is similar in terms of its technical characteristics and technological properties of TKET. The differences between the fabrics are the structure of the threads used to make them. For the manufacture of PVP fabric, polyamide textured elastic fibers of linear density 7 tex × 2 of domestic production are used. For TKET, a specific structure of crimped kapron threads (polyamide) is used (kapron elastic thread of the classical manufacturing method 5 tex × 2 - TU-04-50-90).

SE "UNIKTI" DINTEM "carried out research in order to determine the possibility of using PVP fabric instead of TKET in the manufacture of VTZP bottoms, as well as testing the manufacturing technology of VTZP bottoms using the specified fabric.

In the process of performing the work, flat rubber-fabric samples, two prototype DN05.2028.00 samples, and an experimental back-plate TZP 05.0376.0150.0200.00.0 were made.

According to the results of analysis of vulcanized flat samples, it was found that the samples have a slight penetration of the fabric with rubber, and there are no delamination along the fabric-rubber boundary. It is also noted that the PVP fabric is well impregnated with the rubber compound.

It was found that the bond strength of rubber with PVP fabric during delamination is 1.76 kgf / cm (based) and 2.7 kgf/cm (weft). At the same time, the strength of fastening rubber with TKET fabric during delamination is 2.95 kgf/cm.

In the process of testing the technology for assembling the bottom, 2 prototypes were made. General approaches The technology for assembling prototypes was fundamentally similar to the main stages of the technology for assembling VTZP standard bottoms.

The results of the development of technology for the manufacture of prototypes made it possible to produce a regular VTZP rear bottom. At the same time, the technology of manufacturing the VTZP bottom did not require significant adjustments.

After vulcanization of the VTZP of the posterior bottom, a change in the color of the PVP tissue (dark cream) was observed. The thickness of the technological cover made of PVP fabric has significantly decreased and is approximately 1.2-1.5 mm. The nature of punching a fabric with a rubber mixture is almost the same as punching a fabric of VTZP bottoms assembled using TKET fabric. No detachment of PVP fabric from the rubber mass of the bottom along the inner surface and in the spacing space was observed. The section of the VTZP cover of the rear bottom, (20 ± 5) mm wide, which contacts the metal surface during vulcanization, has retained the necessary relief for further work.

According to the results of the work it was established:

PVP fabric TU U 13.9-16287311-162-2016 for its main technical characteristics is suitable for use in the manufacture of VTZP front and rear bottoms.

When cutting the petals for sewing covers, it is necessary to take into account the direction of weaving of the fabric threads.

Reuse of the technological cover in the manufacture of VTZP bottoms is not possible due to a significant reduction in the thickness of the fabric after the first vulcanization cycle.

Tests as part of the MD corps confirmed the possibility of using PVP fabric for the manufacture of solid-propellant solid-propellant rocket engines.

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COMPARATIVE CHARACTERISTICS OF MECHANICAL PROPERTIES OF WELDING HEAT AFFECTED ZONE OF STEELS 30CH2SN2MFA AND 28GR

Currently in the Ukrainian defense industry for manufacture of welded hulls of armored combat vehicles (ACV) with bulletproof level of protection, along with alloy armor steel of domestic production, widely used foreign-made protection steels.

It is well-known that during welding of quenched and tempered steels, including high hard armor ones, due to the influence of welding heat, the regions which were heated to temperatures A_{c1} to A_{c3} (intercritical heat affected zone – ICHAZ) and those heated to values from 500 °C and to ones slightly lower than A_{c1} (subcritical heat affected zone – SCHAZ) are softened. This can lead to a decrease in the ballistic resistance of welded joints as compared to the parent metal in delivery. In turn, the magnitude to which HAZ softens and width of the softened regions depend on factors such as welding thermal cycle (heat input) and chemical composition of armor steel. In connection to the above said there is a need to compare the effect of the welding heat input on the mechanical properties of alloy armor steel of domestic production 30Ch2SN2MFA and one of the foreign protection steels 28GR.

Experiments were based on the bead-on-plate test. GMAW bead deposition was performed with an electrode wire of austenitic class G 18 8 Mn on plates 10 mm thick. Protective gas was a mixture 98% Ar + 2% CO_2. Welding parameters were set so that the heat input was increasing. After welding, samples were cut perpendicularly to beads' axis with waterjet method to further study the microhardness distribution in the HAZ and the Charpy impact tests.

It was found that the HAZ metal of both investigated steels undergoes significant softening as a result of welding heating typical for conventional technology of GMAW with austenitic filler metal. Regardless of welding heat-input value the hardness of some regions in HAZ lowers to values of austenitic welds (215…240 HV).

The hardness of the metal adjacent to the weld coarse-grained region of HAZ boron microalloyed steel 28GR was dependent on the heat input. When welding at low heat input of 0.5… 0.65 kJ/mm, it is at or equal to the hardness of the base metal. At values of heat input of 0.78… 0.9 kJ/mm, no noticeable re-hardening of the metal of this region is observed. In turn, the hardness of the metal coarse-grained region of HAZ steel 30Ch2SN2MFA, at all values of the heat input exceeded the hardness of the parent metal.

The metal hardness of HAZ region, which under effect of welding heating undergoes high tempering, in protection steel 28GR decreases in more than 2 times in comparison to the base metal hardness. In 30Ch2SN2MFA steel in the same conditions the loss of hardness is less significant - in 1.65 times.

With the increase of the welding heat-input from 0.5 to 0.9 kJ/mm the width of softened HAZ region in 28GR steel increases in 2.9 times, in 30Ch2SN2MFA steel - in 1.5 times. It should be noted that for both investigated materials there was determined significant variation of base metal microhardness values. In this case, the determined minimum hardness of the base metal for 28GR steel was 430 HV, and the steel 30Ch2SN2MFA - 400 HV.

Microstructure of HAZ metal for bead deposited with a maximum heat input of 0.9 kJ/mm showed that in the coarse-grained region of steel 30Ch2SN2MFA, the average diameter of austenitic grain was 55 μm, and of steel 28GR - 70 μm. At the same time, the initial size of the primary parent grain was substantially smaller in the 28GR steel - approximately 10 μm, compared to 20 μm in the 30Ch2SN2MFA steel.

The defined impact energy (KV) of the base metal of 28GR steel is on average 30 J and the rolled steel sheet of 30Ch2SN2MFA is 14 J. For GMAW bead deposition with a heat input of 0.9 kJ/mm, the impact energy of the coarse-grained region of the 28GR steel was 41 J and the steel 30Ch2SN2MFA - 9 J. At the same heat input, in the softened HAZ regions, the average impact energy for 28GR steel increased to 93 J, against 42 J in 30Ch2SN2MFA steel. In general, the results of the Charpy test are correlated with microhardness studies, since the toughness values are inversely proportional to the hardness values.

Differences of HAZ softening characteristics for investigated steels are explained by the difference in their alloying. High content of carbide-forming elements Cr, Mo, V in 30Ch2SN2MFA steel prevent the softening processes in HAZ regions which are heated to temperatures of high tempering. At the same time, the high content of Si in this steel not only delays the formation of cementite at temperatures of 200…350 °C, which contributes to the increase of tempering resistance, but also adversely affects its toughness.

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AUGMENTED REALITY IN THE INTERESTS OF ESMRM AND MUNITIONS SAFETY

The key to NATO's munitions safety policy is the Explosives Safety Munitions Risk Management (ESMRM). The ESMRM guides are outlined in the Allied Logistics Publications ALP-16 Ed. A “ESMRM in NATO Planning, Training, and Operations”. The custodian of the ALP-16 is ESMRM Panel (AC/305) of the NATO Logistics Committee. As an important current task, ESMRM panel experts consider reducing the gap between risk assessments and decision-making on a specific storages topology.

According to the author, in this context, the application of the technology of Augmented Reality (AR) can be very effective. It will allow you to virtually work out the optimal 3D topology of the storage in the real-world terrain with the choice of the required combination of munitions in the stacks and the distance between them, taking into account dynamic visualization of the distribution of risk areas (site plan). In addition, with the help of AR, it will be possible to share information on the current distribution of risk areas at the tactical level so that commanders of any management unit could choose safe locations and least risky routes for moving units or knowingly make appropriate decisions based on the expected level of ESMRM risks along the selected route. For this purpose, the visualization on the AR devices of ESMRM risk areas will be provided when they are intersected by combat vehicles or soldiers on foot, standardizing the required symbols. The reason for this should be to update the APP-6 Ed.D for the introduction of special symbols to display different levels of risk zones on the map of estimated explosive safety of munitions in storages. This will create the basis for the use of such symbols in the tactical AR system in order to inform when maneuvering or the selection of places of disposition.

AR will radically update the learning and training process for munitions safety officers and ESMRM, which will simplify the process of integrating ESMRM into NATO training and maneuvers. On this base in the future, it will be possible to effectively carry out inspection of the storages with the UAV for compliance with the design scheme and the requirements of AASTP-1, AASTP-5, ALP-16 with the virtual overlay of the 3D-topology of the storage stacks compliant with the standards, on the actually implemented. The scope of AR applications also includes visualization of data from embedded munitions monitoring sensors.

Of no less interest is the prospect of combining AR and algorithms of artificial intelligence (in particular, Microsoft Common Objects in Context (MS-COCO) or Limpid Armor Inc. (Ukraine)) to recognize objects in images for controlling the access to storages and remote guidance of weapons in their perimeter security systems.

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COMPARISONS AND ANALYSIS OF THE STATE OF THE NAVIGATORY ARMY OF THE UKRAINIAN ARMED FORCES

The experience of warfare in internal armed conflict gained in recent years has confirmed the growing role of artillery to defeat the enemy in conducting operations against illegal armed groups, especially when they have armored vehicles, artillery, anti-aircraft weapons, and other weapons and weapons. Troops and artillery are the only versatile means capable of firing with the necessary precision and performing the bulk of the fire tasks.

The undoubted condition of success in any operation is the reliable fire of the enemy, much of which is performed by the missile troops and artillery. The importance of missile troops and artillery is determined by the fact that only this kind of troops is capable of performing the tasks of firing the enemy in any weather, terrain and time of combat, as well as to provide fruitful interaction and continuous support missile strikes and fire artillery formations.

Currently, there are different types of barrel artillery, self-propelled and trailed artillery, ranging from 105-mm to 203-mm, armed with artillery units of the Armed Forces (AF) of all countries of the world. Data analysis shows:

- the largest groups of barrel artillery have the USA, Russian Federation, Peoples Republic of China;
- the group of barrel artillery of countries at the European theater of war (with the exception of the Russian Federation) does not exceed 1000 units, and the share of self-propelled artillery in these countries is more than 50%;
- Artillery units of the NATO countries of the NATO bloc are equipped with the same artillery systems, artillery in these countries is not divided by organizational and staff characteristics;

- the leader in the design and production of artillery systems belongs to the US and their European allies in the NATO bloc (UK, Federal Republic of Germany, Italy);
- the Armed Forces units of the Armed Forces of the Armed Forces of Ukraine (taking into account those systems that are in storage) are different in caliber and purpose artillery systems (trailed; self-propelled);
- artillery systems armed with the Armed Forces of the Armed Forces of Ukraine have been inherited from the former USSR and have the vast majority of limited technical resources, morally outdated, the vast majority have tactical and technical characteristics that do not meet the current conditions.

The loss of artillery systems during the Anti-terrorist Operation (ATO) in eastern Ukraine, reducing the useful life of artillery barrels lead to a decrease in the number of artillery systems in the artillery units, to a decrease in the combat performance of artillery units and reduce the amount of fire missions they perform.

Technical condition, combat losses require the implementation of appropriate measures that would improve the condition of providing the Armed Forces of Ukraine with artillery weapons, namely:

- Carrying out works to restore the technical resource of existing artillery systems that still have sufficient useful life for artillery barrels;
- development of national modern artillery systems (or their purchase in the countries that produce them).
- Armed with artillery units of the Armed Forces of the Armed Forces of Ukraine (subject to those systems that are kept in storage) are the following self-propelled guns (SG): 122 mm SG 2C1 "Gvozdika", 152 mm SG 2C3 "Acacia", 152 mm SG 2C5 " Hyacinth-S", 152mm SG 2C19 "Msta-S", 152mm SG 2C7 "Peony".
- Analysis of world trends in the development of modern self-propelled artillery shows that in recent years the process of their development and modernization is mainly aimed at the implementation of tactical and technical requirements to improve fire performance, range and accuracy of fire, reduce vulnerability to fire damage against artillery firing maneuverability.
- Increasing the fire performance is achieved by the introduction of "flames of fire" or "pseudovolley" by automatically changing the angle of increase of several shells, flying at different trajectories and simultaneously fly to the target;
- the introduction into combat sets of cluster artillery shells with high-precision (homing or self-aiming) combat elements.
- Increasing the firing range is usually due to:
- transition to guns with new ballistics (barrel length of 45 or 52 calibers)
- the use of structures of improved aerodynamic form and active-reactive projectiles or projectiles with bottom gas generators.
- Increasing the accuracy of shooting is ensured by:
- equipment of artillery guns fire control systems, navigation systems, sensors, taking into account ballistic and meteorological conditions of firing;
- the inclusion in the combat configuration of cluster munitions, which are equipped with homing or combat elements.

- Reducing the vulnerability to fire damage to enemy artillery is achieved by reducing the time to prepare for opening fire on the target and reducing the time spent in the firing position.
- Increased operational maneuverability is ensured by reducing the total mass and size of artillery systems to ensure their transportation by transport aircraft, or on the outer suspension of helicopters.
- The conducted review of the condition of self-propelled artillery of the Armed Forces of the Armed Forces of Ukraine shows that the main SG are 122-mm 2C1 "Gvozdika" and 152-mm SG 2C3 "Acacia". WG data was adopted in the early 1970s and has been in operation for over 40 years. Despite the fact that the 122-mm SG 2C1 "Gvozdika" and 152-mm SG 2C3 "Acacia" have proven to be reliable, unpretentious, easy to operate system, but in terms of tactical and technical characteristics, they are significantly inferior to self-propelled guns, which are on armed with leading militarily countries. The main advantage of modern SG over 122 mm SG 2C1 "Gvozdika" and 152 mm SG 2C3 "Acacia" is that they have the best performance in such parameters as: fire performance, range, accuracy, firing vulnerability to enemy artillery fire. .
- Technical condition, combat losses during the ATO require the implementation of measures that would improve the condition of providing the Armed Forces of Ukraine with artillery weapons, the main ones being the modernization of existing artillery systems and the development of national modern artillery systems.

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MAIN PROVISIONS OF MANUFACTURING LOCAL ROBOTIZED COMPLEXES

Ground robotic complexes are designed to perform varioty of work with hazardous objects. Such objects include explosive devices, toxic, radioactive or biologically dangerous substances. Designing terrestrial robotic complexes of special purpose is relevant and important for the national security of Ukraine.

The ground robotic complex must perform various operations with a dangerous object. The main types of operations are: reconnaissance (survey); preparatory; technological (working); final (transport)

The ground robotic complex must perform dozens of different functions without human intervention. Ground robotic complexes have a small mass (20..60 kg) and dimensions (about 1000 mm). Moving and positioning the robotic complex takes place under difficult conditions. When working with dangerous objects, the robotic complex is in an uncertain position.

The main provisions of the design of multifunctional ground robotic systems have been developed based on theoretical and experimental studies. These provisions include choice of a geometric scheme, the substantiation of the characteristics of the main subsystems of complexes, the development of design schemes of the main units and aggregates of ground robotic systems.

The design of ground robotic complexes is proposed to be implemented on a modular basis. Separate modules are specialized and designed to perform certain functions. Including transport with moving and orientation of the complex in space, surveillance and communication functions, and object manipulation functions. Work modules intended for machining operations have special adaptations, set of tools, means of measurement and control.

The review functions include a visual study of the object, the establishment of its features and the definition of individual characteristics of the object or its elements. In the process of conducting reconnaissance operations, not only a review of the object but also establishes its exact position in space, determines the exact dimensions of the object through 3D scanning. Preparatory functions include cleaning the object from dirt, moving or changing its position, separating parts of the object, or installing protective devices, etc. Technological functions of the ground robotic complex include direct work with the object. Possible operations of mechanical and physico-technical processing with special adaptations.

Modules of the ground robotic complex are universal and connected in the necessary configuration. It provides the flexibility to implement a strategy for dealing with a dangerous object. At the same time, quality of the performance of certain functions of the ground robotic complex is significantly increased.

The developed modules are united by the general approach to the design of ground robotic systems. In the process of designing terrestrial robotic complexes, calculations of modules that provide the performance of certain functions are performed. They have a set of typical nodes and aggregates, drives and a system of parameter measurements.

For testing basic principles of designing terrestrial robotic systems has been developed an experimental sample of a multifunctional modular ground robotic complex that has several modules. The complex includes a wheeled module with a limited load-carrying manipulator. This module is intended to diagnost operations with hazardous objects, including inspection and 3D scanning. The module carries out reconnaissance operations. In the complex, there are modules of average load capacity. They have power manipulators to work with dangerous objects. Individual modules of the complex have different types of engines. A crawler engine module provides basic training and technological operations. It is equipped with manipulator of lifting capacity and facilities for machining the object.

The conducted researches of the developed experimental model of the multifunctional modular ground robotic complex confirmed its efficiency.

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DATA QUALITY IMPROVEMENT METHODS ANALYSIS IN THE NoSQL DATABASES

Analysis of the existing approaches for improving data consistency in the NoSQL databases, allowed identifying three main types of consistency that significantly affect data integrity: causality, strict consistency and consistency in the final state.

Thereby, it has been established that the LibRe method has become quite widespread in implementing the issue of improving the quality of consistency. It implements consistency algorithms in the final state. Its implementation is to ensure high availability of data with a high level of data consistency. The advantage of this approach is to increase the level of consistency of strict consistency through the introduction of an additional registry, which for a while stores information about updating records and db replicas on which this particular record was updated. The disadvantage is required delay for determination of the desired replication.

Another method that is quite widely used in the area of data consistency is the method of ensuring causality in conflict handling. This kind of coherence is an extension of the classic causal coherence. Advantages of the method: enhanced data consistency by introducing a commutative and associative conflict handling function. Disadvantages: Conflict detection is a complex task whose solution significantly delays the system. For example, one of the three components of a conflict detection system is the introduction of an explicit causal relationship between the operations of the current and previous version of the record, which requires the execution of an additional dependency check operation.

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THEORY AND PRACTICE PROVIDING TACTICAL AND TECHNICAL CHARACTERISTICS OF COMBAT ARMORED VEHICLES AT DESIGN AND TECHNOLOGICAL STAGES

Tactical and technical characteristics of combat armored vehicles are achieved at the design and technological stages of their development. The engineers face several contradictory challenges:

– increased requirements for the tactical and technical characteristics of combat armored vehicles;

– intensified exploitation and combat conditions;

– shortened terms of design development and technological setup.

Thus, traditional approaches, methods, models and research means do not satisfy the given circumstances. Accordingly, improvement of the existing research tools that would bring tactical and technical characteristics of combat armored vehicles to the up-to-date level forms a large-scale scientific problem. The present work is concerned with its solution.

The development of advanced approaches, methods, models and means of research should take into account the whole complex of loads and damage factors that affect the elements of modern combat armored vehicles. At the same time, it should be noted that these factors require thorough analysis that includes: nonstationary processes; shock-contact interaction; loss of stability; non-linear deformations of non-traditional materials that are increasingly used (for example, non-woven materials); dynamic effects in a wide spectrum of frequencies and amplitudes; elastic-plastic deformation; action of moving load, etc.

Meanwhile, there are contradictions between the requirements for the adequacy of the computational models and the accuracy of the obtained results on the one hand, and their efficiency – on the other. This requires the development of new mathematical models and numerical methods.

In particular, new variants of boundary element method, statistical micro-macromechanics, variational inequalities etc. are proposed. They are implemented in corresponding software and model complexes. The application of these complexes enabled to develop recommendations that justify technical solutions and parameters of combat armored vehicles elements with high tactical and technical characteristics.

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THE METHODICAL APPROACH TO DETERMINING THE AIR RESISTANCE FUNCTION FUNCTIONS (DRAG-FUNCTIONS) F OR RIFLE ARMS

According to existing approaches, the trajectory of ball flight is calculated on the basis of standard laws of resistance to air ball flight (the most common law is 1943 - for the former USSR, including Ukraine, as well as laws G1 and G7 - for Europe and the USA) using the matching criterion - ballistic coefficient. The main disadvantage of this approach is that the ballistic coefficient does not change the air resistance function itself, but only displaces it with respect to the characteristics of the ball chosen for the model. This approach adequately describes the trajectory only at the initial firing sections, while the trajectory portions of the ball velocity approach the transition to subsonic velocity (also the velocity transition section at subsonic velocity and the non-subsonic velocity sphere).

To adequately describe the trajectory of the bullet's flight across the firing range, it is necessary to use the drag function for a single type of bullet firing from a specific type of barrel, since even a bullet of the same type of barrel may have different drag function. An example of this phenomenon is the externally ballistic characteristics of a 48.7 g 12.7 × 108 mm bullet-and-gas ball bullet, which are significantly different when fired from a NBC machine gun and a DSK machine gun.

The issue of determining the drag-function of the ball in the field is solved on the basis of experimental shooting data to determine the magnitude of the falling trajectory of the ball, which does not require the use of expensive laboratory equipment. Such investigations may be conducted by arrows in any unit of the Armed Forces of Ukraine. The only measuring equipment used in the studies is a device for determining the initial velocity of the ball, which is quite common among the shooters.

The necessity of using such a device is determined by the specificity of the mathematical apparatus used to determine the drag-function of balls, namely: the specificity of the differential computation on the finite sections of the function determines the occurrence of certain errors, namely: when conducting differentiation to determine the velocity of the ball on the flight path, the error of determination the initial speed is up to 10%.

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PROVISION OF FASTENER MACHINE PROTECTION FROM REASONS

One of the technical implementations of masking and limited audibility of firefighting from aerial intelligence is being studied. Fortified buildings of open type on the line of defense in the form of a trunk for a tank with a limited firing sector are considered.

It is proposed to cover the trench and the tank with a cylindrical shell of two co-fragments separated by a liquid. In addition, the lower part of the shell partially immersed in the soil under the pit. Influencing the outer shell by acoustic radiation, we perturb in its surface a circular wave, which is at a frequency below the limit when the condition of a significant wave size of the outer shell.

The aberration of radiated sound waves created by this condition creates a zone of kaustikos in a liquid in the form of a confocal inner surface of the outer shell with a cross-section in the form of a circle.

When artificially shaping the wave coincidence, the caustic zone creates such a degree of turbulence, which will become an insurmountable obstacle to echolocation, and on the screen of the sensor will be formed instead of the image of the contour of the tank only vague spot.

Of course, to solve the problem you can use non-circular but bending waves of the outer shell, but in this case, the periphery of the surface of the tank on the screen will be clearly visible.

The main element of the test bench can be considered as an acoustic oscillation generator. His functions are assigned to an ultrasonic industrial design that forms an ultrasonic beam at 36 kHz with a flat front wave. Power of radiation 300 W. The immersion unit of ultrasonic emitters consists of a block of ultrasonic emitters made of stainless steel and an ultrasonic generator. On the lid of the unit inside the cabinet there are ultrasound emitters that convert electrical energy into ultrasonic oscillations. On the back wall is an output of the network cable. The submerged unit is connected to the ultrasonic generator.

The layout of the tank is placed in a round shell that is immersed in water.

When the radiation is off, the contours of the layout of the tank are well displayed on the screen. The activation of the ultrasound unit forms in the vicinity of the outer shell a circumferential wave that emits a liquid sound wave in the separating shell of an angle to the vector of the circumferential wave velocity. Thus, a cylindrical zone of caustic fluid in the vicinity of the inner surface of the outer shell of the tunnel is created. The surface of the caustic, in contrast to the static state of the liquid, has an elevated energy state that manifests itself in the form of a turbulent structure. The image of the tank, due to this, becomes less clear, but, at the same time, the remarkableness of the tested sample is sufficient to classify it as a means of fire technology.

By changing the direction of the ultrasound beam in relation to the normal of the outer shell at an angle of incidence, we obtain the appearance of a resonance situation, which is expressed in the form of "acoustic transparency" of the outer shell. This is the reason for a significant increase in the capacity of the ultrasound beam penetrating into the liquid, practically without the dissipation of sound energy, which allows you to achieve the desired result, namely to transform the image of the tank into a blurred spot on the screen.

Also interesting is the removal of images, on the screens of the locator sensor, outlines of serving the military equipment of people. The effect of the invisibility of staff and the material provision of fire technology, as in the first case, is realized in the same volume and in the same quality.

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PROSPECTS FOR DEVELOPMENT OF ANTI-TANK ROCKET COMPLEXES FOR THE ARMED FORCES OF UKRAINE

The experience of wars and armed conflicts in different parts of the globe, as well as in the East of Ukraine, shows the saturation of the battlefield with tanks, BMPs, APCs and the means of combating them. These complexes are equipped with anti-tank guided missiles, which are capable of striking armored targets at distances beyond the direct range of the main battle tanks and armored vehicles and opens new prospects for their developers.

Anti-tank guided missile (ATGM) is designed to defeat modern armored fixed and mobile objects that have combined or monolithic armor, including dynamic protection, as well as helicopters.

Creating a domestic, modern, 3rd generation anti-tank missile system using anti-tank guided missiles with automatic systems provides the necessary sample of weapons for the Armed Forces of Ukraine.

Analogous to the American ATGM "Javelin".

The main advantages of the ATGM sample are the increase of:

the likelihood of hitting the target;

survivability of calculation and complex;

noise immunity.

Passive homing infrared heads carry out autonomous search, recognition and support of the target on their thermal radiation, which allows firing missiles on the principle of "shot and forgot". This principle provides high survivability of the weapons complex due to the secretive use of weapons and will allow launches from closed firing positions and conditions of lack of direct vision of the target, as well as leave the position unmasked by the signs of missile launch.

The introduction of new anti-tank missile system developments will allow the Armed Forces of Ukraine to effectively hit armored and other targets. It will certainly strengthen Ukraine's military capability and defense capability.

In the future, the development of the ATGM should be directed to the creation of a mobile anti-tank missile complex, which for purpose and tactical and technical characteristics may be a promising complex of high-precision weapons of the new generation (reconnaissance fire multi-purpose ATGM), combining the quality of artillery and anti-tank complexes.

The complex can be designed for the defeat of modern and advanced samples of armored vehicles, vehicles, stationary engineering structures, surface targets, low-speed air targets, manpower in shelters.

The implementation of the project of this complex opens new directions of combat use of anti-tank weapons - the transfer of fire into the depths of combat units of the enemy units and the ability to repel an attack on a large area of defense without changing the firing position. This will prevent the advance of the enemy armored units at the turn of the attack and reduce the loss of their troops.

The use of such tactics poses the task of radically expanding the range of reconnaissance and defeat of armored units with promising ATGM s, which should be able to cover the entire area of responsibility of their units to the full depth of the nearby tactical zone (25-30 km).

The use of external reconnaissance and targeting tools, including those placed on remotely operated aircraft, will allow the most complete implementation of the basic provisions of the concept of "contactless war", shorten the deadlines for the tasks and to widen their range with minimum required means of engagement, and minimize material costs for the operation.

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LASER RANGE FINDER ILLUMINATOR SOLID-STATE LASER WITH OPTICAL PUMPING BY SEMICONDUCTOR LASER DIODES

The evolution, modern methods and tasks are discussed regarding the high efficiency achievement for the laser range finders-target designators based on a solid-state laser with semiconductor laser diodes optical pumping in order to ensure the fire of guided artillery ammunition with a semi-active laser guidance system, including the capability of operation at the light level lowered to 10^{-3} lx and at night; the own directing point coordinates determination (an equipment with a built-in GPS satellite navigation module); the targets acquisition, recognition and identification maximum range ensuring (up to 5000m) with the high accuracy of coordinates determination and data transmission in adverse weather conditions and round the clock.

For increasing the range finder-target designator countermeasures resistance, the pulse duration (target illumination time) should be as short as possible, namely not more than 10 ns at 1.064 μm wavelength (1.54 - 1.57 μm), which will not allow the enemy to capture the radiation source and cause interference.

The optical pumping sources include matrix semiconductor diodes (laser diodes). The use of laser diodes as a radiation pumping system allows a compact laser emitter creating and the range finder-target designator mass reducing. Thus, it is possible to obtain the range finder-target designator mass not exceeding 6-8 kg for a 80-100 mJ power.

The scheme with the pumping diodes horizontal (transverse) arrangement is the most effective for their even cooling and reduces the range finder-target designator overall dimensions.

The issue of creating the range finder-target designator of this class is a current problem, but the laser diodes matrices providing the required pumping power are not manufactured in Ukraine. Such emitters include Cutting Edge Optronics (Northrop Grumman Corp., USA) Gigashot™ laser, Crystaltechno Ltd. (Russia) LH-106 diode-pumped laser and Ekspla (Lithuania) series NL230 lasers.

The SE SIC “Progress” and SE “Izyum Instrument-Making Plant” of the Ukrainian Defence Industry UKROBORONPROM in the co-operation with the NAS of Ukraine organizations including the Institute of Physics, SSI “Institute for Single Crystals” and V.E.Lashkaryov Institute of Semiconductor Physics have the technical abilities to design and produce the range finder-target designator of this class.

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CRITICAL TECHNOLOGIES

Provision of state support for the development of critical technologies in the field of arms and military equipment (OVT) is currently an urgent task.

In accordance with the decree of the Cabinet of Ministers of Ukraine dated August 30, 2017, No. 600 “Some Issues of Development of Critical Technologies in the Field of Arms and Military Equipment”, the question of determining the most relevant technologies for the creation of military-industrial complex was raised.

"Critical technology is a new technology that creates the preconditions for further development of advanced technological directions, has a wide potential range of applications and, in the aggregate, helps to solve the most important technological problems in the fields of national security and defense of the state."

Prospects for enhancing the performance of modern optoelectronic systems (ECOs) for exploration, detection, identification, identification and guidance related to their differentiated capabilities weather conditions, round the clock, protection from interference and false goals, independence from natural light and due to the need to create dual-band photodetectors (IRF) infrared (IR) range 3-5 microns, 8 - 14 microns.

Research on the creation of dual band IRF FPPs is critical.

Technologies for creating our own multi-element, dual-band IRF IRF (3-5, 8-12.5 μm) based on CdHgTe epitaxial layers (cadmium, mercury, tellurium - CRT) and dual-band (3.65-5.2; 2.85-3.35) microns FPT IR radiation based on indium antimonide (InSb) are currently relevant in Ukraine and will allow:

1. to increase the tactical and technical characteristics of the available samples of military equipment or weapons;
2. improve the performance of military equipment or weapons;
3. ensure the competitiveness of military (dual) products;
4. upgrade the existing armaments and military equipment;
5. create fundamentally new models of military equipment, weapons, special equipment.

Dual band FPP (3.65-5.2; 2.85-3.35) microns based on InSb will provide thresholds for spectral, integral sensitivity (increased range), increased resolution, interfering security, and high speed air targets.

Creation of a hybrid dual band (3-5, 8-12.5) μm multielement (not less than 640x512, 1280x1024) CdHgTe exploration, detection, recognition, identification and aiming on horizontal and inclined tracks, on high-speed targets on a celestial, marine, terrestrial background tebased PPP (cadmium, mercury, tellurium - CRT) is required for use in systems.

FPPs integrated into a single detection system will provide an increase in range, the ability to work under different weather conditions, reduce the overall size of the UES, increase the likelihood of detecting faulty (thermal traps, laser radiation).

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DIRECTIONS FOR IMPROVEMENT OF ARMORED DEMINING VEHICLES

The analysis of combat operations during the Joint Force Operation(JFO) in the Donetsk and Luhansk districts shows an increase in the use of mine-explosive barriers by Russian terrorist forces and a significant increase in our losses in personnel and equipment due to the explosion of mines or otherenemy controlled explosive charges. Hereof, there is a growing need in thefurther improvement of means for overcomingof the mine explosion barriers, including with employment of armored demining vehicles (ADV).

The ADVs should ensure the passage of vehicle convoy and the formation of passages in mined areas by sweepingof main types of anti-tank mines (anti-track mines, anti-bottom-attack mines with contact mechanical, non-contact magnetic and radio detonators, anti-hull-surfacemineswith acoustic and infrared target sensors) with the use of special equipment and, if necessary, by landing of landing troops.

As a base vehicle it is expedient to use a chassis of a tank or an armored personnel carrier, which must have a combat compartment for placing a crew and a landing troop of three deminers, and to be additionally covered with a set of dynamic protection. The bottom should be armored to ensure the protection of the crew and the landing troop of the deminersat the explosion of anti-bottom-attack minesor other landmines. The fastening of the seats of the crew and of the landing troop, as well as the interior equipment, must be assembled on special amortized supports, which do not have the direct contact of the seats and interior equipment with the bottom of the car.

For deception purposes, the ADV should be equipped with a mortar for firing of smoke grenades. To provide internal and external communication in the car, radio stations and communication devices should be available. In order to monitor the radiation and chemical conditions, the vehicle should be equipped withthe special corresponding reconnaissance devices.

During the formation of passages in antitank minefields,the ADVs should provide the designation of the formed passages without the need of the crew to leave the car. It is necessary to provide thecontrolby the vehicle during the clearance directly by the crew or remotely ether with wires or wirelessly. The range of control in such a case should be at least of 300 m.

The vehicle should be equipped with a cargo platform for the placing of mine-clearing facilities in their transport positionswith the crane equipment on it. The assigned crane equipment should ensure the transfer of roller sections to the working (combat) or transport position. It can be assembled in the form of a crane boom capable for carrying a minimum of 2.5 tons,and implying a possibility to provide the control by the crew using the remote control panel.

Equipment for mine-clearingshould be a of a roller type,of continuous push-up sweeping, to be equipped with a set of knife sections (right / left), as well as with a mine-clearing device for hull-surfacemines (using a gun for shooting the pyrotechnic cartridges) and with a set of electromagnetic console. The time of transferring the equipment for mine-clearinginto the working configuration should not exceed 60 minutes, and the transfer to the transport position, correspondingly, 45 minutes. It is necessary to provide the possibility of accidental disassembly of the equipment in 5 seconds. The equipment must provide a safe radius of U-turn of not more than 50 meters. Anti-miningresistance should provide at least 10 explosions of coupled mines of the type TM-62M below the equipment of mine-clearing without the necessity of replacement of its constructional components.

The basic technical requirements for the object multi-range electro-magnetic noise generator should provide the preventing of the actuationof radio-controlled mines and land-mines within the radius of up to 100 meters.

The formed passage in the minefields filled with anti-track, anti-bottom-attack mines with contact detonators must be at least 4.0 meters wide, and foranti-track mines with magnetic detonators, correspondingly, 6-7 meters wide.

When equipping an armored vehicle with the equipment for microwave radiation, its main technical requirements should be to ensure the destruction (deactivation) of mines and other explosive field-chargesequipped with the electronic sensors at a distance of at least 100 meters.

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THE METHODICAL BASIS OF THE COMPLEX APPROACH TO MODERNIZATION OF MILITARY VEHICLES

In scientific, methodological and organizational aspects, the system of modernization should have a complex of closed scientific, production, technological, regulatory and methodological cycles, which provide the solution of the tasks of the system. At the same time, it should be based on the legislative and regulatory frameworks, scientific and technological capabilities of Ukraine.

In order to define the tasks related to the creation of the modernization system, a general methodology for extending the life cycle of military automotive equipment to the deadline has been formed based on the development and implementation of relevant innovative technologies. It is based on the general provisions of the methodology for the development and research of complex technical systems and the general methodology for extending the life cycle of military automotive products. It was taken into account that such a system should consist of separate elements, each of which should solve partial problems, and their totality - the main task - the modernization of military vehicles.

To create a system of modernization of military vehicles, a number of system-conceptual requirements, namely:

to provide the necessary legal status to the works on the modernization of military automotive products by developing, implementing and improving appropriate regulatory support;

to develop scientific, methodological and informational support of works taking into account limited information on their parametric and reliable characteristics, as well as the nonlinear nature of changes in the properties of military automotive products;

to create appropriate technological support for the modernization system, taking into account the capabilities of Ukrainian enterprises of Ukroboronprom; to create a cooperative of enterprises of industry, military management bodies and research institutions of the Ministry of Defense of Ukraine for carrying out works on modernization on the principle of the closed cycle of production.

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POSSIBLE OPTION OF CLASSIFICATION OF PERSPECTIVE ARMORED WHEELED VEHICLES

At present, the Armed Forces of Ukraine have adopted (commissioned) armored wheeled vehicles (AWV), which are close in function, but differ in combat technical characteristics and structural performance. Considering this and taking into account the further development of the AWV and the need to equip the Armed Forces of Ukraine with modern models of such equipment, the question of putting into effect the Type of promising AWV is urgent.

The report proposes a possible classification of perspective armored wheeled vehicles by functional purpose, manufactured (purchased) for the needs of the Armed Forces of Ukraine, made according to the main technical characteristics of the samples (full mass, number of axles, overall dimensions, ground clearance, power and capacity) characterizing the combat properties of the sample (load on the axis, specific power, specific gravity). This possible variant was calculated using the methodology developed in the framework of the research work, the code «Perspective-AWV», which was performed at the Central Research Institute of Arms and Military Equipment of the Armed Forces of Ukraine in 2010-2012.

AWVs by functional purpose are divided into:

Light shocks - for conducting reconnaissance, reconnaissance and sabotage operations in the rear of the enemy;

Light, medium and heavy tactical - to solve combat and logistical tasks in the tactical area of units and units, use of various Arms and Military Equipment, fire support units, diagnostic and maintenance facilities, towing weapons and trailers for various purposes, use of trailers and trailers tactical area of action of troops;

High Mobility MRAP - for transporting personnel, solving military tasks, ensuring law and order, national security, peacekeeping operations, use during disasters, maintaining general security, during special operations;

MRAP patrols - to solve the tasks of patrolling the assigned area on the road network, transportation of personnel in the number 6-10 people, including in city conditions, as well as logistical support, use for the installation of various special equipment, as well as heavy fighting vehicles for the transport of groups for disposal of unexploded ammunition.

According to this classification, AWVs refers to:

«Kozak», «Bars-6», KrAZ «Cougar» - light tactical;

«Bars-8», KrAZ «Spartan-APC», «Dozor-B», «Triton» - medium tactical;

KRAZ «Hurricane», «Warta», KRAZ «Shrek», KRAZ «Feona» - patrol MRAP;

«Kozak 2», «Renault Sherpa Light Scout» - High Mobility MRAP.

This methodology is the result of scientific research, so it does not have the status of a normative document, but can be used in the implementation of measures to develop the type of advanced armored wheeled vehicles with the involvement of interested agencies and organizations of the General Staff of the Armed Forces of Ukraine and the Ministry of Defense of Ukraine.

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ANALYSIS OF THE CAUSES OF VERIFICATION OF THE RIFLE OF THE FIRE ARMS UNDER THE SHOOTING DURATION AND THEIR EFFECTS ON THE ACCURACY OF THE SHOOTING

One of the most important characteristics of small arms and artillery products, which determine the effectiveness of its use, is the accuracy of shooting. Barrel fluctuations affect the accuracy of firing due to the bend of the barrel and the resulting lateral velocity of the muzzle of the barrel. For accuracy, it is important that the moment of departure of the bullet from the muzzle with each shot corresponds to a certain and constant value of the angle of deflection of the muzzle of the barrel, ie a certain phase of oscillation.

The rifle barrel when firing is subjected, among other things, to the following forces: the axial component of the friction of a bullet (projectile) on the surface of the barrel channel and the pressure of the leading device on the rifling side of the rifles, which stretches the barrel in the longitudinal direction; the transverse component of the pressure force of the master device on the cutting edge of the rifling, which twists the barrel around the longitudinal axis; the forces of inertia arising in the walls of the barrel due to the rapid development of the pressure of the powder gases or as a result of accelerated movement of the barrel. They are the cause of oscillatory motion. The nature and extent of the oscillations depend on many factors: the length of the trunk, its transverse dimensions, the presence and location of the concentrated masses, the conditions of attachment, etc.

The above is difficult to take into account when determining the nature of the oscillations of the barrel, so when studying them often take the barrel in the form of a cylindrical or conical rod with one fixed end. Such a rod usually has the following types of transverse oscillations: first order or pitch oscillations; the node of these oscillations is at the point of attachment of the end of the trunk; second order or first pitch vibrations; one node of these oscillations is at the point of attachment of the end and the other is at a distance of 0.22 l from the free end of the barrel; higher order oscillations with an appropriate number of oscillation nodes, the higher the oscillation order, the greater the frequency and the shorter the oscillation period of the trunk.

All these oscillations occur mainly in the vertical plane and overlap one another. They affect the accuracy of firing both non-automatic and automatic weapons. As the length of the barrel changes, the conditions of oscillation change and the scattering changes periodically, passing sequentially through the maximum and minimum.

When firing from non-automatic and self-loading automatic weapons, as shown by the experience of rifle shooting, the second order oscillations have the greatest influence on accuracy. This is explained by: second-order oscillations give a large angle of deflection of the muzzle; the frequency is greater, so the phase delay at scattering will be greater.

Rifle barrels have a first-order oscillation frequency of about 30 ... 60 periods per second and a second order of about 200 ... 400 periods per second. The second-order oscillation frequency is approximately six times the first-order oscillation frequency.

When firing an automatic weapon, first order oscillations occur. In this case, the dangerous resonance of the oscillations renewed with each subsequent shot, if the number of oscillations in the time between two subsequent shots is a multiple of the firing rate. Obviously, fluctuations that do not have time to dampen until the next shot will be important for accuracy. First-order oscillations are of the highest duration and are of interest in this case.

The variables that influence the variation of the barrel oscillations are barrel length, modulus and mass. During firing the barrel heats up. When heated, the length of the barrel changes; due to the fact that the value of this indicator is within the hundredths of a percent for the temperature of 200 ° C, it has little effect on the accuracy, but because the change of the modulus of elasticity of steel for the same temperature is about 8… 9%, and for 600 ° C increases almost twice. That is much higher. The trunk becomes softer, the bending phase of the trunk shifts forward to the point of departure of the ball, the aggregation falls. Therefore, the weapon may perform better with either a cold or a hot barrel.

The complexity of accounting for all the main factors affecting the fluctuations of the barrel, especially the difficulty of determining the moment of onset of oscillations of the muzzle, do not allow to make a reliable analytical study of the fluctuations of the real structures of the trunks and their impact on the accuracy of firing, so experimental methods are of great importance.

The ways of reduction of the range of fluctuations of a barrel and their influence on shooting accuracy are analyzed.

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WAYS OF DEVELOPMENT AND IMPROVEMENT OF RIFLE WEAPONS OF THE SPECIAL FORCES OF THE ARMED FORCES OF UKRAINE

Currently, in developed countries, work is underway to improve the effectiveness of combat use of assault rifles and assault rifles to equip special operations forces, which is conducted in the following areas:

the creation of a 21st Century infantry armament complex;

creation of new rifle complexes and modular systems using electronic fire control systems and sighting modules;

It should be noted that the great attention of foreign military experts is given to improving the accuracy and efficiency of firing.

Some sample machines have variants with complex metallic examples, as well as variants with truncated trunk. "Shortened" submachine guns in their combat capabilities are similar to submachine guns. Such automatic machines are especially convenient for actions in the conditions of the limited space, at transportations, landings, etc.

A separate group of them is comprised of bullpup designs.

When creating assault rifles like "bullpup", there are two ways - a completely new weapon is being developed, or an existing classic layout weapon is being adapted to the new configuration. The first option promises more efficient use of the potential of the bullpup scheme, because it allows to make weapons more balanced, as well as to implement a particular scheme of weapons. The second method can significantly reduce the time and financial costs of both development and re-equipment of production, moreover, it allows you to convert existing existing weapons in the system "bullpup". The rifles upgraded to the bullpup system have a number of disadvantages, such as the low efficiency of firing weapons from the left shoulder, poorer weapon balancing, and often the significantly less convenient arrangement of controls.

Comparison of the tactical and technical characteristics of perspective and existing assault rifles and assault rifles shows that the machine guns and rifles of the bullpup system most closely meet the requirements of modern combat and are most suitable for arming units of the Special Operations Forces of the Armed Forces of Ukraine.

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JUSTIFICATION OF THE STRUCTURE OF THE ARMED MACHINE

When developing samples of armored combat vehicles, the developers are faced with the problem of choosing a rational design of samples of vehicles with increased level of ballistic protection and justification of the decision to apply a technical solution to increase the level of ballistic protection. To address this, they use a systematic approach whereby the design model that is being designed is characterized by many possible structures and output parameters. Injection vector projections reflect the effects of the lesions. The likelihood of specimen damage leading to mobility loss will be the main output parameter. Equipped sample mass is a component of total mass, the ratio between which and the weight of the payload determines the specific load capacity and characterizes the efficiency of the vehicle. The cost of the sample is a parameter, which depends on the possibility of adopting one or another design variant.

Each projection of the vector of initial parameters characterizes only one of indicators of quality of a design, that is its partial indicator. In order to simultaneously consider all the components of this vector and to find such rational structure (design) of the sample, which provides the optimal value at the same time for all entered partial indicators, we use a generalized quality indicator, which leads to the model of making the optimal decision - problems of vector (multicriteria) optimization. It should be emphasized that the choice of an admissible vector according to some initial parameters relates to problems that are difficult to formalize. To avoid this, use an approach that is to use as a valid vector - a vector of perfect sample, in which all parameters have the best value of all known. As a result of using the procedure described, there may be a situation where there are many acceptable structures that satisfy the conditions. One parameter is better than one, the other the other, that is, the admissible structures create a Pareto set.

Different methods have been used to select the optimal distribution solution. It is proposed to use one of the known methods - the method of sequential optimization, which is to compare structures for each partial indicator in combination with the principle of "concessions". As a result, partial criteria are combined into a single complex one. The sequential optimization method boils down to this. It is assumed that the indicators can be ranked in a number of advantages. The optimization procedure is multi-step. At each step, structures are compared by one indicator. They choose the structure (s) in which the first parameter is the best. It should be noted that all selected parameters are inverse. In the next stage, new best structures are included in the review. The ability to include new structures arises due to the fact that some "concessions" are made to the parameter. The expanded set of structures by the same logic is compared by the second parameter, then by the third. At each subsequent step, due to "concessions", it is possible to exclude structures that are recognized as the best in the previous step. Thus, as a result of the described multi-step procedure, it is possible to arrive at a single structure that is considered optimal.

The method of sequential optimization is advantageously algorithmic simplicity, and, in addition, it can be seen at the cost of the concessions in each partial indicator to achieve optimization as a whole. The initial value of the concessions is defined as the absolute error of measurement or calculations of indicators and is gradually reduced to the value when it is possible to achieve optimization as a whole and to arrive at a single optimal structure of the structure of the car with the increased level of ballistic protection.

Thus, the choice of rational design of samples of armored combat wheel vehicles by the method of sequential optimization in combination with the principle of "concessions" is substantiated.

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TECHNOLOGICAL LUBRICANT FOR PROCESSING OF THE FIRE BARREL CANALS BY THE DEFORMING BROACHING

Today in Ukraine the development of industrial technology for processing and strengthening the inner surface of fire barrel canals is a rather urgent task.

One of the ways used by manufacturers (Lothar Walter, Shillien, Hart, Weatherby, Bergara Barrels Factory) to form screw trunks of the trunk canal is deforming broaching (DB).

The DB allows for substantial deformation strengthening and a significant increase in the resource of the finished product without the use of reinforcing coatings, provides high productivity, high coefficient of material use, that is, a material and energy saving process. In addition, it does not require using special equipment for its implementation.

In the Institute for Superhard materials of the NAS of Ukraine, research is being carried out to create an industrial technology for the formation of smooth-cut rifles on gun barrels using a DB.

Typically, artillery steel of type 38Х2МЮА or 38ХН3МФА (HRC 28 - 32) is used for making trunks.

As the research has shown, in this case, when shaping the threaded profile of the barrel by shaped deforming tool, the contact pressure in the zone of its interaction with the treated product can reach 3.5 GPa and more, which leads to such a negative phenomenon as grasping. The consequence is the formation of stinging on the surface to be treated and the deterioration of roughness, that is, an irreparable defect.

Avoiding this negative phenomenon is possible by the use of efficient technological lubricants.

For processing by deforming protrusion of materials inclined to gripping with a tool, a number of lubricating compositions, both solid and liquid based on chlorine-based additives, molybdenum disulfide, graphite, cadmium iodide, etc. were proposed. Each of these compositions is created for certain processing conditions.

The analysis of literary sources and studies made it possible to determine the basis of the lubricant composition, namely, the chlorine additive, oleic acid and vegetable fats. This composition provides high shielding properties, which allows processing of parts from the above-mentioned steels by deforming stretching. To improve the operational properties of the lubricant, its modification was carried out by adding to its composition fillers, such as chalk of different origin, molybdenum disulfide, vegetable fats, soap solutions etc.

As a result, the composition of the lubricant composition has been determined, which ensures the treatment of the shafts by deforming stretching without gripping, at a contact pressure up to 3.5 GPa: chlorinated paraffin, oleic acid, vegetable fats and soap solution.

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FOR PROCESSING OF THE FIRE BARREL CANALS BY THE DEFORMING BROACHING

Today in Ukraine the development of industrial technology for processing and strengthening the inner surface of fire barrel canals is a very urgent task.

Manufacturers use five main methods of forming screw trunks of the trunk channel: one-pass cutting, stretching a multi-strand, rotary forging, deforming broaching (DB).

Single-threaded threading involves cutting cuts one at a time, which requires the use of complex equipment and a lot of time.

More productive are the methods of radial forging (hot or cold).

The use of cold forging allows due to deformation hardening and low roughness of the treated surface to significantly increase the product life compared with the obtained blade processing. But the process of radial forging requires to use the expensive equipment which is not produced in Ukraine.

DB as a method of profiling a threaded trunk channel, used by Lothar Walter, Shillien, Hart, Weatherby, Bergara Barrels Factory.

In the manufacture of smooth trunks, the finishing operation of the channel processing is usually a labor-intensive honing operation, which may take several hours.

The following material contains the results of the use of DB in the treatment of threaded and smooth trunk channels.

The DB allows for substantial deformation strengthening and a significant increase in the resource of the finished product without the use of reinforcing coatings. The implementation of the method does not require the use of special equipment.

In the Institute for Superhard materials of the NAS of Ukraine, the industrial technology of shaping the channel of the trunk of the subbarrel of grenade launcher Ø40mm with the use of the DB was created.

The revealed features of shaping can be used in the development of the technology of processing the trunk of other calibers.

The trunks were manufactured from 38X2MЮA steel (HB 280). A shaped deforming tool was used, the cross section of which corresponds to the cross section of the trunk. The tool was made of solid alloy *BK*15.

We applied the technological scheme of the DB in a hard shell. This scheme eliminates the radial plastic deformation of the outer surface of the workpiece and allows for high quality and precision of the surfaces to be treated.

Output divergence of the internal diameter of the workpiece after the DB was 0.05 mm, surface roughness - Ra 6 microns. After processing received divergence of the sizes: on depressions - 0,02 mm; on protrusions - 0,01 mm. The surface roughness was: on cavities - Ra 0.13 microns; on protrusions - Ra 0,17 - 0,2 microns. All the values correspond to the value indicated on the grenade launcher drawing.

The use of a DP as a finishing operation in the treatment of a hole in smooth trunks reduces the artificial processing time to several minutes and ensures the precision and roughness of the treated surface in accordance with the requirements of the shaver.

The technology is tested at the finishing of channels of mortar barrels with a caliber of 60 mm. In this case, the accuracy of the size of the hole is 0.05 mm and the roughness of the processed surface Ra 0.1 - 0.3 μm. The curvature of the axis was observed.

Thus, the use of the DP as a finishing operation in the processing of channels, both threaded and smooth shafts, provides a hole in the part in accordance with the requirements of the drawing, can significantly improve the productivity and (due to deformation hardening) product life.

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APPLICATION OF NON-AUTOCLAST NON-RESISTANT CONCRETE - AN ENERGY EFFICIENT SOLUTION FOR PROVIDING MILITARY SERVICES WITH AVAILABLE HOUSING

With the increase in the volume of housing construction in Ukraine and the development of a number of requirements for energy efficiency and thermal performance indicators for residential and residential enclosures, the urgent question of finding composite building materials with high thermal characteristics arises. One of these materials is modern cellular concrete. It is possible to achieve normative thermal parameters and reduce production costs by improving the quality of finished products made of cellular concrete and increasing its industrial production according to the needs of modern monolithic frame construction of affordable housing for servicemen. Non-autoclaved aerated concrete is a type of cellular concrete. The combination of aerated concrete with low average density and high design strength is an excellent feature of this material.

The complex of properties creates non-autoclaved aerated concrete technically and economically significant due to the reduction of energy intensity of its production compared to autoclaved aerated concrete. In addition, it should be noted that with the steady increase in energy prices, the cost of binders is steadily increasing, which requires finding options for partially replacing them in the composition of concrete for the waste of the energy sector, while preserving the unique physical and mechanical properties of the porous material.

Thus, scientific work related to the improvement of production technology and improvement of construction and operational properties of aerated concrete is relevant. Progress in the field of mineral-based composite binders contributes to an in-depth study of the chemical aspects of hydration of non-autoclaved aerated concrete with a modified solid component. Modification transformations of porous material are based on the complex action of lime-carbonate additives containing calcium carbonate (calcite), calcium hydroxide (portlandite) and additives of plasticizing and accelerating action. Researches aimed at the development of aerated concrete with a modified solid component have made it possible to obtain non-autoclaved aerated concrete with a density of 500 kg / m^3, which is classified as class C2 material by compressive strength.

The presence of modern synthetic foaming agents, which are sufficiently stable in alkaline environments, and compact high-performance foam generators, allow to supplement the process of preparation of aerated concrete mixture by foam porosation in one process. Such complementarity of traditional methods allows to increase the positive effects of gas and foam method of porization, to increase the technological properties of the mixture and the performance of porous concrete, while reducing the total consumption of pore-forming additives.

The urgency of the construction of non-autoclaved aerated concrete houses is due primarily to their high energy efficiency, comfort of living, environmental factors that meet the modern requirements for wall structures in residential construction. As external wall structures it is advisable to use blocks with geometric dimensions: length - 600 mm, width - 300 mm and thickness - 200 mm according to. For interior partitions and interior walls with inner layer blocks with dimensions 600 × 300 × 100 mm of DSTU B V.2.7-137. It is also necessary to provide for wall structures of long span the arrangement of deformation joints with special elements.

The production introduction of non-autoclaved aerated concrete was carried out at the production facilities of the «New Building Materials» LLC Complex in Kyiv region. The obtained aerated concrete is characterized by the following technical parameters: mark on average density D500; compressive strength class - C2; brand of frost resistance - F50; thermal conductivity in the dry state not more than 0,13 W / (m ° C); drying shrinkage - not more than 3 mm / m; a porosity of at least 74%. Non-autoclaved aerated concrete according to physical and mechanical properties satisfies the requirements of DSTU B V.2.7-45.

Thus, the results of the research work can be used to broadly involve in the production of building materials waste of the energy sector of the industry, which will allow to solve environmental issues of the regions of the country and to obtain in the future structural and thermal insulation products with a density of less than 500 kg / m^3.

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RADIATION-PROTECTIVE CONCRETE FOR THE PROTECTION OF MILITARY SERVICES FROM THE INFLUENCE OF IONIZING RADIATION

Particularly heavy concrete is an effective building material for the protection against nuclear radiation from shelters intended for military personnel. In addition to conventional heavy concrete, particularly heavy concrete has a higher average density exceeding 2500 kg / m^3. This material provides effective protection of structures against ionizing radiation, which is significantly dependent on the thickness and mass of the enclosure. In order to increase the average density of concrete, it is possible to introduce into its composition a small amount of iron ore materials according to DSTU 3704, which have a high density - up to 7000 kg / m^3.

For the manufacture of these concretes, it is advisable to use cement with the addition of blast-furnace slag, for example Portland cement M400 (type II) with the designation ПЦ II/А-Ш of DSTU B V.2.7-46. The choice of binder is due to the fact that the selected cement must have the lowest rate of heat during hydration, that for the 7th day of curing should not exceed 290 kJ / kg. At the same time, the chemical composition of Portland cement $3CaO{\cdot}SiO_2$ and $3CaO{\cdot}Al_2O_3$ should not exceed 58%.

As a filler for radiation protection concrete use materials from heavy ores with high density: limonite, magnetite, hematite, barite, etc. Basalt crushed stone can be used as a large aggregate produced in Ukraine. The average density of pieces of rocks or grains of basalt crushed stone produced by PJSC "Ivano-Dolynsk Special Quarry" is on average 2890 kg / m^3, which is 11% higher than the density of crushed stone of granite.

As a small filler, sand is used by the natural producer of JSC Nikitovskiy Granite Quarry. For regulation of particle size distribution of aggregate it is possible to use river sand (river Dnipro). Radiation-protective high-density concrete was obtained only with the use of river sand with a modulus of 1.33, whereas the compositions of concrete on sand with a modulus of 2.51 had smaller average density.

Not only chemical additive but also ash of dry removal of thermal power plants (TPP) can be used to reduce heat release of concrete mix in the early stages of hardening and increase of corrosion resistance of concrete.

The initial data for determining the composition of particularly heavy concretes are: average density of concrete, mobility of concrete mix and strength of concrete. The mobility of the mixture should be within the cone sediment (2.5-8.5) cm, which corresponds to the mobility of the mixture under the brands P1 and P2. The viability of the concrete mix should be at least one hour.

The composition of the concrete was selected according to according to the method used for conventional heavy concrete and specified experimentally in trial mixes. Mixing and preparation of the concrete mixture was performed in a 10 l compulsory laboratory mixer. The required average density of concrete was obtained by appropriate selection of aggregates of fractions 5-20 mm and screenings of 2.5-5 mm. The mixing time of particularly heavy concrete should be increased compared to conventional concrete. The stirring time should be at least 2 minutes.

Vibration seals must be used to seal the concrete mixture. For concrete and large-scale concrete construction, the mixing and sealing of the mixture must be performed in layers (layer thickness up to 300 mm), with breaks after laying of the previous and subsequent layers no more than 40 minutes, depending on the air temperature and the properties of the cement.

Radiation protection concrete must meet the requirements for the thermal properties of concrete, which is mainly used to protect structures from ionizing radiation and should not be considered as a major structural element. The main thermal properties of concrete are the coefficient of thermal conductivity (W / m ° C), heat capacity (J / kg ° C). Obtained especially heavy concrete is characterized by the following physical and mechanical characteristics: average sample density of 2564 kg / m^3, compressive strength of concrete for 7 days - 47 MPa.

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DETERMINATION OF PANCHING STEEL ARMOR BY SOLID CORES

Dynamic processes of impact, penetration and panching are very diverse and depend on the speed and direction of impact, the size and shape of the penetrating body, the design and technology of the production of interacting bodies, as well as the physical and mechanical properties of materials. Therefore, in the simulation, the main emphasis is placed on the structural features of the interacting bodies and the conditions of bending, which are for the steel armor defining or serving as a criterion for its ability to absorb the kinetic energy of the solids. At the same time, the reliability of the results obtained with these methods, in many respects, depends on the behavior patterns used in the process of dynamic load.In order to assess the possibility of armor-piercing of different cores, it is necessary to know a significant number of mechanical indicators as a core material, as well as armor material. In this paper, an attempt was made to create a methodology based on the use of substantially smaller numbers and more traditional indicators.

First of all, we note that by making some assumptions and constraints of a non-principal nature, one can reduce the problem of the conjugation of two elastic-plastic bodies to the boundary quasistatic problem of mechanics of a deformed solid state or the destruction mechanics, which makes it possible to apply the method of finite elements to its solution.

Having chosen this method and its program implementation as basic, when formulating the calculation scheme, kinematic and static boundary conditions, we will consider the solid core of the body of rotation, and the armor in the general case – as a single or multilayer solid body. In addition, suppose that: at the initial moment of time, the bodies that are shocked are free of any strain; the thermal phenomena caused by the heating of the shock wave and the contact interaction of the solid core with armor, due to their speed, do not significantly affect the physical and mechanical properties of the materials, the processes of penetration and penetration at the speed of impact, close to the ballistic boundary; the time of collision considerably exceeds the time of passage of stress waves on a drummer and armor in the form of a steel plate of finite thickness; the impact has a local character, or in other words, a relatively small part of the armor is involved in collision, the size of which is comparable to the diameter of the solid core.

To determine the ballistic boundary or the ultimate ballistic velocity (the minimum speed of a solid core, which is possible through the breakdown of armor), we will use the deterministic approach. It involves the definition of a ballistic boundary based on physical principles, such as the laws of conservation of the amount of motion and the amount of energy, which leads to the need to solve differential equations in partial derivatives. In this we use the model of Mer and Bodner and the equation of the energy balance of the Rehta-Ipson equation.

According to the calculations, the formation of a plug in a flat armor layer occurs at 8–9 μs, and the deformation of the solid core lasts to about 15–20 μs, after which the velocity of movements in the core and the stoppers are aligned and they, as a solid body, continue to affect the layer steel armor, the destruction of which consumes the kinetic energy of the remaining core. The speed of the latter at this moment is about 40–50 %, and the kinetic energy – less than 10–15 % of the original.The final penetration of the solid core into armor is usually accompanied by further dispersion and destruction of the material, which results in the formation and displacement of conical or cylindrical stoppers, which are characteristic for brittle and plastic materials, respectively. Modeling of these processes has become possible only recently as a result of the final-realization of the models of Holmquist, Johnson-Cook and others.In the case of a normal hit, the value of the radius of the arm "involved" to the shock interaction is defined as the boundary beyond which the axial voltages are less than 10 % of its maximum value. For angles $\theta \neq 0$ as the general criterion, the value of the radius of the kernel of compression (adjacent to the impact zone) was taken, the size of which was determined based on the distribution of maximum principal stresses.

By comparing the stress fields for a normal impact, the value of the stress ratio was determined, which determines the boundary of the compression kernel for all angles of impact. Since, at speeds close to the ballistic limit, the forces of inertia can be compared with the strength characteristics of armor, then knowing the force of impact, by solving the contact problem, one can assess the boundary state of the material and the value of the specified compression core. As a criterion for the non-breakdown of armor for all occasions, it was assumed that the condition for the equality of zero ballistic velocity was fulfilled. For the considered approach, the main analysis of the core of tungsten cobalt solid alloys of the grades VK3M, VK8 and VK20KS at the breaking of steel armor of 40 mm thick (the core has a cylinder shape ∅ 17 mm in length 68 mm, a speed of 1000 m/s, the impact is carried out on the normal to the armor surface). At the same time, a different mechanism of deformation in the presence of a core of armor, varies from brittle to low-cobalt alloys to plastic for alloys with a content of more than 15 wt. % of cobalt.

Analyzing the obtained results, it can be concluded that the most effective broaching of armor is made by the core of the solid alloy VK3M, then from the alloys VK8 and VK20KS.

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METHOD OF ANALYSIS OF FAILURES (FAILURES) OF MILITARY VEHICLE EQUIPMENT DISCOVERED

Conducting modern combat operations and the experience of the operation of the Joint Forces in the territories of Donetsk and Luhansk regions shows that the use of good military motor vehicles is an important element of the combat missions of the Armed Forces of Ukraine.

The results of the analysis of the set of operational properties of military vehicles and their components from the standpoint of research of complex technical systems, we can conclude that as the main indicator of efficiency in solving the task of estimating and predicting changes in the technical state of the systems, it is advisable to consider reliability.

However, the factors that determine the conditions and modes of operation of technical systems, including the features of their intended use, structure and effectiveness of maintenance and repair, are taken into account in a rather limited composition, and the influence of the correlation relationships of the interacting factors is taken into account very approximately. This approach leads, ultimately, to obtaining only approximate estimates of the current level of operational properties of technical systems and the dynamics of its change based on the results of the predicted estimates.

The report looks at the failure process and shows the cause and effect of using the Fish Skeleton scheme (Professor Ishikawa's diagram).

In the proposed method, the end result (reliability indicator, external failure manifestation, failure criterion) is depicted by a central arrow. The phenomena (factors, principles) that affect the outcome are depicted by arrows pointing to the center line.

The report shows that the end result can be presented as a table. The results of the calculation on the table make it possible to formulate the main shortcomings of the current system of operation of OJSC and to reasonably solve a number of organizational and technical measures aimed at maintaining the reliability of military automotive equipment, which has been in operation for a long time.

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METHODOLOGICAL ASPECTS OF TACTICAL AND TECHNICAL EVALUATION CHARACTERISTICS OF WEAPONS AND MILITARY EQUIPMENT

In the research of the military-technical aspects of the national security of the state, one of the main tasks is the question of substantiation of the basic directions of development of arms and military equipment (OVT) and formation of tactical-technical requirements to them.

The concept of scientific work in the Armed Forces of Ukraine has been historically adopted in Ukraine, which was approved by the decree of the Minister of Defense of Ukraine on May 7, 1997, in which theory of the development of military-industrial complex is referred to the main areas of military science. As a priority tasks that are solved in the framework of the theory of the development of VT, consider the conceptual apparatus of a unified methodology for research and the selection of generally accepted criteria for the assessment of technical status and effectiveness of VT.

To accomplish these tasks, it is necessary to unite the efforts of research institutions (organizations) of all ministries and departments that will ensure the defense capability of the state, within the framework of scientific support of the State Defense Order, the State Targeted Defense Program for the Development of Arms and Military Equipment of the Armed Forces of Ukraine until 2022.

The central role in solving these problems belongs to the Central Research Institute of the Armed Forces and Military Equipment of the Armed Forces of Ukraine, as the main research institution of the Ministry of Defense of Ukraine for the study of military-technical policy in the field of military-industrial development.

From the standpoint of the systematic analysis methodology, it is advisable to study any TPA on a continuous basis at 3 levels:

composition - properties;

structure - function;

organization - functioning.

At the initial stage of research (level 1), the composition of a new type of TPA is analyzed and its properties, accounting (quality), and their totality are revealed. The accounting (quality) of any type of IWT is determined by a set of tactical and technical characteristics, of which the main (most important) are those that characterize the technical perfection of the IWT and have the greatest impact on the effectiveness of its application (use) as a whole.

As a rule, the concept of combat effectiveness is not introduced at the first level, as it does not directly address the issues related to the purposeful purpose (functioning) of the VTS and is the subject of analysis at subsequent levels of research.

The task of selecting a TTX nomenclature to evaluate the technical excellence of VTs can theoretically be solved using different approaches, but within the framework of analytical research.

According to the accepted set of basic characteristics of the OVT, a quantitative measure of its technical perfection can be obtained in comparison with the basic (standard) sample (system) - generalized indicators of the technical level.

Methodological approaches are used for calculations of technical level indicators, as in the general form such task belongs to the class of multicriteria (vector) optimization: comparison with the basic sample (system), spectral approach and linear extrapolation method.

Thus, the functioning of a set of tactical and technical characteristics of the VTS is the most important stage of development and creation.

DEVELOPMENT PROSPECTS OF THE AIR FORCES ARMAMENT AND MILITARY EQUIPMENT

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MEASURES TO INCREASE THE EFFICIENCY OF TECHNICAL EQUIPMENT BY AIRPOWERS, AVIATION EQUIPMENT AND ARMED FORCES OF UKRAINE

The current state of the art of aviation equipment (armaments) and air defense equipment needs significant improvement.

The solution to this problem is possible only under conditions effective implementation of the objectives of military-technical policy, including:

Creation of a rational weapon system of the Armed Forces of Ukraine;

Support existing weapon systems in combat efficiency of state;

ensuring the development, production and supply of samples of the military and military forces necessary for the Armed Forces of Ukraine, taking into account the economic capabilities of the state;

Prevention of scientific, technical and technological backwardness from the developed countries of the world in the main directions of the development of military-industrial complex;

Preservation and development of scientific-technical and production potential of the defense industry for the creation and production of new weapons and equipment, modernization of obsolete weapons and equipment;

Forming substance of science and technology in the field of basic and critical technologies, including dual-use technologies;

Ensure the required level of mobilization readiness and mobilization to create conditions for increasing the output of IWT;

Ensuring the development of interstate military-technical cooperation.

The report analyzes the global trends in the development of anti-aircraft missile weapons, aviation equipment (weapons), as well as radio equipment. In addition, attention is focused on the problematic issues of UAV in the Armed Forces of Ukraine and improve the air defense system to combat UAV enemy.

An assessment of air weapons and anti-aircraft missiles, the results of which formed the proposals on volumes repair these products and the content of the program of work on continuing their intended targets.

Based on the results of the analysis of these factors and taking into account the capabilities of the defense companies of Ukraine, the ways and means of equipping the Air Forces of the Armed Forces of Ukraine are determined.

The report also identifies priority areas of research on military-technical issues to which involvement of the Institutes of the National Academy of Sciences of Ukraine is possible.

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APPROACHES TO INCREASE THE EFFICIENCY OF INFORMATION AND ANALYTICAL SUPPORT FOR THE PROCESSES OF TECHNICAL EQUIPMENT OF THE UKRAINIAN ARMED FORCES THROUGH THE APPLICATION OF LOGICAL AND LINGUISTIC MODELS IN DECISION MAKING

The article deals with solving the problems associated with the low level of automation of the technical equipment of the Armed Forces of Ukraine requires a set of measures to create an information infrastructure, an appropriate information-analytical system, and subsequently a unified information system for defense resources management (DRMIS).

To increase the efficiency of processes equipping the Armed Forces of Ukraine proposed implementing software solutions based on component creation aggregated cognitive services that will ensure the necessary level of efficiency, accuracy and completeness of the information.

It is advisable to build an appropriate information-analytical system on the basis of component architecture of cognitive services, which will provide a full-scale solution of meta-problems of analysis, structuring, selection and synthesis.

This system should be an innovative complex of network software-information and methodological means of integrated use of distributed information resources and corporate knowledge systems, which have a large number of interdisciplinary relations and are created on the basis of different information technologies and standards using ontological principles of processing heterogeneous spatial information.

Models used for processing complex structures of different types of data and knowledge are the use of logic-linguistic models, that is, models where the basic elements are not numbers and computational operations, but names and logical connections.

It is shown that the implementation of logical and linguistic models in intelligent information-analytical system it is advisable to carry out in the form of growing pyramidal network and built on the basis of its ontology.

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ANALYSIS OF THE USE OF UNMANNED AERIAL VEHICLES IN THE COURSE OF THE ANTI-TERRORIST OPERATION AND THE OPERATION OF UNITED FORCES OPERATION

The analysis of the experience of conducting anti-terrorist operation (ATO) and operation of the Joint Forces (OJF) in the territory of Donetsk and Luhansk regions shows that a significant role in solving the issues related to the order of performance of specific combat (special) tasks, fire damage of various objects (objectives), conducting aerial reconnaissance, staging active and passive obstacles, targets, relaying information in order to increase the range of operations of reconnaissance and strike complexes, forces and means of reconnaissance in operations (combat operations) , belongs to Unmanned Aviation Complexes (UAV).

Application UAV due to several advantages, including:

lack of crew on board the aircraft;

high maneuverability;

low visibility and low vulnerability;

relatively low operating costs;

mobility;

the ability to work in conditions that are dangerous for personnel.

The main task of UAV is to conduct aerial reconnaissance, which plays an important role in the overall intelligence system of the troop (forces) of the leading countries of the world. This is primarily due to the following main reasons:

значним зростанням динаміки бойових дій, мобільності та maneuverability of troops;

use to perform tasks rescuers by masking significant improvement troops;

powerful development of air defense facilities.

The use of UAV for aerial reconnaissance, both by itself and at the same time as performing other functions, such as percussion, is, and will remain, a major consideration, according to most experts.

The Armed Forces of Ukraine has adopted and commissioned more than ten types of UAV in the conditions of a special period by orders of the Ministry of Defense of Ukraine: PD-1, RQ-11B “Raven”, “Leleka-100”, ASU-1 “Valkyrie”, “Mara-2”, A1-C(CM) “Fury”, “Fly Eye”, “Sparrow”, “Spectator-M1”, ACS-3 “Raybird-3” etc.

During the analysis studied the experience of the crew, the results of applying these UAV in the area of environmental protection (ATO), handling drones in the influence of enemy electronic warfare and harsh weather conditions and the possibility of transferring intelligence information in real time.

The analysis revealed a number of problematic issues (both military and technical), the solution of which will allow:

significantly improve the quality (performance) of the application;

to formulate unified views on tactics, procedures and organization of UAV units management;

increase and improve the intelligence system, increase the completeness, timeliness and reliability of intelligence;

improve the enemy fire system;

unify the preparation of UAV crews and their logistical support.

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ANALYSIS OF POSSIBLE OPTIONS FOR REPLACING THE PARK OF REACTIVE TRAINING AIRPLANES FOR TRAINING AVIATION PARTS FOR THE 2030 PERSPECTIVE

The main type of all aircraft currently providing flight training for cadets in the Armed Forces of Ukraine for its tactical aviation is the L-39 jet training aircraft. By extending the assigned service life, the existing L-39 aircraft fleet is capable of providing ongoing training for flight training cadets.

Analyzing the sum of the assigned resources and service life of the L-39 aircraft aviation training fleet and considering the annual flight required for the training of cadets, we can conclude that at the beginning of 2024 a number of aircraft will be shut down due to the exhaustion factor of the assigned service life. For the rest of the aircraft, the load factor will increase, which will increase the intensity of their resource depletion. Therefore, it becomes an acute problem to replace the L-39 aircraft fleet with the newest training and combat aircraft.

A comparative evaluation of existing and prospective combat training aircraft for the replacement of the L-39 fleet has been made. The estimated values of the resources required for this purpose have been determined, and recommendations have been made as to the optimal choice of options for replacing the L-39 training aircraft fleet.

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REAL STATE AND PROSPECTS OF DEVELOPMENT ON AIR BASING COMPLEX ARMED FORCES OF UKRAINE

Now the park of aerostat aircraft (AeAc) of the Armed Forces of Ukraine consists only of automatic balloons and barrage balloons of production 60 - 70th years of the last century which any more are not applied in the world, owing to low efficiency of action and a possibility of creation by them of danger to performance of flights of aircraft including on the international air-lines.

The low duration of stay in air specified bind kytoon it is caused by gas permeability of a cover and loss of the bearing gas. So, for kytoon of a balloon of AZ-55 about the volume of 740 m^3 the gas permeability of a cover (a two-layer rubber matter) in 24 hours at a normal temperature is up to 8 l/m^2. Besides, land utilities have critical condition. Therefore for increase in range of stars to between ground command posts by means of a repeater during conducting anti-terrorist operation in the east of the country balloons which were developed by a aeronautic association of Ukraine were used.

Recently the management of the Armed Forces of Ukraine paid attention to performance of a number of actions for application in the Armed Forces of Ukraine of aerostat complexes and existence in perspective structure the Armed Forces of Ukraine of aeronautic divisions.

In the most effective way of the solution of tasks development of the existing systems of investigation and management of armed forces of Ukraine and their association in the uniform unified management information system of investigation, the notification and management is further. The perspective mobile aerostat radar complex (MARC) identification of the low-level purposes (LLP) has to become one of the most important elements of this system.

The main strategic task of the integrated MARC is "shadowing a situation", that is control of a functional state LLP situation in peace time, the menacing period and during fighting on the strategic directions.

Thus, fighting application of MARC as a part of trans-species the universal system of investigation, the notification and management will allow to solve the whole complex of the strategic, operational and tactical tasks directed to increase in efficiency of planning, application and direct management of armed forces of Ukraine.

The carried-out analysis shows that certain enterprises of Ukraine have long-term experience in the sphere of design and creation of AeAc of various schemes and appointment and also significant experience of creation of means of a radar-location with world-class characteristics that confirms existence in Ukraine of research and production achievements in branches of aeronautics and a radar-location. Besides, in AF of Ukraine there are also specialized structures from fighting application of AeAc. Everything specified is real help for realization of an opportunity own to development, production and operation of mobile aerostat complexes on identification of LLP.

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TRENDS AND THE FORECAST OF DEVELOPMENT OF A MILITARY RADAR-LOCATION IN THE 21st CENTURY

At the modern level of development of the radar equipment (RLT) widespread introduction of digital technologies and also effectiveness of new perspective technologies of obtaining radar information (RLI) give a real basis of system integration and to use of all potentially possible information resource for ensuring radar investigation.

Proceeding from universal trends of development of the radar equipment, it is possible to allocate the main directions of its development:

digital ways of formation of the directional pattern;

automatic digital procedures of formation and processing of signals, receiving and transfer of RLI to one - and multiposition complexes;

integration of active and passive sensors is more whole.

The relevance of researches is caused by need of studying of the specified directions on further development of a military radar-location and providing recommendations for her developers and the industry.

For achievement of a goal it is necessary to resolve the following issues:

to carry out the analysis of trends and forecasts of development of radar station of detection of air targets;

to carry out the analysis of trends and forecasts of development of radar station of detection of the land purposes, moving;

to carry out the analysis of trends and forecasts of development of radar station of counterbattery fight;

to develop modern techniques of the forecast of development of the theory and the military radar equipment;

to define new effective ways and means of radar detection of the air and land targets;

to develop the draft of the concept of development of radio engineering means of investigation.

By results of researches it is expected to receive the following results:

definitions of effective ways and means of radar detection of the air and land targets;

development of a modern technique of the forecast of development of the theory and military radar equipment;

development of the draft of the concept of development of radio engineering means of investigation.

The expediency of carrying out researches on definition of effective ways and means of radar investigation of the air and land targets, development of the draft of the concept of development of radio engineering means of investigation is proved in the report.

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JUSTIFICATION OF REQUIREMENTS TO TECHNICAL CHARACTERISTICS OF RADAR STATION WHICH ARE PLACED ON UNMANNED AERIAL VEHICLES OF PLANE TYPE, FOR MONITORING OF AIRSPACE AT SMALL HEIGHTS

Now creation of the round-the-clock, continuous, radar field for the purpose of identification of air attack from the adjacent states or violations of the rules of use of airspace of Ukraine by aircrafts at small and extremely small heights due to increase in number of radar stations because of difficult economic conditions in the state is impossible, and further and economically heavily.

In this context are of the interest of a research on questions of placement of radar stations of detection of the low-level purposes (LLP) on unmanned aerial vehicles (UAV). Nevertheless, not each UAV suitable for placement on its board of radar station, including with synthesizing of an aperture of the antenna.

At placement of viewing radar stations on the UAV with rather small sizes and cost their survivability is provided and the loss (in particular due to absence of crew) in case of their destruction decreases. Solutions of this task it is connected with considerable difficulties in ensuring small weight, dimensions and power consumption of the equipment which is placed on the UAV and contains together with survey radar station of a means of exchanging data, navigation devices and the equipment of management. The survey radar station which for ensuring necessary range has to have the antenna of the large sizes and high power of radiation is the most problem in this question.

Possibilities of the radar equipment which is placed onboard the UAV, are defined by a resource concerning the weight, dimensions and power consumption which can allocate the UAV for radar station. These opportunities increase upon transition from the UAV of the middle class to heavy UAV.

As the main method of survey of space in radar station on the UAV synthesizing of an aperture of the antenna at the expense of the movement UAV is expedient to apply a side visibility of space with realization of the additional mode. Other functions of a system of a radar-location can be implemented by adaptation of the equipment of radar station of a side visibility to the solution of additional tasks.

Justification of requirements to technical characteristics of radar station which are placed on unmanned aerial vehicles of plane type, for monitoring of airspace at small heights is given in the report the advanced scientific and methodical device.

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REQUIREMENTS FOR THE ACCURACY OF THE ORIENTATION OF THE ANTENNA SYSTEM, TAKING INTO ACCOUNT OF ORIENTATION ERRORS

Experience in modern warfare demonstrates the widespread use of EW tools to disorganize the control system and suppress data transmission channels. Radio-electronic counter conditions may cause the task of directing radio-assisted radiation to an object with known coordinates (receiving antenna, electromagnetic effect, etc.) in the absence of feedback to evaluate the accuracy of guidance. Related tasks arise when determining the coordinates of a target by passive radar or reconnaissance. The definition of guidance accuracy is a function of complex technical and economic compromise.

The report presents the results of modeling the antenna system guidance processes and determining the real-world scope of the radio equipment. The research methodology is as follows: tool coordinates and targets are defined in the external coordinate system; the target vector of targeting and the control parameters of the guidance subsystem are determined; errors are made consistently to determine the position of the tool, its orientation, and errors in aiming; for each variant of randomly distributed errors, a set of experiments is performed, the targeting vector and control parameters are calculated taking into account the errors made; the alignment of the reference vector of targeting with the values obtained during the experiments is determined; statistical analysis determines the parameters of targeting error distribution and the effect of component errors on the result.

The results of the study allow us to conclude about the range of permissible errors with different requirements for accuracy of aiming. Precision requirements increase with increasing range and narrowing range. The results of the analysis of possibilities of providing the requirements for accuracy of guidance in modern means are presented.

The results obtained can be used to justify the tactical and technical requirements for radio equipment.

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EXCITATION OF A MULTI-FREQUENCY OSCILLATORY SYSTEM BY STOCHASTIC DISTURBANCE

Many natural or technical processes (systems) are described by second-order differential equations and are oscillatory reactions of resonant nature. The literature suggests the reaction of the system is given in the form of response to single-frequency effect, although the characteristics of the response to an arbitrary effect can be found using e.g. the method of residues. The methodological basis for determining the reaction of a linear vibrational system to a harmonic effect is a solution of the linear differential equation of the second order. In order to determine the specific solution of such equations in some papers it is proposed to consider the total effect of individual harmonics obtained by the results of the expansion of the function of influence in the Fourier series. At the same time, for a general type of random function, the influence of a solution is not formalized. There are present the result of research the characteristics of the response of a system of coupled resonant circuits to stochastic perturbation.

The system of coupled oscillatory circuits is considered. Arbitrary effects represent the spectral density of a random process with a prevailing frequency.

In the study of statistically-varying forces, the spectral characteristics of the response are the greatest practical interest. The applying of inverse Fourier transform leads to an integral function that has no analytic solution. Therefore, the methods of direct search cannot be applied to the arbitrary impact. At the same time, the spectral characteristics of the system response help us to find an application of the theory of residues.

The spectral density $S_q(\omega)$ of the system reaction is determined by it transfer function $W(j\omega)$:

$$S_q(\omega) = |W(j\omega)|^2 S_E(\omega). \tag{1}$$

The variance of the system reaction is described by an improper integral:

$$D[q] = \int_{-\infty}^{\infty} S_q(\omega) d\omega = I(\omega). \tag{2}$$

The conditions of application are checked and the Cauchy theorem is directly applied [6] by analytical expanding on the $I(\omega)$ to the upper half-plane of the complex plane ($I(\omega) \to I(z)$, $S_q(\omega) \to S(z)$, $z = \omega + jy$). The result can be desired as follow:

$$I(\omega) = 2\pi j \sum_i \operatorname*{Res}_{z=z_i} S(z), \tag{3}$$

where $\operatorname*{Res}_{z=z_i} S(z)$ is the residue of the function $S(z)$ at the point z_i, and z_i are singular points of $S(z)$ in the upper half-plane of the complex plane.

After calculation, the value of the dispersion of the output process for the selected system of coupled oscillation circuits is obtained.

An analysis of the response of a system of coupled circuits to a random effect indicates the presence of resonant phenomena when the prevailing frequency of exposure approaches the intrinsic resonant frequencies of the oscillatory circuits of the system. At the same time, the large Q-factor of the oscillatory circuits (the smaller resistance value) narrows the width of the realization of the impact tasks. An increase in resistance leads to a decrease in resonant maxima, a decrease in them, as well as an increase in the width of realizations.

Similarly, the problem is solved for a larger number of contours. The proposed algorithm for finding the value of an improper integral contains simple, but time-consuming procedures. To simplify the process, you can use existing mathematical applications: Wolfram Mathematica to search for special points, Matlab scripts to calculate residues. The verification of the obtained analytical results was carried out in the Simulink package by analyzing the power spectral density of the output signal. The simulation scheme is based on the system of equations. The response of the system to a signal with a uniform spectrum confirms the analytical results on the nature of the resonance phenomena and the values of the resonant frequencies.

Thus, the study developed a method for finding analytic solutions for determining the reaction of a complex multifrequency oscillatory system that is universal for stochastic input effects represented by the spectrum if the components of the resulting inferior integral satisfy the conditions of the Cauchy theorem. The analysis of reaction at different parameters of influence was carried out. The reliability of the obtained results is confirmed by the convergence of analytical results with the results of modeling. The direction of further research can determine the application of the developed method for solving practical engineering problems.

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METHOD OF FORMING THE ANTENNA ARRAY RADIATION PATTERN

The advantages of digital beamforming led to the active development of digital antenna arrays in various applications using radio equipment. The main trends in the development of digital antenna arrays: improving signal processing algorithms, methods for constructing an antenna field, as well as methods for forming a radiation pattern with predetermined characteristics.

The problem remains the provision of requirements for the width of the diagram and a given level of side emissions when it is rejected or scanning is performed.

Minimizing the level of the side lobes allows you to get energy gain at the same radiation power. In the conditions of modern warfare and the active use of electronic warfare, a reduction in the level of interference and deliberate interference is also provided. In addition, in the conditions of a dynamic tactical situation, the level of exposure of personnel of their units' decreases.

With stringent requirements for the formation of a given level of surface density of electromagnetic radiation power in a certain region of space, existing methods can be used only to a limited extent due to the long simulation time.

The report proposes an improved technique for the formation of the digital antenna arrays pattern due to a preliminary search for quasi-optimal solutions of the amplitude-phase distribution. The essence of the technique is as follows: the primary amplitude-phase distribution is formed, which provides the necessary radiation level in the direction of the main lobe; the condition of ensuring the necessary (minimum) level of the side lobes is checked; the variation (discrete) of the amplitude and phase of the current distribution in the aperture of the antenna is carried out according to the stochastic algorithm; the specified conditions for the distribution of the field are checked and, if necessary, the calculation cycle is repeated. The stored values of the variations in the amplitude and phase of the distribution of currents are stored for future use for practical actions.

The report substantiates the parameters of the stochastic optimization algorithm and the criterion for stopping the search for solutions.

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SYNTHESIS OF IMAGE OBTAINED BY A BALINICAL OPTICAL-ELECTRONIC SCANNER

The main indicators of the quality of optical-electronic images, which determine the deciphering properties of images, include spatial resolution, radiometric resolution and dynamic range. The main methods for improving the quality of optical-electronic images are software, parametric and technological.

Software techniques for improving the quality of space optical-electronic materials are designed to improve the visual perception of images. They are implemented in the form of components of a special software and mathematical software for terrestrial information complex. Programmatic methods, by means of automatic (automated) search and visual representation of the objective correlation properties of image cells, allow to improve the indicators of efficiency of performance of decryption tasks. But they cannot act as sources of new information, and their effectiveness is often determined by a subjective factor - the experience and qualifications of the decoder.

The essence of parametric methods for improving the quality of space optical-electronic imaging materials is to coordinate the parameters of the optical system (focal length, diameter of the incoming pupil, etc.) and orbital parameters (eccentricity, large half-axis of the orbit, etc.) to provide the required quality indicators. Parametric methods for improving the quality of space imagery materials allow, within the limits set, to choose a compromise option for implementing the parameters of the orbital information system of the space system. But they have a mutual contradictory influence on partial performance indicators of the system. At some stage, the use of parametric methods becomes impractical either in terms of the deterioration of other indicators or because of the size and economic constraints.

The need to further enhance the information of the shooting results, taking into account the limitations of the parametric methods, requires finding directions for improving the production and recording of optical radiation, in particular, reducing the size of the receiver elements. However, the decryption properties of the obtained images are significantly affected by the deterioration of the dynamic range and radiometric discrepancy due to the decrease in the signal-to-noise ratio in the received image.

The results of the analysis of the influence of indicators of optoelectronic equipment on the deciphering properties of materials of space shooting make it possible to conclude that in the practice of the development of optoelectronic equipment there is a contradiction between the need to reduce the size of the elements of the optical radiation receiver to improve the index of spatial resolution and the need for enlargement of elements range and radiometric resolution. Three basic technologies are used to eliminate this contradiction: pitch deceleration (analog integration), time-delayed accumulation (digital integration), and line-shift bi-linear scanning.

The essence of the technology of pitch deceleration lies in the analog summation of optical radiation in the focal plane, which allows to increase the signal-to-noise ratio. In this way, the ability to maneuver the scan angle, which leads to a decrease in system performance.

The use of time-delay and accumulation technology increases the requirements for electronic components and the hardware carrier's support complex: the matrix must be fully interrogated for a one-line shift, requiring a wide band of preamplifier; the available technologies do not always allow for the production of single-crystal scan registers, sampling keys, preamplifiers, storage registers and other signal processing devices, which leads to increased power consumption, deterioration of mass and overall characteristics, reduced maneuverability.

The bi-linear scanner element technology is a trade-off: the relatively large size of the receiver elements allows sufficient energy to be stored and an acceptable signal-to-noise ratio in a single channel, and further co-processing of adjacent line information enables the synthesis of images with improved quality. The analysis of the available sources indicates the successful practical implementation of the technology in modern models of space technology. At the same time, only theoretical approaches to determining achievable quality indices of the obtained images are given.

In order to study the processes of optical radiation registration in opto-electronic scanning systems, the report considers an improved model of optical radiation registration, which, unlike the existing ones, is based on the method of spatial-temporal sampling of radiation energy. The application of the advanced model allows: to take into account in calculating the energy characteristics different time of accumulation of radiation coming from different parts of the stage; to predict the quality of the images of reference images; clarify the effect of the parameters of the opto-electronic system on the quality of the obtained images; to investigate the process of registration of optical radiation by scanning optical-electronic systems with displacement of elements.

In order to investigate the possibilities of using redundant information obtained from the output of bilinear scanning systems, the report examines the first developed method of synthesis (automatic formation) of a digital image based on a snapshot of a bi-linear optical-electronic scanner with an offset of elements, based on the method of reducing the statistical redundancy of real images. Application of the developed technique allows to obtain aerospace optical-electronic images of the improved quality on the basis of species information of the linear scanners.

In order to check the reliability and adequacy of an improved optical radiation registration model and digital image synthesis technique, the report considers an advanced technique for automatically evaluating the quality of digital optical-electronic images to perform military decryption tasks, which, unlike existing ones, takes into account the real distribution their decryption properties. As a criterion for evaluating the quality of digital aerial photographs, use the equivalent of their informative object detection. The methodology for calculating the proposed criterion is as follows: the target environment (number, size, tone of search objects and background formations) and the shooting conditions (light, atmospheric condition, etc.) are predicted by probabilistic models that meet the objectives and conditions of use of the system; characteristics of reproduction of decrypting features are modeled on the basis of characteristics of optoelectronic equipment; the known probabilistic model calculates the number of detected objects; the results are adjusted for the spectral characteristics and the grouping of the objects. The quality of aerospace images is judged by the statistical characteristics of the simulation results.

Based on the obtained scientific results, the technology of image synthesis of a bi-linear optical-electronic scanner with element shift is proposed. The report presents the results of the study of the effect on the quality of the pictures of the target environment, shooting conditions, characteristics of optical-electronic equipment and control parameters (the interval of the survey of the elements of the scanner, parameters of the plan of use of the equipment, etc.).

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PROSPECTS FOR THE USE OF RADIO EQUIPMENT ON UNMANNED PLATFORMS DURING THE OPERATION OF THE COMBINED FORCES

During the operation of the United Forces in the territory of the Lugansk and Donetsk regions, unmanned aerial systems are widely used, intended primarily for conducting optical-electronic reconnaissance. Work is underway to develop shock and reconnaissance-shock unmanned systems. These tools are used to detect the enemy, determine the position and further defeat him or the elements of the battle formation.

Often, to expose the enemy’s actions to mislead (equip false positions), to timely detect maneuvers, to perform other reconnaissance tasks, it becomes necessary to use means of radar, radio and radio reconnaissance. The energy and weight and size indicators of modern radio equipment do not always allow you to install them on existing unmanned platforms, it limits the development of appropriate tools and their use in the interests of armed struggle.

The report presents the results of the analysis of spatial, temporal and probabilistic indicators of modern and promising intelligence tools on unmanned aerial platforms. The results of a comparative analysis of the information content of the results of the use of optoelectronic, radar, as well as radio and radio reconnaissance target equipment.

The possibility of installing promising samples of radio-frequency weapons on aircraft unmanned aerial platforms is being considered. The results of the substantiation of the required characteristics of power, directivity, accuracy of guidance and stabilization to provide the necessary efficiency of performing typical tasks are presented.

To influence the personnel and equipment in certain areas of the battle formation (operational formation) of the enemy, the expediency of using air platforms on airships is substantiated.

For various types of platforms, the report substantiates the role and place of radio equipment. Depending on the nature of the battle (operation), forms and methods of using radio equipment are proposed, indicators of efficiency and combat (target) effectiveness are substantiated. Depending on the desired required performance of tasks, it is expressed by a probabilistic indicator, the necessary composition of radio equipment is substantiated.

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METHOD OF EVALUATION OF EFFICIENCY OF FLIGHT TRAINING OF CADETS FOR TACTICAL AVIATION OF AIR FORCES OF UKRAINE

The Air Force has implemented a three-stage system of flight training of cadets, which allows to ensure a sufficient level of their training for flight operation and combat use of tactical aircraft. The training system includes the step-by-step training of cadets on a motorized aircraft, a training aircraft and a combat aircraft. This training system requires new approaches to assess the effectiveness of flight training at each stage. This is due to the fact that at each of these stages, the cadets are trained on different types of aircraft and apply different approaches to acquire the necessary professional competencies. A comprehensive assessment of the results of the training of cadets is also required to monitor the compliance of training programs with the requirements of tactical aviation in the context of modern armed conflict and the timely implementation of lessons learned during combat operations at the OUF (ATO).

Application of statistical methods of research and analysis of quantitative and qualitative indicators of the system of training of cadets of pilots does not give to the full extent to receive an estimation of results of their preparation. Therefore, it is proposed to apply a systematic approach to develop a system of criteria for assessing the training of pilots. Obtained regularities will allow to build mathematical models and to develop a method of evaluation of training of cadets of tactical aviation pilots of the Air Forces of the Armed Forces of Ukraine.

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USAGE OF UAV WITH MULTI-PROFILE AUTONOMOUS ARTIFICIAL INTELLIGENCE FOR INFORMATION SUPPORT OF MILITARY OPERATIONS

<u>Information Technologies, Artificial Intelligence & Military Operations.</u> Arrival of information era as well as digital transformation of different aspects of human activity are realities of modern society’s life. Analysis of available literary sources

allows to conclude about a tremendous “hidden potential” of information technologies and artificial intelligence for military operations. In particular, it is noted that the collection, processing and dissemination of information is becoming a “center of gravity” of modern approaches to warfare. Knowledge, extracted by the way of analysis of existing information, gives a possibility to successfully perform “knowledge-based military operations”. One of the documents stresses that such an approach, grounded on the use of knowledge, has resulted in “a revolutionary change in the way US Forces conduct operations”. It is necessary to note that the attention to this research direction has especially grown within the last years. For instance, a monograph “Artificial Intelligence and Operational-Level Planning: An Emergent Convergence”, published in 2018 by the US Army, stresses the need for the use of artificial intelligence technology in the military field as well as appropriateness to “integrate this technology into its planning methodology, the military decision making process”. At the same time, it is noted that “Army has yet to identify how artificial intelligence technology can aid in decision making”. USA Center for Global Security Research paper “Artificial Intelligence on the Battlefield” (dated of 2019) considers the military potential of artificial intelligence. One of the conclusions of the study is that “the nature of warfare is changing; Artificial Intelligence is fueling many of those changes”. A vivid example of such changes is the establishment on June 27, 2018 by the Department of Defense of its Joint Artificial Intelligence Center.

Potential of UAV with Autonomous Artificial Intelligence. Within the last years, extensive diffusion of Unmanned Aerial Vehicles (UAVs) as well as their equipping with various types of sensors and powerful on-board computer & communication facilities for information processing have created necessary prerequisites for UAV usage in information support of military operations, especially at the operative and tactical levels. Informational support of military operations is facilitated by the following positive features of UAVs: small effective reflecting surface; possibility of both low and extra-low altitude flights; capability of masking in the folds of the terrain. At the same time, it is necessary to note that modern radio intelligence equipment allows to locate and neutralize UAVs with radars operating in an active mode. Therefore, it is reasonable to execute both detection and identifications of adversary’s objects by UAV-based complexes that do not use active radars. One of the promising options is combining optical cameras as well as acoustic sensors into a unified autonomous on-board complex. Analysis of the data provided by the above devices gives a possibility to implement the following intellectual functions: object recognition with the assistance of computer vision methods; object recognition by their acoustic signatures; planning of efficient actions as well as their correction in the process of task’s execution; adaptation to changes in both external conditions and parameters and structure of the complex. The specified intellectual functions could be used to provide a proper informational support for military operations. In such a way, general principles for intellectualization of information technologies have been transformed into specific models and algorithms, which are based on the use of artificial intelligence's elements and allow to perform informational support for military operations. The proposed approach may also be a basis for the creation of an intelligent platform aimed at the development of autonomous on-board systems for a high-precision control of operative & tactical UAVs in the process of various flight plan's execution.

Prospects for the development of artificial intelligence. The majority of researchers in the field of artificial intelligence divide it into two types: general intelligence and narrowly-profiled one. At the present stage of scientific development, the task of creation of general artificial intelligence is rather difficult for practical solving. Existing solutions are usually targeted to the construction of systems designated for operation in narrow domains. Therefore, a promising direction of research is the development of technologies and systems with the elements of a multi-profile artificial intelligence based on the combination as well as usage of knowledge from different domains. The proposed approach envisages an increase in system's functional capabilities by the way of incremental addition of artificial intelligence's elements from possibly adjacent but different domains (i.e., the addition of an acoustic signals analysis channel to a computer vision one). This gives a possibility for a step-by-step increase in capabilities of intelligent technologies as well as creates conditions for transition from systems with a narrow-profile intelligence to the systems with a general artificial intelligence.

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SECURITY OF MILITARY AND CIVIL OBJECTS UNDER LOCAL IMPACT LOADS

Many objects of modern technology are exposed to shock and impulse loads. Under the action of local impact loads, a three-dimensional dynamic stress-strain state arises in them. The processes of dynamic deformation proceed in the elastic-plastic stage. In this case, it is necessary to take into account the dynamic properties of the material, which depend on deformations and strain rates. At intense impact loads, finite deformations and displacements start to appear. Therefore, the analysis of dynamic stress-strain state is an actual and complex problem. It requires the construction of three-dimensional mathematical models that consider all features of the process of high-rate deformation.

Solving the problem of protection of civil and military installations includes experimental studies of dynamic material properties, numerical studies of impact loads on critical objects of modern technology and development of measures to reduce danger of dynamic loads.

Experimental installations for high-rate deformation of specimens allow for determining the characteristics of dynamic properties of materials. These characteristics are presented in the form of dependences of stress intensities on the strain intensities and strain rates. All characteristics can change during deformation.

Investigations of variation of equivalent stresses, under shock loads in time, have been carried out what facilitates the choice of material for protective structures. The action of impact loads on protective elements is carried out using finite element method based on three-dimensional models.

Modeling of high-rate deformation of constructions, taking into account the dynamic properties of materials and large displacements, is carried out. Numerical studies of the dynamic stress-strain state of the structural elements of vehicles and gas turbine engine corps are carried out using the finite element method. The use of multilayered protective elements under the action of local shock loads is shown. Intensity of the stresses in local shock loads decreases rapidly in space and time. This makes it possible to use a denser grid in the area, where it is advisable to carry out specified calculations. In this case, the grid density varies tenfold.

Protective elements of the composites have the necessary dynamic strength and less weight than steel, although they experience great dynamic displacement.

The greatest impact resistance from the considered protective elements has a three-layer element, comprising thin layers of titanium alloy, between which there is a ceramic alloy. At high speeds of projectiles, even unless there is complete penetration in the top layer, the element saves it protective properties.

The results allow for giving practical advice to reduce dynamic stresses and to increase the dynamic strength of the elements of responsible structures.

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EFFICIENCY OPERATIONAL CHECK METHOD OF THE HELMET MOUNTING TARGET DESIGNATION SYSTEM

Obtaining the results of an operational check of the operability of aviation devices and systems with the necessary reliability and at the same time ensuring the simplicity of the actions of technical personnel is an important task at the stage of pre-flight preparation of flying machines (FM).

In modern front-line aviation, helmet-mounted target designation and indication systems (HMTDIS) are widely used, which display the necessary sighting and flight information in the pilot's field of view, as well as generate signals for guiding guided weapons and surveillance systems.

A pilot is involved in the HMTDIS target signal generation loop, which in head-turn process with a protective helmet on and a helmet-mounted display unit installed, tracks the position of targets.

In this regard, when fully testing the performance of the HMTDIS, an operator wearing a protective helmet with an installed helmet block, is in the FM cockpit and simulates the actions of the pilot.

The operator, having checked the availability of signals about the operability of individual HMTDIS units generated by the integrated test system, assesses the accuracy of the formation of target designation signals. To do this, the operator, by turning the head (protective helmet), combines the aiming mark of the helmet-mounted indicator with a fixed mark in the field of view of the optical sight, head-up display (HUD). The accuracy of the HMTDIS is estimated by comparing the target designation angles obtained at that moment with the angular position of the sighted HUD mark.

These actions do not allow us to evaluate the accuracy of the HMTDIS, but to carry out an approximate assessment of the functioning of the HMTDIS, since the error in aligning the tags due to the head turning depends on the “human factor” – subjective capabilities of a particular person to control the spatial position of the aiming mark of the helmet-mounted indicator with the head turning. In this case, the error of combining labels with the operator can reach several degrees, which significantly exceeds the permissible error of the hardware for generating a target designation signal.

To assess the accuracy of the HMTDIS, it is necessary to exclude the so-called "human factor" from the verification process.

This is achieved by using a collimated radiation beam source located on the HMTDIS helmet-mounted unit. The radiation vector of this source is oriented (set at a certain angle) relative to the direction of the aiming mark of the helmet-mounted indicator. Thus, the angular position of the radiation vector corresponds to the angular orientation of the aiming mark. By registering the position of the radiation vector, the direction of the aiming mark is determined.

As a registrar of the orientation of the collimated radiation beam, a standard optical-location block from the controlled HMTDIS is used. It determines the angles of direction to the reference radiation sources of the helmet-mounted block.

Turning and linearly moving the head, operator combines the image of the aiming mark with the entrance pupil of the optical-location block, which registers the angle of illumination of the collimated radiation beam. Further, the obtained value is compared directly with the target designation angle, which is formed with all the errors typical for the operation of the HMTDIS.

Such a scheme for monitoring the efficiently of the HMTDIS allows you to get the result of assessing the real state of the HMTDIS with virtually no time. This will allow the pilot to verify directly the operation of the HMTDIS before flight, since it will be enough for him to look at the entrance pupil of the optical-location block and receive the corresponding signal.

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PARAMETRIC ANALYSIS OF THE INFLUENCE GEOMETRIC PARAMETERS OF THE SPIROID WINGTIP DEVISES ON THE AERODYNAMIC CHARACTERISTICS OF THE WINGS AT LOW REYNOLDS NUMBER

The geometric parameters of the aerodynamic surfaces determine the aerodynamic characteristics (ADC) of the glider elements and the aircraft (LA) as a whole. Determining the best aerodynamic layout is one of the main tasks of aerodynamics. The solution of the inverse problem of aerodynamics in order to determine the best layout for the given ADC is a great difficulty. Therefore, an approach is used to solve a series of direct problems when changing the geometric parameters of the aerodynamic layout of the wings - spiroid wingtip devices (WTD). The ADC of the wings with WTD is determined by the theoretical and experimental method. The basis is the division of emerging forces into their components, depending on the nature of their origin. So the normal forces due to the pressure distribution over the surface are well calculated by solving the problems of flowing through a noncompressible incompressible medium. In this paper, a well-known and practically modified discrete vortex method is applied. Profile resistance due to tangential forces (friction forces) and normal (pressure distribution over the profile surface) can be considered constant with slight changes in the angle of attack. Due to the complexity of the calculation of the profile resistance, especially at small values of the Reynolds number, which is characterized by the flight of small-sized UAVs, the profile resistance is determined from the analytical dependencies. Significant in this technique is the periodic inspection of the results obtained by tests in the wind tunnel..

In the general case, the ADC layout of the wing - spiroid WTD with constant geometric characteristics of the wing is a function of the geometrical parameters of the spiroids. Namely, the radius, angle of collapse, area, step of spiroids, etc. So parametric studies were performed for rectangular wings in plan with profile NACA 23012 extension 3, 4, 5. It is established that with increase of elongation of the wing, the effect of installing WTD decreases. This is due to the decrease in the relative area affected by the end vortices. The highest value of aerodynamic quality is achieved at the angle of collapse, which provides the largest span of layout wing - WTD. Increasing the radius of the spiroids leads to an improvement in ADC as a result of an increase in the area of the bearing surface and an increase in the extension of the system. At the same time, the radius increase is limited by the strength of the layout wing WTD. Small radius of the spiroid WTD lead to a decrease in the ADC of the original wing without the WTD. According to the results of parametric studies, the arrangement was chosen in which the maximum increase in aerodynamic quality in the flying range of angles of attack ΔK at the number Re = 70000 was 21%, and at the number Re = 210000 was 15%.

In the future it is planned to use the selected wing - spiroids on the WTD on small-sized and low-speed unmanned aerial vehicles.

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ANALYSIS OF CONDITIONS AND FACTORS AFFECTING THE PARTICIPATION OF THE ARMED FORCES OF UKRAINE IN THE CONDITIONS OF THE TRANSITION TO NATO STANDARDS

Delivered state leadership task of transition Armed Forces of Ukraine to NATO standards require adaptation of the first Ukrainian standardization system to standardize systems of foreign countries. This issue is a priority within the framework of the NATO Trust Fund for Logistics and Standardization in Ukraine.

One of the major problems of defense standardization identified by NATO experts in the analysis of the existing defense standardization system was the lack of a single governing body in that field. Thus, the Ministry of Defense of Ukraine is responsible for issues of material standardization. The General Staff of the Armed Forces of Ukraine is responsible for operational and administrative issues of standardization.

As a key element in achieving interoperability, standardization requires this approach, starting with defining requirements, making further decisions, fulfilling them, and verifying the appropriateness of those decisions. In accordance with agreed NATO governing procedures, this also includes interoperability with non-Alliance entities.

Standardization should work out solutions to problems in order to achieve interoperability requirements. Such requirements come either from the NATO Defense Planning Process (NDPP), the Alliance's concerted NATO and Operations Planning (so-called "top-down" tasks), or based on best practices, training results and the assessment of troops (forces).) (so-called bottom-up tasks).

It is also necessary to arrange for compliance of standardization documents with the requirements of interoperability. NATO's standardization processes are an integral part of NATO's feedback through compliance with relevant NATO procedures, both with regard to the implementation of the standards put into place by the STANAG and the compliance with interoperability requirements.

Decision on standardization concerning interoperability requirements should be introduced as soon as possible. NATO member states and Alliance bodies (structures) should focus their efforts on accelerating the achievement of standardization goals that directly contribute to enhancing the interoperability of identified capabilities. The development and implementation of standards before the crisis is of particular importance in the context of rapid response to threats and strengthening of NATO member states. The main terms of implementation of NATO standards in the Armed Forces of Ukraine and Ukraine are:

- availability of their official version;
- consistent with applicable law;
- the absence of legislation or regulations in the relevant field, or if the requirements of NATO standards supplement those requirements;

the military standardization body.

The task of Euro-Atlantic integration of Ukraine and transition of the Armed Forces of Ukraine and other components of the defense forces to NATO standards by strategic defense documents Ukraine, a package of Partnership Goals and the decisions of the leadership of Ukraine.

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THE FUZZY MODEL OF CALCULATION OF THE SAFETY LEVEL OF THE COMBAT AVIATION SYSTEM

As known, different factors have an effect on aviation crews during combat missions. For example - meteorological conditions and bird hazard. Additionally, the effect of the application aircraft armament, influence of the enemy air defense and electronic warfare systems matter. Therefore, in order to understand in what conditions the crew will perform the task, it is advisable to introduce the concept of "combat aviation system" (CAS), under which we understand the aviation system that performs combat missions.

The commander of the aviation military unit decides to perform the task in conditions of some uncertainty. In turn, the Chief of the Flight Safety Service (FSS) is obligated to identify risks in the CAS and to develop proposals for their reduction. However, at present, there are no means of automation with effective methods of calculating risk in the arsenal of the FSS chief.

In order to calculate the level of safety risk in the CAS, proposed to take into account the hazard scenario, the likelihood of implementation of this scenario and the consequences of the implementation of the scenario or measure of the severity of the consequences of the implementation of the scenario. The authors propose to use the system of programs MATLAB.

The fuzzy model for calculating the level of flight safety of the combat aviation system was created for programming in the system of MATLAB which includes: fuzzification operations that converts fixed vectors of factors; fuzzy knowledge base that determines the relationship between incoming and outgoing data in the form of a linguistic rule; machines of fuzzy logic output; defuzzifying, which converts a fuzzy output to a clear value.

Thus, the introduction of a mathematical apparatus based on fuzzy models gives opportunity to the commander to make informed decisions under conditions of uncertainty, taking into account possible options for the development of future events or circumstances. That, in turn, will have a positive impact on the decision-making processes on flight safety issues.

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REQUIREMENTS ARGUMENTS OF ADMISSIBLE RELIABILITY LEVEL OF AVIATION GUIDEDED MISSILES DURING REPAIR AND MODERNIZATION

Nowadays, Ukrainian arming forces have in service aviation air-to-air guided missiles (AGM), which were in exploitation during 30 years. This fact is lead not only to physical ageing, which consist in gradual increasing of defective components at operating entities, but also to moral ageing, which consist in level decreasing of specific performance characteristics of AGM in reference with better world analogues.

One of the most economical effective way to solve foregoing problem is reconditioning of air-to-air missile's technical condition by means of major repairs with modernization. In the same time, this process allow to use power ballistic resources of AGM, which are in service at Ukrainian arming forces and to improve their specific performance characteristics.

Reliability is one of the main characteristic, which determine modernization organization and realization suitability of AGM. Reliability level is determine in performance requirements.

Common requirements to reliability level changes are based on requirements to rates, which are characterized effective use of missiles during their functioning in exploitation (storage, transportation, repair, maintainability and proper use).

In purpose of admissible reliability level estimation during decision-making about AGM modernization suitability it is important to underline rates:

– complex operation ratio;

– probability of failure-free operation.

Totality of this rates characterized AGM efficiency during the processes of supporting readiness to proper use, bringing to operability use and directly proper use.

In this case AGM is observed like repaired complicated technical system, which means that during exploitation technical condition is controlled and repaired.

Appearance of the missile rejection during all life cycle phases is described by probability of transition from operable condition to nonoperable condition.

For describing of transition process is used accidental Markovian process, which property consist in probability of the complicated system condition at every period of time in the future is depended only on the system condition in present moment and does not depend on the how the system come in this condition.

Transition process from operable condition to nonoperable condition is describing by heterogeneous Markovian model (probability of the transition from one state to another is depended on time).

Every transition from one state to another is characterized by probability and probability coefficient. Probability coefficient is observed like probability distribution in time, which means that transition between AGM conditions appears in at accidental period of time and defined by transition intensity. Complex operation ratio represents efficiency of AGM exploitation, which consist of: tactical efficiency rate, fighting performance rate and operating availability rate.

Tactical efficiency rate and fighting performance rate are characterized reliability of AGM as element of the air complex at the period of it's proper use and are used foe efficiency estimation. Tactical efficiency rate, in the case of this study, means the probability of failure-free operation before preparation to the proper use.

Fighting performance rate in the case of this study, means the probability of failure-free operation during built-in test and preparation to the proper use.

During modernization it is necessary to take into account AGM operating environment, because complex operation ratio is depended on amount of maintenance, which also define the requirements to control equipment.

In conclusion, in order to define admissible reliability level during modernization process it is necessary to estimate military requirements, which caused by designation of AGM. Reliability ratio decreasing level is necessary to define with taking into account specialty of AGM fighting performance and minimal influence on target –destruction probability.

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MODERN MANAGEMENT OF MULTI-STRUCTURAL MILITARY SYSTEM

A management study of a multi-structure military system is impossible without a system-conceptual perception of the problematic of the formation process and implementing the corresponding management decisions. In the problematic of the theory and practice of managing multi-structured military systems, the key problem is effective management in the context of dynamic changes in the operational-strategic and operational-tactical situation in the theater of operations (combat area).

The main goal of solving this managerial problem is to provide the organizational and functional-target structure of complex systems, technology of conflict-resistant control of forces and means of properties of quick and effective adaptation to changes in the situation in the theater of operations (in the combat area), which contributes. Structural dynamics of a multi-structural military system is the process of changing its structure over time under the influence of various factors, which is purposefully guided and driven by the need to activate structural and functional components in the case of the occurrence and development of unfavorable situations.

Management of structural dynamics refers to the process of formation and implementation of targeted control actions on the system, which ensure its transfer to the desired multi-structural macrostate with the principle of subordination of the structure to the functions of the system.

Modern effective operational management should provide, first of all, the superiority over the enemy in speed and quality of the planned mining management solutions through the implementation of advanced technology, information and software. This requires a high degree of interoperability between the units of troops (forces) and their rapid adaptation to changes in the environment, as well as a high degree of adaptability of the operational structure. It is possible to provide a fundamental change in the personnel officers of the armed forces which are able to creatively and extraordinarily control forces and means, and in general, all personnel capable of professionally ensuring the use of: modern management tools; intelligence information and communications equipment; modern weapons and military equipment. Systematic transition to the modular structure becomes possible in the presence of automated information management systems and advanced powerful telecommunications system, constituting a single unit at levels from strategic to tactical control troops (forces).

Confirmation of the possibility of fulfilling this list of conditions requires a comprehensive analysis of the influence of various factors on it using the scientific and methodological apparatus adequate to this problem, including methods of general system analysis, decision support, simulation modeling of the functioning of these systems, methods of managing objects with a structure that is rebuilt, adapted to the requirements of a dynamic (non-stationary) external environment, methods of the scenario approach management, methods of stable situation management.

A well-known scientific and methodical apparatus does not allow a deep, quite effectively, fully and comprehensively conduct research in the field of governance issues with multi system for military purposes. Therefore, the necessity for further development (improvement) of management theory and the development of scientific and methodological tools that allows to explore new topical aspects from a unified system position in the theory and practice of managing complex military systems is arising. At the same time, the extent to which the scientific and methodological apparatus is adequate to the conditions and factors that influence the formation of management decisions, the more effective decisions will be made.

The effectiveness of the implementation of their research (substantiated) functions by the scientific and methodological apparatus depends on the consistency of its methodological tools in the framework of a systematic approach to conducting comprehensive studies of current problems arising in the defense sphere as a whole, and in part, problems of theory and practice of managing a multi-structured military system .

The scientific and methodological apparatus should integrate the procedures for substantiating, forming, implementing and monitoring the progress of the implementation of processes for the effective management of the structural dynamics of complex multi-structural military systems.

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DEFINITION OF “DEFENSE PLANNING”

The notion of term and terminology is key in science. The term ensures the accuracy and clarity of understanding of scientific thought.

The key term in the process of planning for the development of armament and military equipments is "defense planning".

In the Law of Ukraine “On Organization of Defense Planning”, which has now lost its force, defense planning refers to the component of the system of strategic planning and management of state resources in the defense sphere which is carried out within the deadlines set by the law in order to provide the necessary level of defense capability of the state through substantiation of development prospects of the Armed Forces of Ukraine and other military formations, taking into account the nature of real and potential threats in the military sphere and the economic capabilities of the state, indicating the value of specific activities, performers and timing of their implementation.

In the Law of Ukraine "On National Security of Ukraine" adopted in 2018, this term was clarified by broadening its concept, namely, that defense planning is an integral part of the state strategic planning system, which is implemented with the purpose of ensuring the defense capability of the state by defining priorities and directions the development of defense forces, their capabilities, armament and military equipments, infrastructure, training of troops (forces), and the development of appropriate concepts, programs and plans, taking into account real and potential threats in the military sphere and financial and economic capabilities of the state.

Indeed, such a broader definition of “defense planning” is better than the previous one. It additionally states the need to take into account the priorities and directions of development not only of the Armed Forces of Ukraine, but of all components of the defense forces, their capabilities, armament and military equipments, infrastructure, and states the need to develop appropriate concepts, programs and plans in time of planning. However, according to the author, this interpretation of the term “defense planning” also needs refinement.

According to domestic experts, the definition of the term "defense planning" should indicate the following main features:

ensuring systematic development of defense planning documents - defense planning documents must be developed on a strictly defined list, in a consistent sequence and be linked to each other in terms of activities, goals, objectives and deadlines;

the correlation of long-term, medium-term and short-term defense planning documents with each other;

the bind between defense and budget planning;

ensuring continuity in the management of the defense planning process;

the use of the capability-based defense planning method used by NATO countries;

the use of a program-based planning method, which is currently recognized in the world as the most effective in ensuring optimal allocation and efficient use of public resources;

ensuring planning of measures of use of troops (forces).

It is therefore proposed that a more meaningful interpretation of the category of “defence planning”, namely:

“Defense planning is a systematic and continuous process of defining the priorities and directions of the development of defense forces, their capabilities, armament and military equipments, infrastructure, training of troops (forces), taking into account real and potential threats in the military sphere and financial and economic capabilities of the state, as well as and timely adjustments based on the programmatic targeting method and planning method based on the capabilities of the documents (strategies, concepts, programs, plans, etc.) defined by the legislation of Ukraine, agreed together with documents and budget planning the timing, goals, priorities, objectives and activities and aimed at the development, maintenance and use of comprehensive defense forces. "

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OPERATIONAL MODEL FOR DEVELOPMENT AND PURCHASE OF WEAPONS IN THE SYSTEM OF DEFENSE PLANNING

The Ministry of Defence of Ukraine is moving from threat-based planning to threat-based planning. An important part of any capability is the armaments equipped with units of the Armed Forces of Ukraine. Until recently, the creation or improvement of capabilities meant the creation or improvement of weapons.

Therefore, the Materiel component, which provides for the development and procurement of weapons, is the most important component of the basic capability components of DOTMLPFI. The implementation of this component is fundamentally different from the implementation of other capability components. For a harmonious and balanced development of weapons it is necessary to see the overall picture of the new defence planning system and the place in it of the system of development and procurement of weapons.

In the process of capability-based defence planning to save financial resources and obtain rapid results, approaches that are not related to weapons development are considered first. If such approaches allow to mitigate or eliminate the capacity shortage, then the decision is made to create capabilities without the cost of developing weapons. It is only in the event that such an approach is impossible, that a decision be taken to develop the arms. In this case, the development of a weapons development and procurement program is initiated.

Weapon development remains the most complex and valuable component of capabilities. The peculiarity of the implementation of the basic components of each capability (DOTMLPFI) in Ukraine is that practically all of them should be financed from the article of the State Budget of Ukraine “Assurance of the Armed Forces of Ukraine” (КПК 2101020). Only the Materiel component (armaments) should be financed from the State Budget of Ukraine article “Development, Procurement, Modernization and Repair of Armaments and Military Equipment” (КПК 2101150). Therefore, the implementation of this component is fundamentally different from the implementation of other components of capabilities.

In view of this, it is proposed in the process of developing any ability to separate the Materiel component from other DOTMLPFI capability components. As shown earlier, a similar approach is being implemented in NATO countries.

For the gradual transition to defence planning by capabilities and adaptation of the current system of development and procurement to the prospective, it is proposed to revise the current State Targeted Defence Program for the Development of Weapons and Military Equipment for the Period up to 2022 (hereinafter – Program-2022) in order to bring it into compliance with the Law of Ukraine "On State Targeted Programs", which has been operating in Ukraine since 2004. In particular, the content of Program-2022 does not meet the basic requirements of this law by definition – Program-2022 does not constitute "a set of interrelated tasks and activities that are agreed upon in terms of implementation, composition of executors, resources". Instead, Program 2022 provides a simple inventory of weapons and military purchases.

To bring Program-2022 into line with the Law of Ukraine “On State Targeted Programs”, it is necessary to divide it into several state-targeted defence programs or projects with the support of a number stipulated in the “Project Management Guidelines” approved by the Minister of Defence of Ukraine on February 20, 2019. In particular, these programs may comply with sections of the current SCOPROVT-2022:

1. Technology development program.
2. Program for the development of armoured weapons and equipment.
3. The program of development of rocket-propelled weapons and equipment.
4. Program for the development of artillery weapons.
5. …

Each state defence target program must cover the whole process of creating a sample of weapons:

1. Analysis of possible options for the development of weapons;
2. Development of appropriate technologies, basic research;
3. Applied research (finding ways to create a sample of weapons),
4. Research and development work,
5. Production preparation,
6. Production and supply to the troops of the constituent series of products (battalion, squadron, division).

A portfolio approach is used to effectively manage all programs and projects in the world. The same approach is provided in the mentioned Methodological Recommendations. It involves combining all the above programs into one portfolio. In the NATO countries, due to its effectiveness, the “portfolio approach” to managing weapons programs is becoming increasingly popular. In particular, in the United States and the United Kingdom, a portfolio approach was introduced in 2007.

Cranfield University, an academic partner of the United Kingdom Department of Defence, has recommended a "portfolio" approach to strategic defence planning as the most appropriate in today's context, characterized by extremely complex and extensive planning and implementation procedures. For many years, the use of the portfolio approach in the United States and the United Kingdom has seen an increase in the effectiveness of the defence sector. The following are the advantages of using portfolio-based approaches:

– creates an overall picture of the total amount of investments required;
– formulate a strategic vision for the volume of changes required;
– helps to prioritize programs and projects;
– allows rational allocation of limited resources;
– allows management to form a complete vision of the problem;
– identifies shortages as well as important elements of the relationship;
– creates a rational management structure;
– associates "vision" with "practical results";
– allows you to build links between "projects", "programs" and "strategy";
– coordinates the work of the various components of the defence sector.

The contents of the Armaments Development Portfolio should be reviewed annually as the portfolio horizon is advanced one year in advance.

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SUBSTANTIATION OF THE CRITERION FOR ASSESSING THE QUALITY OF AEROSPACE SURVEY MATERIALS

The analysis of the results of the implementation of measures within the framework of the National Target Scientific and Technical Space Programs of Ukraine indicates the limited possibilities of the national scientific and production potential for the creation of optical-electronic systems of spacecraft of remote sensing of the Earth, in particular it concerns the possibilities of ensuring the required quality of the obtained optical-electronic images.

The limited quality of space-based material from national systems makes them poorly suited to performing species intelligence tasks. The probabilistic indicators of object detection and classification are determined mainly by the decrypting properties of the images (the nature of the decryption of the objects in the image) and the experience of the decryptor-analyzer.

The main indicators of the quality of optical-electronic images, which determine the decrypting properties of images, include spatial resolution, radiometric resolution and dynamic range. The main methods for improving the quality of optical-electronic images are software, parametric and technological.

Existing image quality assessment methods are limited to determine the aerospace imagery's deciphering properties: subjective methods reflect a real perception of the ability to decrypt only available images; objective based on mathematical models of visual perception, allow for statistical analysis, but require a reference image of the same dimension. Calculating the frequency-contrast characteristic of an optical-electronic system is equivalent to predicting the quality of the images obtained for test measures only, without regard to the motion of the medium and the distribution of the brightness field of real images.

The report proposes to use the equivalent of their informative object detection as a criterion for assessing the quality of digital aerial photographs. The methodology for calculating the proposed criterion is as follows: the background objective (number, size, tone of the search objects and background formations) and the shooting conditions (light, atmosphere) are predicted by probabilistic models that meet the objectives of the system application; characteristics of reproduction of decrypting features are modeled on the basis of characteristics of optoelectronic equipment; the known probabilistic model calculates the number of detected objects; the results are adjusted for spectral features and group location. The quality of aerospace images is judged by the statistical characteristics of the simulation results.

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ANALYSIS OF TECHNOLOGIES OF INFORMATION-PSYCHOLOGICAL IMPACT FROM THE RUSSIAN FEDERATION

The report presents the results of the analysis of information-psychological impact technologies (IPsIT) on the human psyche and public consciousness, experience of the influence of the Russian Federation against Ukraine. The methodological and organizational foundations of maintaining IPsIT are considered: generalized goals, main objects, basic organizational forms of IPsIT. The basic views on the technologies and methods of destroying legitimate power are examined using the examples of the events of the "Arab spring", color revolutions, and Russian interference in the internal affairs of other countries.

The factors and features of media manipulation are proved, the postulates of manipulations, factors and methods of support are found. Emphasis is placed on the high efficiency of audiovisual content to ensure manipulation. The possibilities of Internet technologies in IPsIT are considered. Estimates of the dynamics of the volume of political activity in social networks are generalized. The features of the nationality of social networks are considered.

The latest technology is the study of psychological profiles by analyzing the activity in social networks and targeted advertising exposure. Information on the use of Big Data technologies on the eve of important socio-political events is presented in the media and has become scandalous in terms of influence on public moods and beliefs. A feature is the cooperation of social network owners with special services, which has become a prerequisite for the prohibition of some social networks in our country. To ensure the sustainability of personnel, it becomes important to study and understand the methods of neuro-linguistic programming. Timely identification of the use of such methods allows self-regulation of the psychological response to the materials presented. Another area considered in the report is the technology of psychocorrection of academician I. Smirnov. Some facts point to the use of group psychocorrection when applying the Cambridge Analytics and Social Data Hub techniques.

In monitoring the activities of the media, it is also important to identify the techniques of consensual wars. A feature of these techniques was a gradual, but long-term change in the value orientations of society, a deformation of the self-identification of citizens.

Thus, the use of information-psychological weapons transforms the individual’s memory, creating a person with predetermined parameters that satisfy the aggressor, make the enemy’s government system and its armed forces insolvent. These circumstances require the improvement of technologies and countermeasures.

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THE MECHANISMS OF BIOLOGICAL ACTION OF RADIO FREQUENCY RADIATION

The primary mechanism of action of radiofrequency radiation (RfR) in most countries was based on the thermal concept, according to which recommendations were developed on the maximum permissible levels of surface density of the flux of electromagnetic radiation. The thermal energy that occurs in human tissues increases the overall heat release of the body. If the body's thermoregulation mechanism is not able to dissipate excess heat, an increase in body temperature may occur. This occurs starting with a field intensity of 10 mW/cm^2, which is called the thermal threshold. Human organs and tissues that have mild thermoregulation are more sensitive to radiation (brain, eyes, kidneys, intestines, testes). Overheating of tissues and organs leads to their disease. An increase in body temperature of 1 °C or higher is unacceptable due to possible pathological consequences.

New studies show that the human body is a complex electrodynamic system that has its own vibration frequencies (resonant frequencies), including individual organs, cells and subcellular formations of the body. Therefore, the impact on the body of low intensities of RfR is called a control or information impact. The informational effect of RfR on biological objects is manifested when the radiation intensity is lower than thermal thresholds, i.e., non-thermal effects or a specific action of radio waves are observed, which is determined by the informational aspect of RfR, which is perceived by the body and depends on the properties of the RfR source and the communication channel. Obviously, information processes also play a role in the thermal effects of an electromagnetic field on an organism.

The following mechanisms of information impact of RfR are conditionally distinguished:

direct effect on tissues and organs, when the functions of the central nervous system (CNS) and the related neurohumoral regulation are altered;

reflex changes in neurohumoral regulation.

In the zone of electromagnetic field generation, a continuous transition of the electromagnetic field into a magnetic one takes place. The electrical component of the RFF is absorbed in the medium where polar molecules or free electric charges are located.

Hemoglobin and myoglobin, moving electric charges arising in the course of metabolism, as well as free radicals formed during biochemical and mechanical-chemical reactions, and ferromagnetic particles that enter the lungs of a person with air in the form of dust can act as acceptors of the magnetic components of RfR.

As experimental studies show, an RfR 1-10 cm long at a surface flux density of about 10 μW/cm^2 is enough to produce a reaction from the central nervous system.

It should be noted that bioeffects depend on the exposure time of RfR on the human body, in addition, amplitude modulation by a sequence of rectangular video pulses was more effective than modulation by sinusoidal harmonic. The information effect of the action of RfR largely depends on the natural frequencies of oscillations of organs and systems of the body, a synthesis of which is given in the report. From the point of view of the informational impact of RfR on the human body, it should be noted that:

millimeter waves affect the human body and its individual organs through biologically active points;

centimeter waves affect the vessels of the brain and central nervous system

decimeter waves affect the central nervous system.

Thus, pulsed RfR modulation with frequencies close to the natural frequencies of organs and body components (cells and subcellular formations) leads to changes in the state of the human body, including the occurrence of auditory hallucinations.

Electromagnetic radiation with certain parameters and modes of exposure to a biological object can lead to functional disorders of the central nervous system, overstrain of adaptive-compensatory mechanisms, significant deviations of the functions of organs and systems, metabolic and enzymatic activity, hypoxia, organic changes in organs and systems. The central nervous system responds to the intensity of radiation, lying significantly below the thermal threshold and the threshold of reactions of other systems.

When electromagnetic radiation interacts with biological objects, resonant effects occur. These processes are frequency-dependent in nature and affect a single information management system of the biosystem. In determining the maximum permissible levels of human electromagnetic radiation, it is necessary to take into account recent studies of the biological effects of radio frequency exposure.

Information about the selective (resonant) nature of the response of biological objects to modulated radio frequency radiation requires additional studies to justify the limitations of not only the frequency and energy parameters of the RfR, but also the

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NEW TREATMENT MEASUREMENT AGGORITHMS FOR TRAILER MEASUREMENT SYSTEMS

The development of rocket-propelled weapons in Ukraine requires the improvement of the range, in particular the creation of the latest systems of trajectory measurements that have the highest possible accuracy of determining the coordinates of objects on the trajectory.

Today we have trajectory measurements based on a GPS type system.

A system of trajectory measurements based on the scheme where the radio frequency sensor is located at a controlled object (CO) is proposed. The problem of measuring the exact coordinates of an object is solved within the assumptions that the reference point has different heights; distances X, B and height Z are known in advance with high accuracy; the speed of propagation of the signal from the radiation source is close to the speed of light C.

Algorithms for information processing have been developed, which will allow to construct the flight path of high precision CO aircraft. The observation points (OP) are along the planned trajectory. The coordinates of the aircraft with the accuracy of astronomical methods are defined in the geographical coordinate system. The single-time standard is used by the GPS signal.

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MODERNIZATION OF RADIO LOCATION COMPLEX "ZOOPARK-3" CONTRABARTABLE FIGHT

The experience of conducting an anti-terrorist operation in the east of Ukraine, namely the widespread use of artillery and MLRS during its conduct testifies to the need for urgent equipping of the Armed Forces of Ukraine with radar complexes (RLC) of artillery intelligence "Zoopark-2", which was developed by "ISKRA" at the request of the Ministry of Defense and was adopted by the Armed Forces of Ukraine in 2001.

The closest analogue of this RLC - 1L219 ("Zoopark-1", Russian Federation) was successfully used for counter-combat during combat operations in Chechnya and Georgia. In its tactical and technical characteristics complex 1L220 significantly exceeds the capabilities available at this time in the combat composition of ARC-1M complexes.

At the earliest possible modernization of the "Zoopark-2" product, representatives of the Armed Forces of Ukraine insisted, referring to the experience of conducting anti-terrorist operation, since there were no complexes of this class at the beginning of 2014 in the Armed Forces of Ukraine. The product "Zoopark-2", adopted by the Armed Forces of Ukraine in 2001, was not manufactured serially, which led to its moral degradation. During the modernization of the sample, it has laid and achieved characteristics that correspond to the global trends in the development of artillery reconnaissance complexes.

The modernization of the complex was carried out according to a tactical and technical task, developed by the Central Research Institute of Weapons and Military Equipment of the Armed Forces of Ukraine (hereinafter - CRI WME AFU) in the period from 2016 to 2019. In March-April 2019, state tests of the modernized sample were carried out according to the Program and methods, also developed by the CRI WME AFU.

State tests of the modernized radar complex of the counter-battery fight were conducted at the all-military landfill of the Armed Forces of Ukraine with the involvement of a considerable amount of weapons and military equipment and were of a complex nature, namely:

the use of barrel artillery and rocket launcher systems in the interests of the reconnaissance complex;

involvement of topogeodetic service specialists;

interaction with the RA Service and the Armed Forces of Ukraine (provision of ammunition and light fuel).

During the state trials, the commission indicated a number of comments and recommendations, some of which were eliminated during the trials.

It should be noted that the characteristics of the modernized complex, recorded during the state tests, not only correspond to those specified in the TTT, but also exceed them in some parameters (in particular, in the range of reconnaissance firing positions of mortars and barrel artillery).

As a result of the work carried out by the State-owned enterprise "Iskra", measures were taken to correct the WDD and refine the prototype. In July 2019, an inter-ministerial commission verified the implementation of these measures and prepared a joint decision recommending the adoption of a modernized Zoo-3 counter-battery combat complex.

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RATIONALE OF THE NECESSITY OF THE ESTABLISHMENT OF SMALL OVEN HIGH-AUTOMATED RADARS FOR THE FORMATION OF A SMALL-SIZED FIELD IN THE AREAS OF THE GOVERNMENTAL BORDER

Permanent radar reconnaissance of a given airspace is carried out mainly by the radio-technical troops (RTT) of the Air Force of the Armed Forces of Ukraine.

Obviously, in order to accomplish this task, the airspace should be constantly monitored (controlled), especially along the state border and in areas of important state objects. Such control at any time of the day, at any time of the year, in simple and complex meteorological conditions is possible only by radar exploration and creation of a continuous radar field (CRF) at altitudes from 25-50 to 35000-45000 m.

The global trend of integration of military and civilian airborne radar systems into a single radar system does not solve the problem of creating a continuous radar with the necessary parameters, especially when it comes to turbulent times or exploration of small and extremely low altitudes along the state border and around areas with special regime use airspace. This is due to the fact that the bodies of the civil air traffic organization (CATO) of Ukraine control only the areas where they provide air traffic services. The implementation of ICAO's strategy and the concept of "CNS / ATM" in the field of civil aviation involves the interaction of CATO bodies and RTV units only in route flight space and at medium and high altitudes. CATO bodies at low altitudes only control airfield areas and not at regular intervals, but at fixed intervals.

Therefore, the creation and maintenance of continuous radar at low altitudes (with the upper limit to 3 km and the lower - from 50-100 m) was and is the most important and costly task of RTV.

Nowadays, the importance of providing low altitude (PLA) radar is increasing, first of all, because the traditional means of air attack (AA) of the enemy tend to constantly improve, namely to increase the radius and range of heights of combat, improve maneuverability, artificially reduce the effective scattering surface hypersonic speeds, an increase in ammunition and electronic warfare (EW), a significant increase in the effectiveness of personal protection, and the like. In addition, the rapid development and presence at low altitudes of small aircraft, both manned (mostly private) and unmanned (in most military applications), the rise of terrorist threats and various attempts at the illegal use of airspace (in most cases private).

According to an air assault analysis, one of the biggest threats to troops and targets is the use of enemy low altitude targets such as cruise missiles and drones. They have flight altitudes up to 20-60 m, small EPR - from 0.1 to 1.5 m2 and a large speed range (up to supersonic and hypersonic). UAVs will continue to be inconspicuous and maneuverable, capable of operating at altitudes of 25 to 40,000 m, depending on the type.

Military-scientific analysis of local wars and armed conflicts of the last decades, analysis of trends and prospects of development of radio-electronic counter-means in the advanced countries of the world, allow to formulate the following conclusions concerning the prospects of development of electronic-counter-means in the wars of the sixth and seventh generations:

- development of means of functional destruction (electromagnetic weapons) of radio-electronic means;
- development of integrated reconnaissance anti-aircraft fire systems operating on a real-time basis within the framework of the battlefield concept of "electronic-fire defeat" in the course of armed struggle;
- development of software for the destruction of information infrastructure of the newest telecommunication networks;
- development of REB complexes with robotic systems and weapons.
- development of EW aviation facilities, including EW aircraft, helicopters and EW unmanned aerial vehicles.
- development of REB complexes with high-precision weapons systems, including complexes of radio- and opto-electronic suppression of systems and

controls for high-precision ground, air and naval weapons;

- development of complexes of electronic suppression of modern radio electronic systems and means of information transmission (systems of satellite, radio relay, tropospheric, cellular and trucking communication).

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JUSTIFICATION OF THE CREATION OF A HIGH-PRECISION MULTIFUNCTIONAL SYSTEM OF TRAJECTORY MEASUREMENTS OF AVIATION AIRCRAFT, ROCKET AND SPACE

The analysis of open sources of information shows that active work is being done abroad to find new technologies and precision positioning tools, to determine the motion and navigation parameters of high-dynamic objects, including spacecraft output and control in given orbits. In particular, there is a sphere of trajectory measurements during the flight tests and processing of autonomous control systems of high-dynamic special purpose aircraft. For example, a ship-based SATRACK system that uses GPS signals transmitted from the facility is deployed to process marine-based ballistic missile control systems. The direct use of GNSS technologies and the deployment of appropriate facilities on board controlled objects (CO) is also fundamentally possible, for example, the use of GNSS receivers on board highly dynamic facilities in flight control systems integrated with inertial navigation tools, extreme correlation or astronautics. One should also mention the relatively new trend in precision positioning technologies that is evolving. It is implemented in a LOCATA multi-position terrestrial system (Australia, USA) that does not use GNSS signals.

In Ukraine, due to objective reasons, technologies in the field of trajectory measurements have not been developed. At present, there is an urgency and need for the creation of effective high-precision tools for determining the trajectories of different types of weapons and military equipment in the course of landfill tests, as well as for promising spacecraft of Ukraine in their derivation and navigation on the Earth's orbit, including zones of discontinuous GNSS navigation field.

In view of this, there is the task of creating a multifunctional trajectory measurement system (MTMS) with the highest possible precision characteristics.

The MTMS should be designed to obtain the required measurement parameters of object trajectories with a given accuracy when testing a wide range of new and upgraded weapons and military equipment. The system shall be mobile ground-based (with the possibility of placing part of multi-channel receiving stations and signal processing on floating devices) to provide trajectory measurements when conducting polygonal tests.

The MTMS must address the following objectives:

simultaneous tracking and accurate measurement of current navigation parameters of at least 20 objects of various types, moving at speeds from 0 to 3200 m / s at altitudes up to 35000 m;

issuing, in real time, estimates of motion parameters (current coordinates and components of the velocity vector) simultaneously for at least 20 accompanying objects;

automated registration, accumulation, storage, processing and transmission of measurement information with anchoring (synchronization) to the UTC or polygon time scale;

display of operational trajectory information (in coordinate systems with the customer), both by group objects (not less than 20 CO), and by any single CO, selected from the set of accompanied MTMS in real time and its documentation;

an indication of the occurrence of emergency situations and the signal of the departure of the CO beyond the permitted limits of airspace;

receiving, processing and issuing telemetric information from the board of the CO (telemetry information composition is agreed with the customer);

the ability to transmit the information received to offline display and interaction tools.

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EXPERIMENTAL CONFIRMATION OF THE ACCURACY OF MULTI-POSITIONAL PHASE SYSTEM OF TRAJECTORY MEASUREMENTS «VEGA-V» USING GPS-OBSERVATIONS OF THE UKRAINIAN REFERENCE STATIONS

The results of an experimental accuracy assessment of the multi-positional phase trajectory measurement system (MPSTM) «Vega-V», which is intended for conducting range field tests of highly dynamic flying vehicles (HDFV), as well as for determining the motion parameters of spacecraft, are presented.

The purpose of the experiment was to confirm the performance of the principle of trajectory system constructing and its accuracy by modeling using real GPS observations of a previously selected ground-based sub-network of Ukrainian reference stations. The idea of the experiment, in the absence of a real system prototype, was to process real GPS observations of one or two GPS satellites (as the objects of trajectory determination) from the current working constellation, estimation of their trajectory parameters, and comparing these results with the precise motion parameters of these satellites obtained from the international service IGS.

To achieve this purpose, a mathematical model of MPSTM observations was created and the methods and algorithms for their processing were developed, including ultra-high-precision synchronization of time scales of MPSTM measurement points spaced apart (at basic distances of up to ~1000 km). In Matlab programming system, a prototype of software for processing MPSTM observations was created.

An assessment of the actual accuracy of the system (using observations of the sub-network of eleven GPS stations) showed the achievement of the following trajectory determination accuracy of space vehicles at altitudes of ~20 thousand km: in the range-interferometric (query) mode of MPSTI functioning the root-mean-square (RMS) errors of determination of the current coordinates were within ~0,16–0,45 m, RMS errors of the velocity vector components were within ~0.7–1.0 cm/s; in the interferometric (non query) mode, the values of the RMS errors of determination of the current coordinates were within ~21–50 m.

The obtained experimental results allowed to validate reliably not only the fundamental possibility of implementing MPSTM, but also the possibility of achieving the stated accuracy of the trajectory determinations.

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ANALYSIS OF OPERATING UNMANNED AVIATION SYSTEMS AS PART OF OPERATION JOINT FORCE

Nowadays, UAV is one of the main means of obtaining enemy intelligence.

The enemy effectively implements measures of concealment of positions, objects, military equipment, while using natural and artificial means of masking, which significantly complicates the detection and recognition of intelligence objects. In addition, there is an intense work of enemy means of electronic warfare facilities, which in some cases significantly complicates the execution of the flight task due to the suppression of the reception and transmission of UAV data.

In such circumstances, the role of training and experience of the crew (operators) is greatly increased. In some cases, the detection of objects is carried out on indirect grounds: the presence of a running track in certain directions, traces of the movement of technology in the direction of forest areas, landings, etc.

The main positive trends in the use of UAV in the course of the Joint Forces Operation (hereinafter referred to as JFO) are:

gaining and accumulating experience of using UAV in the conditions of real combat, difficult interference, hostile air defense;

exposure of positions, places of concentration of equipment and personnel of the enemy;

acquiring operational capabilities for information regarding possible areas of activation of the enemy;

gaining the ability to control the results of the use of defeat tools on the enemy and correct their actions;

improving the experience and skills of UAV calculations;

identify the directions of action of the enemy's EW;

Highly effective use of the UAV class is tactical - battlefields, their resistance to the impact of the means of destruction. The main common negative factors (shortcomings) revealed by the use of UAV in the course of the JFO include:

lack of an automated control system for troops (forces) to provide real-time intelligence to the consumer (headquarters of various levels);

lack of regular crypto- and intruder-based communications to expedite the transfer of information from the BPAC operator (decoder) to the intelligence headquarters;

it is advisable to equip the BPAC crew with means of communication with crypto and secure data transmission channels;

the acoustic visibility of UAVs when performing aerial reconnaissance flights;

insufficient level of target load stabilization and offset compensation system;

the absence of software and hardware in the UAV control system to compensate for the flight path along the heel, pitch and yaw angles;

long processing time and providing intelligence information, usually at the end of reconnaissance;

the lack of cross-country vehicles for the carriage of the crew, the transportation of UAV, the ability to deploy the NSA and other components of the UAV.

In general, the UAVs used in the framework of (PD-1, Leleca-100, A1-CM "Furia", Spectator-M1, Sparrow) have proven themselves on the positive side and allow you to perform aerial reconnaissance tasks day and night, in simple and difficult weather conditions, in the conditions of interfering environment and action of the air defense of the enemy.

At the same time, according to the results of the analysis of the operation of these UAV in combat situation and in order to increase the efficiency of their application, a number of technical proposals for the further improvement of unmanned aeronautical equipment, which were presented in the speech, were identified.

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MAIN DIRECTIONS FOR IMPROVEMENT UNMANNED AVIATION SYSTEMS FROM THE ANALYSIS OF OPERATION IN COMBAT

According to the results of operation of unmanned aerial complexes in combat conditions, in general, the following directions are determined for their further improvement:

equipping with digital interference-protected equipment channels for receiving and transmitting intelligence information and control of UAVs, as well as increasing the effective range of the specified receiving-transmitting equipment;

comprehensive integration of the UAV into a single, automated troop management system, with the aim of presenting intelligence information to the consumer (headquarters of various levels) in real time;

equipping UAV crews with digital crypto and fraudulent communications;

the use of new aerodynamic forms and profiles of propeller blades, new UAV power units to reduce the acoustic visibility of UAVs, when performing air reconnaissance flights without loss of power of the power plant;

reducing the effective scattering area and the infrared visibility of UAVs;

equipping the target with a system of image stabilization and offset;

refinement of software and control systems of UAV systems for compensation of the evolution of the heel, pitch and yaw angles;

equipping UAVs with a mobile automated decoder workstation to reduce processing time and present intelligence;

equipment units operating UAVs road vehicle for the transport of crew transportation UAVs, the possibility of deployment of its ground control system, crew workstations and other components UAVs.

It is necessary to take into account the presented directions of improvement of UAVs when performing the corresponding experimental-design works for creation of the Class-1 UAVs (Codes "Leleca-100", "Gorobets", A1-CM "Furia") and in the framework of refinement on the bulletins of the manufacturing company (UAVs, which adopted by the Armed Forces of Ukraine - UAVs "Spestator-M1").

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METHOD OF PREDICTING CONDITION OF UNMANNED AVIATION COMPLEX CHANNEL

Analysis methods for adaptive predicting of control channels and data of unmanned aircraft complex (UAC) showed that the promising trend channel estimation UAC is evaluating fractile interference, changing as the measurement fractile equivalent evaluation of pilot-signal certain probability of bit errors.

The systems are based on the measurement fractile have the same computational complexity as the traditional system of power measurement noise.

At the same time, existing methods and algorithms for estimating the fractile of intermittent obstacles have several disadvantages, namely:

large variance of fractile estimation error;

necessity of using complex nonlinear filtration algorithms;

lack of results of mathematical modeling of similar systems and results of analysis of their effectiveness.

Fot this purpose, it is proposed to develop a method for predicting the state of the channels of control and data transmission of unmanned aerial systems.

Main stages of implementing the method are as follows:

input of output data;

filtration of fractile fields, by comparison with threshold level;

reducing the error variance of the error by the method of Kalman filtering, acting as a filter and interpolation estimates fractile;

calculation of the channel characteristics parameter;

calculation of direct and inverse recursion;

formation of a decision on the channel status and the output of the output data.

Developed method has lower computational complexity and will be able to function in conditions of noise with random distribution laws. In this method, the fractile of disturbances were evaluated by facilities of representing fractile obstacles in the frequency-time field.

Conducted mathematical modeling indicates that using the proposed method will increase immunity control channels and data unmanned aircraft systems in 13-18% by reducing computational complexity and improve the accuracy of the assessment.

The direction of further research should consider on the development of a method for managing the parameters of unmanned aviation complexes channels of special purpose.

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JUSTIFICATION OF EXPEDIENCY OF USING SEFDM TECHNOLOGY IN THE CHANNELS OF SAFETY AVIATION COMPLEXES OF SPECIAL PURPOSE

Constant increasing the amount of information transmitted through the channels of control and data transmission of unmanned aeronautical complexes (UAC) requires the search for new technical solutions to ensure a given level of bandwidth.

Alternatively, multiplexing orthogonal frequency sealing technology (Orthogonal Frequency Division Multiplexing - OFDM), in order to increase the frequency efficiency of control and data transmission channels UAC, it is proposed to use spectral-effective signals with frequency seals (Spectrally Efficient Frequency Division Multiplexing – SEFDM).

Increasing of spectral efficiency of SEFDM-signal constructions was achieved due to the transition to non-orthogonal frequency sub-carrier frequency compaction.

However, analysis of SEFDM-signaling structures revealed the following disadvantages:

high level of inter-symbol interference in the channel;

exacting system for synchronization;

high peak factor;

high computational complexity (exponential dependence on the number of subcarrier frequencies and on the volume of the channel alphabet of subcarriers);

low noise immunity.

Analysis of noise immunity of SEFDM-signaling constructions, carried out by simulation, showed that SEFDM-signal constructions have the same immunity to single-frequency signals.

Technically, the transition from OFDM-signaling structures to SEFDM-signal constructions is possible by updating the software of the transmitting and receiving devices, which in turn does not require significant financial costs in the context of the anti-terrorist operation.

This will allow to use SEFDM signaling structures in the control and transmission channels of the UAC, which is relevant in the context of shortages of the radio frequency resource. The implementation of SEFDM-signaling constructions will increase the speed of transmission of information in the channels of control and transmission of data UAC twice in the same bandwidth.

Further research will be aimed at developing a method for the formation of SEFDM-signal structures with moderate computational complexity.

Zhyvotovskyi R.M., PhD, Senior Researcher
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EFFECTIVENESS OF IMPROVEMENT OF THE AUTOMATIC CONTROL SYSTEM OF AN UAV IN AUTONOMOUS REGIME

Rapid growth of resources and speed of computer facilities allows planning and management of flight by unmanned aerial vehicles (UAVs) taking into account the optimality criteria for accuracy of its positioning and performance in real time. This can be achieved by introducing elements of artificial intelligence into UAV control systems.

Therefore, it is proposed to consider the concept of the UAV's intelligent automatic control system (ACS) in conjunction with an autonomous inertial navigation system based on micro-electromechanical systems, whose function is to calculate and process the main part of the data arrays of positioning in a dynamic space. This approach uses the approximating capabilities of the neural network.

The purpose of the proposed system is one or another change in the controlled value, i.e., the output value of the controlled object (the navigational position of the unmanned aircraft). In the framework of such a controlling influence to compensate for external influences that change the required magnitude of the regulated value, an improved method for increasing the accuracy of inertial sensors based on the Madjuk filtering is used. Using this method, an intelligent automatic flight control system for UAVs was built in full autonomous mode without taking into account the global navigation system.

The purpose of the control is to provide a transition process for changing the function of the control signal by the object (UAV), which satisfies the following quality criteria: no overregulation; Provision of a given value of a static error in the steady state operation of a dynamic object; Providing the set time for setting the required output signal with error; ensuring complete autonomous UAV flight without taking into account auxiliary global positioning systems.

The proposed ACS allows to approximate the speed of computing the navigation parameters, minimizes the requirements for UAV mass-size characteristics, greatly reduces the time and cost of design, which in turn reduces the requirements for the required on-board equipment, in general, the effectiveness of such control systems has increased to 20% (time of decision and positioning accuracy).

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DEVELOPMENT OF THE THEORETICAL PROVISIONS FOR THE TRANSMISSION OF DISCRETE MESSAGES IN CHANNELS WITH PROHIBITIONS UNMANNED AVIATION COMPLEX

An analysis of the classical propositions of the discrete messages transmission theory (DMTT) presented in the works of Chenon K., Zyuko A. G., Finka L. M., and others in the presence of fading on the physical level of the channels of the unmanned aviation complex (UAC) has a limit on use. Theoretical contradictions are caused by inconsistencies of the accepted one-dimensional probabilistic model. Such a model does not take into account the dynamics of the random fading process, its characteristics, such as the autocorrelation function and the duration of the correlation interval, and also other central and initial moments of the random process.

While averaging over a one-dimensional probabilistic degree, the condition of the so-called "local stationary" is used, when the signal level (or channel transfer coefficient) is kept unchanged over a certain interval of time. At another interval again the channel is considered constant, but maybe with other characteristics.

To solve theoretical contradictions, it is proposed to introduce two indicators of the quality of communication in the channel with fading: the probability of receiving the message of the final duration correctly and the probability of the final duration connection without breakage.

The first indicator is a general indicator of the quality (communication) of the information transfer and the second is the indicator of the channel quality in the connection period of the final duration. Probability of communication without breaks in the final time interval demonstrates the probability, that during this time the signal level does not fall below a given threshold value.

Using of the proposed quality of communication in a fault channel allows the following:

- without artificial loss of the channel bandwidth to ensure with high accuracy maintaining the required quality of the channel in the current (real) time;
- to predict the probability of the correct receiving the message with using of the necessary measures for setting the modes of discrete messages transmission.

Indicators of the communication channel UAC quality with fading, presented in the report are used in detecting and distinguishing signals in the background of noise, in conducting the calculation of noise immunity and reliability of communication and in assessing the characteristics of the propagation of radio waves.

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FORMATION THE DIRECTION OF THE ANTENNA LATCH METER RANGE RADAR ON THE BASIS OF THE IMPROVEMENT METHOD OF ADJUSTING THE AMPLITUDE OF EXCITATION OF ITS INDIVIDUAL ELEMENTS

State manufacturers are successfully working on the creation of new solid-state digital radar wave meter. Characteristically, the antenna systems of the new radars are built as phased array antennas, the individual elements of which are antennas of the wave channel. The task of calculating the radiation pattern of such antenna systems can be reduced to solving the system of integral-differential equations with respect to the currents of the radiator fields.

The antenna of this type is represented as a structural model consisting of N columns and P rows of antennas of the wave channel type. The assumption is made of: the law of change of the law of current along the active vibrator, the in-phase symmetric vibrators, as well as the amplitude of the current.

The modeling of the resultant radiation pattern takes into account the influence of the reflector, the director, as well as the horizontal and vertical structure of the lattice. Given the necessary conditions for the distribution of the field in the far area, determines the appearance of the radiation pattern for different composition and different ratios of the antenna array. In order to obtain more adequate results, the influence of the earth's surface, which is taken into account by an additional factor, is introduced into the radiation model.

The report presents the results of multivariate modeling of the antenna array pattern. The results of solving the problem of minimizing the level of the lateral petals of the radiation pattern are presented. The conditions of mutual compensation of maxima of individual elements of the antenna array are substantiated. The results of simulation of the antenna array pattern with the minimization of the level of the lateral lobes while adjusting the current amplitude of only the extreme columns of the array are presented.

The results of the investigations show the possibility of reducing the level of the lateral petals in the samples of antenna arrays with amplitude control compared to the in-phase equiphasic excitation.

In contrast to the existing ones, the proposed procedure greatly simplifies the sequence of calculation of the antenna pattern of the wave channel type with three half-wave vibrators and, accordingly, of the antenna systems. The ability to create a radiation pattern has been demonstrated with a reduced level of side lobes by adjusting the excitation amplitude of one extreme pair of external elements of the antenna array, which can be used to reduce radiation in any desired direction, that is, when implementing the adaptive properties of the antenna array.

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PECULIARITIES OF SECONDARY RADIATION OF LOW-ALTITUDE TARGETS OF RESONANT SIZES

Radar signal reflected by low-altitude target are observed on the background of strong electromagnetic response from ground (sea) surface. This fact complicates detection and tracking a considered target. Application of wideband (ultrawideband) sounding signals allow compensate dips in antenna directivity pattern conditioned by interference between direct signal reflected by target and signal re-reflected by ground surface, and also make possible to separate mentioned responses.

More over for best detection of the signals reflected by such low-contrast and low-altitude targets as cruise missiles and unmanned aerial vehicles on a background of reflection from ground (sea) interface, it is rational to use sounding signals of VHF band corresponding to the resonant wavelength region with respect to sizes of considered objects.

For numerical simulating the radar scattering characteristics of resonant-sized targets methods based on solving the boundary integral equations can be applied. In considered case mentioned numerical techniques present the class of exact methods, and have some advantages in comparison with other known methods. Authors of the present work have developed numerical method for computing a radar scattering characteristics of perfectly conducting resonant complex-shaped objects based on solving the magnetic field integral equation. Presented method allows to take into account the electromagnetic interaction between the aerial object and interface between two dielectric media (“air – ground” or “air – sea”).

Peculiarities of developed algorithm are discussed in the work. Results of modeling the signal reflected by cruise missile above the lossy dispersive ground in case of ultrawideband radar sounding are demonstrated. Analysis of interaction between direct signals and re-reflected by ground interface ones, for various foreshortening of the cruise missile, and for various path differences of the waves are carried out.

Numerical modeling results shown in the work and other data which developed numerical technique allows to obtain, can be used for developing algorithms of detection and tracking a cruise missiles and unmanned aerial vehicles on a background of underlying terrain.

Zirka A.L., PhD
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TO THE ISSUE OF PASSIVE RADIOCATION ASSISTANCE IN ANTI-ARMED DEFENSE

In the current context of military conflict, the Air Force's radio units are forced to perform tasks in the conditions of various interferences, the use of enemy aircraft with minimal effective scattering areas, and anti-radar aircraft. This situation leads to a decrease in the effectiveness of the available means of illumination of the air situation and the targeting of the striking components of the anti-air defense. In such circumstances, there is a need to build up the strength and means of the radio component to ensure a reliable stable radar field in certain directions and areas.

At the same time, there are several directions of increasing such capabilities, namely: concentration of forces and means; construction of multilevel and combined radio engineering troops grouping, including the involvement of passive location facilities to illuminate the air environment. The report further proposes to look at modern and promising means of passive location, to determine their advantages and disadvantages compared to means of active location. Passive radar - the radar of an object by its own radiation.

Thus, the absence of radiation of the probe signal increases the secrecy of the work, significantly complicates the detection of passive radar stations (radars) and their interference. On the other hand, in contrast to active, passive radar does not allow you to determine the range of an object that is locked in the signal at only one receiving point. Full detection of the coordinates of the object requires the use of several radars spaced at some (known) distance. At the same time, the choice of the method of detecting the coordinates of the emitting objects by means of passive radar is made in accordance with the defined tasks and expected characteristics of a specific sample.

The range of passive radars for sharply contrasting objects may exceed the range of active (radiating) radars. The accuracy of measuring the angular coordinates of passive and active radar is approximately the same, the accuracy of determining the range of passive radar, as a rule, is lower.

Further, the report provides an analysis of the performance characteristics of existing and emerging passive radar status and prospects of their development in Ukraine.

Zirka A.L., PhD
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APPLICATION OF UNMANNED AVIATION SYSTEMS IN CONDITIONS OF ANTI-OPERATION

Experience of aerial reconnaissance using unmanned aircraft systems in the zone of combat in eastern Ukraine has demonstrated proactive measures on enemy positions masking, facilities, equipment, and the use of natural and artificial means, which complicates detection and recognition intelligence facilities.

In some areas there is intensive work of modern electronic warfare (EW) enemy, which in some cases prevents or complicates the implementation flight mission (primarily from the transfer of information in real time)

There are ways to deal with enemy aircraft, including unmanned, providing basic principles:

destruction of the aircraft in the air;

destruction of aircraft on the ground (at the airfield, during transportation, etc.

counteracting by: masking objects; staging obstacles in different wavelengths, such as search, detection and aiming devices, and directly to aircraft; interference with management and guidance.

According to the experience of using UAVs in the area of ATO, their low resistance to the influence of the enemy's EW means was stated. This provision has recently made it much more difficult for aerial reconnaissance of enemy positions and objects with the rapid transmission of information received from the UAV on a real-time basis.

In view of the above, the report on the analysis of the tactical and technical characteristics of the existing enemy EW facilities is discussed and practical recommendations on possible ways to increase the noise immunity of the UAV control channels are considered.

Zirka M.V.
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QUESTIONS METHODOLOGY EVALUATION OF TECHNICAL RISK IN RESEARCH CONDUCTED WITH THE CREATION (MODERNIZATION) OF ARMAMENT AND MILITARY EQUIPMENT

The experience of recent years such incidents occurred as opening and funding of research projects on the development of weapons and military equipment without sufficient justification of its relevance, which is one of the main risk factors in projects. This is due to many factors, for example, it is quite indicative at the moment - the desire of a likely contractor under any circumstances to get an order. Conversely, if there is a need in the sample, there are sufficient alternatives to choose prime contractor of the project.

According to the results of the execution of each stage of the research work, an appropriate management decision should be made to continue the work, move to the next stage. In fact, this is currently being accomplished by concluding a state contract or agreement (additional agreement) concluded between the customer and the contractor at virtually every subsequent stage of the research work.

In order to optimize the support of the above decisions, in accordance with the current requirements of the normative documents, namely DSTU В-П 15.203-2017, at each stage of the implementation of the research work, the risks of project implementation are evaluated, appropriate plans and reports are drawn up.

Errors (risks) that may arise in certain tactical technical requirements based on the set of operational tactical requirements or incorrect assessment of the project (technical) decision during the general design (early stages) is practically irreplaceable in the following stages, or have a significant additional material and time costs. Since the next stages of development usually involve significant tools and resources, which significantly complicates the feedback and significantly increases the consequences of errors in the stage of general (preliminary) design.

Thus, over the past 15 years, 240 research works have been analyzed on such indicators as: reason for closure / termination of work, at which stage work was completed / terminated, and financial costs.

As a result, they elaborated in more detail on the stages of completion / termination of research work and obtained the following information:

at the stage of sample preparation and preliminary tests termination / completion - 62% of the total number of research works;

at the stage of development of working design documentation for the production of the prototype - 17% of the total number of research works;

at the state testing stage - 9% of the total number of research works;

at the stage of technical project development - 8% of the total number of research works;

at the stage of development of the sketch project - 2% of the total number of research works.

Thus, the development of a methodology for assessing technical risks is an urgent task in the early stages of research. Thanks to which the financial expenses will be reduced, time in case of negative result of performance of research works.

Zirka M.V.
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METHODICAL ISSUES FOR TESTING AIR-SURFACE AIRCRAFTS AIRCRAFT

Unmanaged aerial missiles remain one of the effective means of defeating ground targets. However, the current Unmanaged aerial missiles fleet of C-5, C-8 types is estimated to be critical due to the considerable storage time. In order to upgrade the existing unmanaged aerial missiles fleet, research and development work was developed to develop a domestic Unmanaged aerial missiles type PC-80.

During the preparation and organization of state testing product PC-80, particularly in developing applications and testing methods encountered a number of issues of organizational and technical nature. Thus, the ambiguous terms of solutions to the issue was the volume of tests. As a result, a wide range of aircraft consisting of armament which envisaged the use of Unmanaged aerial missiles type RC-80 comprehensive assessment of products, including security applications needed to attract significant logistical and time resources. In such circumstances, there was a need for scientific and technical substantiation of some management decisions regarding the optimization of the test procedure, as well as their division into several separate stages.

Tests were carried out on the basis of the "Program of state testing prototype aircraft uncontrollable rockets caliber 80 mm", approved by the Director of the Department of military-technical policy, development of weapons and military equipment of the Defense Ministry of Ukraine.

The choice of methods and test conditions was due to test the characteristics defined in tactical and technical specification for development work. The following test methods were used to obtain the required parameter and metric values:

modeling - for estimation of reliability of operation of elements of a product at stages of functioning;

full-scale bench tests - to obtain indicators of reliability, safety of functioning;

flight tests - to obtain quantitative and qualitative indicators of combat effectiveness.

The report further details the methodological features of the tests performed on the PC-80 product.

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PROBLEMS OF EQUIPMENT OF THE ARMED FORCES OF THE UKRAINE WITH ARMS AND MILITARY EQUIPMENT IN RESOURCES OF RESOURCES

The experience of the leading states shows that one of the main tasks of the country's military-technical policy (MTP) for ensuring national security, including defense, is the formation of long-term plans and programs for the development and purchase of aviation systems (aircraft, helicopters, cruise missiles, unmanned aerial vehicles). aircraft, etc.) and finding resources for that. Also, according to forecasts of military threats to states and the possibilities of reducing them, the role of aviation systems in the Armed Forces will increase. It is also important to emphasize that leading countries (USA, PRC, France, Russia, etc.) are developing hypersonic and other non-conventional weapons.

Within the framework of the new MTP for justifying the procurement of aviation complexes for the Armed Forces of Ukraine, the issue of developing methodological approaches to analyze the prospects of their development and justifying the procurement of such complexes for the Armed Forces of Ukraine on the basis of the theory of risk management in the context of scarce resources. To do this, the following measures should be taken:

development of operational and strategic requirements for advanced aviation complexes, which are required to be armed by the Air Force (AF), based on the needs determined by the General Staff;

preliminary estimates of the cost of the necessary prospective aviation complexes with defined operational and strategic requirements for them and the risks of their receipt, taking into account the necessary infrastructure for their operation, training of specialists, necessary armaments and other equipment to be delivered in due time;

preliminary assessments with the ability to identify the necessary financial resources and the risks of obtaining them with the involvement of both the Ministry of Defense of Ukraine, other ministries, the Security and Defense Council and the Verkhovna Rada of Ukraine;

development of appropriate strategies by the institutions to acquire the necessary aviation complexes in the domestic or foreign markets, taking into account the prospects of development of the national defense-industrial complex (DIC) and available aviation technologies in Ukraine, including the issues of organizing and conducting tenders, preparing proposals for possible suppliers of the required aviation complexes, and also the identification of negotiating organizations (the Ministry of Defense of Ukraine and other authorized bodies of the CMU);

elaboration of such options for the procurement of the necessary aviation complexes abroad, which would contribute to the development of the Ukrainian economy, taking into account the corresponding risks from the implementation of such purchases.

As the acquisition of the necessary aircraft complexes for the aircraft is very important, it is advisable to analyze this issue when conducting a defense and defense review in accordance with the Law of Ukraine "On National Security of Ukraine", adopted by the Verkhovna Rada and put into effect by the President of Ukraine in 2018. Another important issue when purchasing the necessary aircraft complexes for the aircraft will be the order of interaction of the central executive authorities to solve the above issues.

Obviously, effective implementation of the tasks is possible only through the use of methodology for programmatic and targeted planning of the development of VVT, which should take into account the capabilities of modern means of processing the original data and thus influence the processes of formation of the relevant information space.

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ASSESSMENT OF AIR MOVEMENT PARAMETERS IN CONNECTING THE RESULTS OF INDEPENDENT PRIMARY MEASUREMENTS IN ACTIVE MULTIPOSITION RADIATION

The idea of integration of radar systems of different agencies stems from the Cabinet of Ministers of Ukraine's Decree and Decree on the “State Integrated Information System for Supporting the Management of Mobile Objects (Communication, Observation Navigation)”.

The use of single radar field information will ensure:

- unambiguous understanding of the air situation in air traffic control centers and control points of the Armed Forces;
- exclude territorial duplication of departmental information systems;
- ensure the sharing of electronic means;
- reduce the type and unify radar systems, complexes of automation and communication.

In the literature dealing with the interoperability of radar information (RLI) from several active radar stations, the question of determining the parameters of the movement of an air object in a single rectangular coordinate system (SRCS) in the processing of signals obtained by a non-coherent system with nonsignoron system space from multiple non-equilibrium sources with different rates of information updates, not sufficiently covered. Some papers have examined the processing of

RLI from several non-equilibrium radars at a common receiving point, but its non-synchronous receipt, estimation of software movement parameters and errors in their measurement in the SRCS have not been considered.

The report presents the algorithm for determining the parameters of the motion of an air object in a single rectangular coordinate system, which takes into account the statistical characteristics of errors of measuring its spherical coordinates by individual radar stations and the variable rate of updating information in a non-coherent system with non-synchronous space inspection.

The values of the current estimates of the motion of an air object and the numerical characteristics of its measurement errors are further advisable to use as a priori data when filtering the parameters of the movement of an air object in a system with non-synchronous space inspection and a variable rate of updating information from several non-equilibrium sources.

The results obtained can be used in existing and promising radar information processing systems and automated control systems to determine the motion of air objects.

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DIAGNOSTIC SYSTEM OF RADIOELECTRONIC EQUIPMENT FOR AIRCRAFT CONTROL

The results of the military conflicts in the world and the Operation of the Joint Forces in the east of Ukraine have shown an increase in the capabilities of the forces and means of air attack of the enemy (manned and unmanned vehicles) to damage important objects (military and civilian). Consequently, the role of radio electronic equipment (REE) has increased as a result of air traffic control in order to timely and accurately recognize the air situation by the regular air force command in the airspace cover sector. This, in turn, introduces new requirements for the reliability and efficiency of diagnosing the technical state of the REE under the control of air traffic.

The experience of operating complex technical systems, primarily systems (complexes) and weapons samples, has shown that the use of traditional diagnostic tools for REE requires high costs of time and labor of highly skilled professionals. This increases the duration of diagnosis of REE and significantly increases the cost of their operation. Effective way of solving this problem is to automate the processes of diagnosing the technical state of the REE by controlling air traffic.

It is shown in the report that the main principles of creating a modern system for diagnosing the technical condition of the REE under the control of air traffic are:

modular design and software;

ensuring the compatibility of individual modules in the system;

automation of the processes of measuring the parameters of the REE, checking their values and performing diagnostics;

the use of standard interfaces to provide interconnections and coordinated work of all components and separate modules in the system;

providing the required accuracy of measuring parameters (characteristics) of the REE;

application of automated (automatic) test control of the efficiency of diagnostic channels of the system.

Creation on the basis of modern information-measuring devices of the system of diagnostics of the technical condition of the REE under the control of air traffic will provide a significant reduction in the number of both the park of measuring instruments and the necessary personnel for their operation and maintenance.

The application of the proposed diagnostic system for the technical state of the REE will improve the quality of air traffic control.

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BASICS OF JUSTIFICATION OF AUTOMATED CONTROL SYSTEMS CREATION

The structure of the process of creation of automated control systems (ACS) separates the conceptual stage (before the design stage - research and justification of development) and the stage of development (execution of research and development work (RDW). The conceptual stage aims at substantiating the need to create (upgrade) an ACS and to analyze all levels of requirements for an ACS.

In fact, at this stage the answer to the question is what the future system should do. This determines:

- system architecture, its functions, external conditions of its functioning, distribution of hardware and software;
- interfaces and distribution of functions between the person and the system;
- requirements for software and information components of the system, required hardware resources, database requirements, physical characteristics of system components, their interfaces;
- restrictions on the development process (policy deadlines for completion of individual steps, available resources, organizational procedures and measures to protect information, etc.).

All requirements for the ACS can be presented in two categories. These are general requirements imposed on any automatic control system regardless of its scale, subject part, automated functions and other characteristics. The second category consists of the temporary (specific) requirements that are imposed on a ACS of specific purpose and are peculiar only to this system.

All time-honored requirements of this ACS must be documented in the tactical-technical task (TTT) for the development (modernization) of the system.

The TTT for the implementation of the RDW is an important document that defines the purpose of creation and purpose of the ACS, as well as the tactical-technical and other requirements and other data defined to it.

Depending on the status of the ACS and the purpose required by the customer, the TTT can be focused on the following activities: development of the ACS, its development, modernization of the ACS.

The TTT for the development of ACS is made when the existing system operates without the use of modern information and communication technologies, there is no necessary information infrastructure that meets the new requirements, etc. In such a situation, the TTT should include the broadest list of requirements for all components and elements of the ACS, a justified sequence of commissioning of components, automating functions, as well as a detailed list of measures for the commissioning of the new ACS as a whole. The TTT for the evolvement of ACS is made under the condition of successful operation of the previously created system and the customer's interest in expanding the range of automated functions. The information infrastructure (including computer hardware and data communication facilities) is sufficiently advanced and has a reserve of computing capacity that can be utilized to provide additional information processing functions. In this case, special attention in the TTT is paid to the integration of new solutions into the existing ACS and efficient use of the existing equipment.

The TTT for the modernization of the ACS consists in the case of moral and physical aging of previously used functions. Factors such as a significant change in the algorithmic basis of automated functions, the need to switch to other software or hardware, the desire to use more modern information and communication technologies while maintaining the list of information processing functions that are performed, etc. lead to the need to replace all or more components of the information system of the ACS while maintaining the system's performance. The main purpose of the ACS is to extend its life and restore the system by replacing elements that have become unusable for new or more sophisticated ones.

In most cases modernization of ACS carried out simultaneously with the development of the system as a whole. Both events are initiated by the customer who is interested in expanding and improving the capabilities of the ACS. For this reason, a "clean" modernization of the ACS is considered as a necessary but insufficient way to maintain the efficiency of the ACS and increase its efficiency.

After deciding on the type of activity of the ACS, designed in accordance with the established procedure, the project TTT allows you to go into the stage of implementation of research and development work on the creation of the control system.

The approved TTT opens the possibility to conclude a contract for the creation of a control system between the customer and the contractor.

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NEW TECHNOLOGIES IN THE FIGHTING WITH CRUICES AND BALLISTIC MISSILES

Characteristic properties of cruise and ballistic missiles (CM and BM) are high speeds, maneuverability, stealth, using in a wide altitude sector.

The counteraction to such missiles should be organized using aviation, missile and information facilities. The main role in the reflection of the raid is played by anti-aircraft missile systems. The time factor, the high speeds of CM and BM, the rapid nature of the attack, all require new requirements for precision targeting anti-aircraft guided missiles (AGM). Traditional aerodynamic control is not effective enough to combat modern aerial attacks.

High-precision aiming is best ensured when using combined methods of the AGM control system, when a noise-tolerant system is used at the initial and mid-flight areas and the target-seeking equipment (TSE) at the final section. With minimal involvement of ground-based anti-aircraft missile systems.

In addition, the AGM must endure considerable congestion in a very short time (about tens of milliseconds). In most cases, such requirements cannot be met by aerodynamic flight controls. There is a need to apply faster gas-dynamic methods of creating control forces and moments. Modern missiles have successfully proven themselves to have gas rudders, baffles, various guards that work in the jet of the main engine. And also, special control motors, jet and other gas-dynamic devices, not related to the propulsion engine. Transverse control engines located near the center of mass may be very promising for eliminating the aiming error at the end of the AGM flight area.

In addition, AGM should have high maneuverability. Precise guidance cannot be achieved without this. If for modern missiles the maximum normal overload is in the range of 20-25 units, then for promising missiles, taking into account the increasing maneuverability of the targets, the required overload may increase by 2-3 times. In turn, this will lead to the using of new materials, new designs and new technologies for their manufacture.

Thus, the fundamentally new key technologies that determine the appearance of modern AGM can be attributed to:

- an abandonment of a semi-active radar homing and transition to a control method that combines inertial guidance with radio correction at the initial flight area and active radar homing in the short wavelength range at the end of the AGM flight segment;

- using of a transverse gas-dynamic AGM control method to reduce the missile response time and, as a consequence, the precise aiming, down to the direct hit on the final homing phase.

Switching to an inertial-command method of aiming at the initial flight range and active homing radar increases the number of targets hit, since in this case there is no need for continuous transmission of control commands or illumination of the target until the missile meets with it. A shorter wavelength (0.8-2.0 cm instead of 3-5 cm) increases the accuracy of homing while reducing the diameter of the TSE antenna and therefore the diameter of the missile.

Using for control on the final phase of homing (approximately for 1-2 s to the meeting point) gas-dynamic way of creating control forces and moments allows to reduce the reaction time of the AGM (time to reach the required overload), especially at high altitudes, in 10-15 times and in as a result, get high accuracy when hitting the target.

Thanks to the introduction of supermaneuverability in combination with increasing the accuracy of information provided by active radar TSE, it is possible to create a relatively small-scale AGM with effective defeat of tactical and operational-tactical ballistic missiles, anti-ship missiles, cruise missiles and aircraft.

The following key technologies are based on the following perspective medium-range AGMs 9M96 (Russia), ERINT (USA), ASTER (France, Italy).

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PROSPECTS OF IMPLEMENTATION OF CIRCULAR ARRAYS IN RADAR OF DETECTION OF AIRBORNE AND ABOVE-WATER TARGETS

The progress of the modern radars is start of use of arrays with the digital forming of antenna pattern. Radars can be created both with the mechanical rotation of the antenna and with the electronic circular surveillance of space.

The circular electronic azimuth scans of beam without the use of mechanical rotation maybe by means of convex antenna arrays. These arrays can be built or from the system of linear arrays that are situated on a cylinder and other linear surfaces, or plane arrays that are situated on the verges of convex polyhedrons. Convex arrays also can be built as a system of circular emitters that are situated on spherical or other rotation surface.

One of the most perspective directions of development of radar of detection of airborne and above-water targets is the uses of circular digital arrays (CDA), which opens up wide possibilities in relation to the adaptive forming of antenna pattern and adaptation of radar coverage to the current situation. Absence of mechanical rotation of antenna increases reliability of radar, simplifies service, provides possibilities to the flexible control of radar coverage modes and opens up prospects to expansion of functionality of radar.

Basic advantages of convex cylindrical and circular arrays are:

- possibility of circular azimuth scan by the beam with constant form and width;
- weak, in comparing to the plane arrays, interconnection of emitters due to of their spatial turn;
- possibility of increase of step of position of emitters to (0,75…1,1)λ and decreases of number of elements (due to nonequidistant location of elements in arrays).

To circular scan by a narrow beam at cylindrical (circular) arrays it is necessary to provide the independent amplitude and phase control in each element of array. The difficulty of one is a basic factor that restrains development of convex arrays. Currently the developments of microelectronics, digital processors, solid-stage receiver and transmitter modules leads to decrease of cost of element base. That provides conditions for creation and development of convex arrays on the base of digital technologies and monopulse methods of measuring of coordinates.

Solving of task of decrease of failures of antenna pattern, that appear due to of reflection from ground, advisable carry out by means of installation of antennas on different height or by forming of asymmetrical antenna pattern in a vertical plane. The different height antennas can be formed by a conditional separation vertical plane of array on two halves with a corresponding separate feed.

The use of electronic scan creates conditions for implementation in such radar additional modes of active-passive multistatic radar, when one active radar works in the active mode with a circular or sectoral azimuth scan, and other radars work only on a receive in passive mode. The advantages of work of radar network in the active-passive multistatic radar mode are complication of determination of positions of passive radar by enemy and decrease of energy consumption of the system, due to passive radar does not radiating. Currently already there are examples of the radars, which use CDA technologies for electronic circular scan by a beam. It radars in decimeter range of waves are AN/TPQ-50, AESA50 (USA), YLC - 18 (China), radars in centimetre range of waves are "Роса-РБ" (Belarus).

The perspective directions of the use of radar with an electronic circular scan on the base of cylindrical or circular digital arrays are:

- counter-battery short-range radar;
- automatic radar on towers with distance control and detection range of airborne and above-water targets up to 60…90 km;
- small high-movable radar on the car of type "Cossack" for detection of above-water targets on seashore directions or increase of the low altitude radar field.

These radars can be also used for the security of alone important objects and security of the wide area of air border, creation of warning stripes of low altitude targets.

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SIMULATING OF INFORMATION PROCESSING AND COORDINATE MEASUREMENT IN COUNTER-BATTERY RADAR

The results of simulating of signal processing, coordinate measurement and recognize of targets in counter-battery radar are discussed. Verification of parameters of counter-battery radar in the real conditions related to considerable difficulties and requires of performing of large number of the real firing. Therefore creation of adequate models of functioning counter-battery radar is an actual and difficult task. The complex of models and programs includes next models which have been implemented in the computing environment "MatlabR2016":

- forming of receive and transmit antenna pattern taking into account influence of environment;
- scanning of beam and surveillance of space;
- forming of signals (chirp or nonlinear frequency-modulated) which were reflected from ground;
- forming of trajectories of motion of targets of different types;
- forming of signals which were reflected from targets taking into account a type and foreshortening of targets;
- receive, analog to digital converting, matched and Doppler filtering of signals which were reflected by targets;
- forming of adaptive threshold and detecting of signals with constant false alarm rate;
- measuring of coordinates and motion parameters of targets;
- display of detected targets and their trajectories.

The complex of models and programs allows:

- to estimate of influence of changes of radar parameters on tactical and technical characteristics of radar;
- to optimize of parameters and construction of radar with the limited number of hardware testing;
- to conduct the direct export of data and programs into program environments of hardware, which are based on signal processors or programmable logical integrated circuits, with the aim of practical realization of technical decisions;
- to reduce of design time of radar.

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PROCEDURE OF DETERMINATION OF EFFECTIVE VALUE OF POWER OF SURVEILLANCE RADAR AS SOURCES OF CONTINUOUS ELECTROMAGNETIC RADIATION

The radars which are on the armament of radar troops (RT) have characteristic features that distinguish them from other types of radiating devices of the technical and domestic use. Firstly, radar RT are the powerful sources of electromagnetic radiation in the meter, decimetric and centimetre waveband. Basic power parameter of radar RT, as sources of electromagnetic radiation, there is average power of radiation by its transmission device. It is from a few hundreds watt up to a few kilowatts.

Secondly, influence of source of electromagnetic radiation on an environment is determined by not only value of power but also degree of concentration of radiation in certain direction. Insofar as all surveillance radars and radio altimeter must forms narrow beam, they contain narrow-beam antenna which have value of directivity from a several hundred to a several tens of thousands (depending on radar assignment, sizes of antenna and waveband). Thus, presence in radar the high-directed antennas strengthens power of radiation in hundred and even in thousand times into main beam.

Thirdly, for radar RT a characteristic sign is periodicity of space review. It means that the radiation of objects by a powerful stream comes true not continuously, but only when they are in the zone of action main beam. Other time objects around radar are under act of lateral radiation power, which is determined by the level of sidelobes of antenna pattern. Consequently, objects around radar are under act of variable power. Operating of the electromagnetic field on living organisms is determined by average power per turn. It can be interpreted as an effective value of power that operates on surrounding objects continuously. Obviously, that an effective (average per period of rotation) value of power is far less from power of stream in direction main beam of antenna pattern. A rate between the marked powers is determined by the coefficient of averaging.

In current guiding documents that determine sanitary rules and norms in relation to an electromagnetic radiation, specified, that for surveillance radars the levels of stream of power of the electromagnetic field, which had been measured on an axial line of main beam of non-rotated antenna, it is necessary to decrease in 10 times. Consequently, the coefficient of averaging is accepted as 10 and it does not take into account type and technical parameters of radar. In the report the procedure of calculation of coefficient of averaging of the radiated power depending on technical parameters of radar is shown. According to calculation with applying of showed procedure had shown, that value of coefficients of averaging for different type of radar are strongly differ and can change from a several ten to a several hundreds. The got results can be used for correction of current legislative base in the questions of protection of population from an electromagnetic radiation.

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INCREASING THE EFFICIENCY OF COMBAT ENGAGEMENT AND TRAINING OF AVIATION UNITS UNDER THE IMPLEMENTATION OF GEOINFORMATION SYSTEMS

The analysis of areas of combat mission execution is an important part of the aviation commanders activity, all levels headquarters (HQs) and flight personnel. Paper topographic maps (PTMs) with operational-tactical information (OTI), are still used by commanders, headquarters and flight personnel in process of preparation for combat missions. In conditions of modern highly dynamic combat operations, PTMs can’t satisfy the requirements of the providing process the OTI. One of the ways to increase the efficiency of combat engagement and training of aviation units is the widespread implantation of geoinformation systems (GIS).

GIS allow to combine topographic maps (TM) and background information, which is provided in digital form and systematized and tied to the corresponding point of the cartographic image. GIS provide the possibility of 3D representation of the terrain digital model in an arbitrary area, which isn’t available for PTK. The digital cartographic information which is provided with the use of GIS as an "electronic battlefield" is much more match with the needs of the HQ AirForse (AF) aircraft, because it depicts combat areas in a more realistic way. GIS allows to keep archives of digital map data, to process requests, provide electronic TM aviation units.

Another advantage of GIS is the ability to reflect changes in the operational-tactical situation in real time. In case of reflection with the use of GIS objects of damage not in conditional marks, and in the form of the maximum appropriate to the real image, pilots and navigators will have a more adequate picture of the areas of combat than with using TPM.

Replacing the PTM with computer simulation on an electronic map can drastically change the character and efficiency actions of the navigator, the officer of combat control.

One of the main requirements that must be ensured for the widespread introduction of GIS is their compliance with the needs of AF aviation. As the main ways of adaptation of GIS to the needs of AF aircraft can be defined:

- submission of scientifically substantiated requirements for improvement of existing and development of perspective GIS;
- image of areas of combat operations and OTI in the form that corresponds to the real one;
- increase analytical and forecast capabilities of existing software applications by using GIS;
- working with the GIS developers and other organizations that are also interested in their development;
- creation of a single bank of spatial geographic information models;
- accumulation and systematization of geographic information resources, bases of algorithms and programs with network access,
- development of modern methods and forms of training, normative documentation, tutorial for the training of users of geoinformation software products;
- introduction of safe methods of access to databases of different departments in the interests of using their software geoinformation products in AF aircraft.

At present, only a few separate services are involved in the implementation of GIS in the training of the flight personnel of aviation units. The solution of the problem of using GIS in AF aircraft can be carried out within the framework of the National Program of Informatization. In order to get funding for works on this important problem from the state budget, it is necessary to develop a program for the introduction of GIS in the AF. The program should identify organizational, economic, scientific and technical issues, a list of research and development projects, funding sources and other issues.

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PRESENT-DAY POSSIBILITIES OF NTU "KhPI" TO CONDUCT TESTS ACCORDING TO NATO STANDARDS IN THE FIELD OF EMC

Conception of the State target-oriented program of reformation and development of defense industry complex for period of 2020 year, which was approved by the order of Cabinet of Ministers of Ukraine #19-p of 01.20.2016, includes, among the priority trends, development and production of competitive kinds of armaments and military equipment, and active promotion of them into foreign market. Attainment of this goal is impossible without coordinated development of legislation in the sphere of production of armaments and military equipment by way of its harmonization with legislation of states – members of NATO (which base is corresponding standards of USA). Because of this, leaders of the State have set the goal that Armed Forces of Ukraine should completely go NATO standards before 2020. The total number of these standards exceeds 1250.

Within the framework of this paper, only standards concerned with requirements of electromagnetic compatibility (EMC) are considered.

Harmonization of requirements to armaments and military equipment by parameters of electromagnetic compatibility is particularly important and complex. Implementation of such requirements is obligatory in connection with wide use of electronic systems of control, data processing, automatic decision making etc. Such systems are very vulnerable to action of external electromagnetic interference of natural and artificial (deliberate) origin.

The order of National standardization body of 12.26.2017 #471 "About adoption of national normative documents harmonized with normative documents of NATO" decrees the following:

Adopt national normative documents harmonized with NATO normative documents by way of confirmation as trial ones with carrying into effect from February 1, 2018 till February 1, 2021. These include the standard in the field of EMC: ДСТУ-П STANAG 4370:2017 (STANAG 4370 Ed:6 / AECTP-500, IDT)

This standard determines requirements to subsystems and equipment of objects of military equipment (OME) for such arms of the service: Ground Forces, Navy, Air Forces, submarines and Space systems. This standard regulates 25 kinds of tests. Part of tests (from 5 to 10 kinds in number, depending on the kind of OME) can be performed by manufacturer of equipment, and the others (from 20 to 15 kinds) should be performed in independent accredited testing laboratory. The test is divided into such four packets: NCE (emission of its own conductive radio interference from equipment into network of electric power and communications); NRE (emission of its own radio interference into environment – "the air"), NCS (immunity to electromagnetic effects of conductive interference) and NRS (immunity to electromagnetic fields). The number of tests in each packet depends on the kind of OME and is, in all, 15 kinds for onboard equipment of airplanes and submarines, 13 kinds for equipment of ground and navy OME, and 7 kinds for space systems. To a large measure, such test packets are in other standards, for example, in standard which concerns requirements to onboard equipment of airplanes of civil aviation DO-160G, according to which the tests are performed already for years, but these standards differ not only in norms of tests, but also in some kinds of tests.

Analysis of testing possibilities of RDI "Molniya" of HTU "KhPI" shows that now it can perform in full 14 kinds of tests that are recommended by standard AESTP 500:2016. Implementation of the other 9 kinds of tests will require creation of new testing equipment, part of which is already in the stage of development. This includes development of simulator of electromagnetic pulse of high-altitude nuclear explosion with the following amplitude-time parameters: electric field strength 50 kV m^{-1}, waveform 2/23 ns which correspond in full measure to requirements of NRS03 kind of tests. Six experimental specimens of testing generators were developed within the frameworks of fulfillment of research projects on providing correspondence of armaments and military equipment of

Ukraine to present-day requirements of NATO standards on electromagnetic compatibility, due to financing by Ministry of Education and Science of Ukraine during 2017-2019.

Fulfillment of tests of specimens of OME in foreign testing laboratories are connected with the following risks (without considering substantial financial costs):
- loss of image when obtaining negative result which probability is very big if the equipment will not pass preliminary factory tests;
- possibility of loss of commercial secrecy, taking into account the fact that there is severe competitive struggle at international markets, in consequence of which an industrial espionage is inalienable part of present-day world.

Therefore, an aerospace state, which seeks to be among the leaders in development and realization of armaments, should carry out tests in its own test centers according to standards of NATO and USA military standards. Operating experience shows significant advantages of using own generators in comparison with those bought in foreign firms, first of all, in cost, maintenance and running repair.

RDI “Molniya” of NTU “KhPI” has potential possibility, with the help of financial support, to in full realize assessment of immunity level of subsystems and equipment of military equipment according to requirements of standard NATO STANAG 4370 AECTP 500:2016.

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PERSPECTIVE WAYS OF INDICATION SYSTEM MODERNIZATION OF SURFACE-TO AIR MISSILE COMPLEXES MEANS

The element base replacement is a well-known trend in the modernization of surface-to-air missile complexes (SAMC) and their components. A promising area is display system units replacement, where monochrome electron beam tubes are widely used as indicators, with modern multifunctional indicators. The urgency of this issue is due to the obsolescence of electron beam tubes and associated radioelectronic devices (deflection systems, specialized high-voltage transformers, voltage multipliers, etc.), their decommissioning, the lack of replenishment of their spare parts. In addition, SAMC indicators, as rules, are only used in combat operations (display of primary or secondary radar information, information on the number and type of missiles, etc.) and when performing some adjustments to the SAMC functional systems during its maintenance.

The modern technologies development makes it possible to significantly expand the indicator systems functionality. First of all, it is to improve the displayed information perception during combat work and to display additional information on the indicator without changing its geometric dimensions due to the use of color displays. In addition, the use of these indicators is possible, provided that there is no need for combat work as:

– monitor of the optical-electronic surveillance system (for the detection of unmanned aerial vehicles, ground protection of the battalion (battery) positions), which will allow to create the main (additional) appropriate observation point in a camouflaged combat vehicle;

– displaying means of interactive electronic operational documentation, which will improve the information support of the maintaining processes a combat vehicle in a capable state, as well as mastering its construction and use for its intended purpose;

– tactical calculation module with the help of a complex of specialized information and calculation tasks, which will improve the quality and efficiency of decision making by officials.

Upgraded device generalized structure is proposed, which includes both hardware and software components. The device hardware includes input signal processing modules, microprocessor module, microcomputer module, display, controls. The software includes modules for processing signals from the outputs of the receiving radar and optical devices, signals for the antennas angular position, signals from the synchronization and tracking systems, as well as a module for storing, processing and preparing them for display, specialized software for displaying operational documentation and calculations.

The implementation of this approach, in addition to the main positive effect will allow to:

– reduce the adjustments number of the indication systems units , which will reduce the operations number during the maintenance and, as a consequence, the duration of their implementation;

– reduce the elements nomenclature of spare parts kits, due to the use in the same blocks of the same hardware, i.e. one device instead of dozens of types of elements (deviating systems, specialized high-voltage transformers, voltage multipliers, etc.);

– improve the trouble-free performance of the display unit, due to the greater reliability of modern devices.

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UNCLASSIFIED TECHNICAL CHALLENGES FOR CYBERNETIC SECURITY IN AUTOMATED SYSTEMS

During the exploitation of automated systems (AS) for various purposes, new cyber security challenges may be identified, for which no technical solutions are currently provided. These unclassified technical challenges require to take advantage of existing cybersecurity capabilities in new ways, add new features, innovate or undertake new research.

One of the ways to solve new technical problems for cyber security in automated systems can be the following:

1. The ability to identify vulnerabilities in our automated systems will enable to correct them timely. It takes time to assess, test, and implement patches that address the just discovered vulnerabilities. We need to be able to fix vulnerabilities faster than our opponents can take advantage of them, and we need to have the appropriate techniques.

2. Development of new analytical methods that can analyze new software and its features to identify vulnerabilities.

3. Creation a database of malware to support their analysis and testing of antivirus solutions.

4. Development and implementation of tools that not only describe complex networks, including devices, software/firmware version and patch level, but also impose command and control logic, data flow, protocols, and physical location of near-real-time AS elements. We need to be able to monitor the aggregate network to select the right moments that would allow us to catch our opponents.

5. When monitoring AS, we often do not know its normal state or abnormal behavior. Staff should act promptly to detect abnormal AS activity. We must be able to accurately and effectively identify, measure and characterize the baseline state of the AS and systematically indicate that it is a deviation from its “normal” activity.

6. Deployment of new and expanding of existing AS increase the burden on network analysts and requires new additional human resources. To increase the potential of cyberspace, it is necessary to implement automation, machine learning and application of artificial intelligence to monitor and detect AS vulnerabilities.

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PROSPECTIVE WAYS OF DIGITAL TROPOSPHERE COMMUNICATION DEVELOPMENT IN THE ARMED FORCES OF UKRAINE

Troposphere communications may be an alternative type of communication at the raid, assault and search-strike activities. For example, according to the US Marine Corps publication, AN/TRC-170 tropospheric communication stations have proven to be very reliable and significantly cheaper than satellite communications. It is advisable to use small-sized, high-capacity tropospheric stations of new generation to communicate in the tactical level.

At the same time, adopted of the Armed Forces of Ukraine, tropospheric communication facilities are characterized by a large number of analog stations of type P-412A, digital stations of type P-417 and P-423-1M require modernization, stations have large dimensions of hardware machines, low bandwidth, great deployment and getting in touch time.

Thus, a prospective way of digital tropospheric communication development in the Armed Forces of Ukraine may consist of several ways:

upgrading of existing P-412A, P-417M, P-423-1M tropospheric communication stations, commissioned in “point-to-multipoint mode” for application in strategic and operational management levels;

creation of mobile combined troposphere-radio relay stations of container type for application in operational and tactical levels, submitted to operate in “point-to-multipoint” mode;

creation of small-scale digital troposphere-radio relay station for placing on vehicles and organization of single-interval tropospheric communication lines in tactical level.

Each of these ways should be accompanied by appropriate research and development work.

Therefore, the main ways of the research and development works for the development of mobile digital tropospheric systems should be aimed at creating:

small tropospheric stations;

combined troposphere-radio relay stations;

tropospheric stations operating in “point-to-multipoint” mode.

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WAYS OF INCREASING THE PROTECTION OF RADIO CHANNELS OF CONTROL AND TRANSMISSION OF UAVS IN THE CONDITIONS OF ACTIVE RADIO ELECTRONIC INSURANCE

Unmanned aerial vehicle complexes (UAV) demonstrated high efficiency in the course of anti-terrorist operation (ATO) and United Forces operations in eastern Ukraine. Their use is conditioned to expedite the detection of military groups and enemy objects.

To counter the enemy of unmanned aerial vehicle complexes actively used complex measures to violate effective management of radio channels and data unmanned aerial vehicle complexes, it uses a wide range of electronic intelligence, and the means of electronic warfare.

Modern radio electronic suppression facilities are capable of high efficiency and suppress unmanned aerial vehicle (UAV) radio channels in the short term. Currently, a significant number of radio electronic suppression tools have been created to disrupt the UAV control channel by suppressing it in different operating frequency ranges using the entire set of intentional interference.

In view of this, it becomes quite difficult to ensure a stable radio communication between the UAV and the ground control station. Successful solution is not possible without the use of special technical and organizational measures to improve the efficiency of the radio system in a complex electronic environment.

Different types of organized interference can be used to suppress radio communication between UAV and NSP.

Especially dangerous for digital radio communications are modulated noise simulation, the effects of which radio communication is operational but does not provide useful information exchange.

In some cases, imitation interference may lead to incorrect information being introduced into the UDF radio control equipment, causing erroneous operating modes by affecting the clock and cycle synchronization of the NPS receiver.

The analysis of the technical characteristics of the equipment also indicates the possibility of staging active interference in barrage and sighting modes. Moreover, structural obstacles are a major threat among sightings. Their use can not only disrupt the progress of the UAV flight task, but also lead to its interception.

Incidentally, the issue of improving the immunity of UAV control radio channels has not been fully explored and there is no clear understanding of what measures should be taken to reduce the impact of structural interference on UAV control channels. Therefore, there is a real danger in the case of the use of UAV, in the area of the enemy's EW means of not performing the flight task.

The report shows possible ways to increase the noise immunity of radio control channels and the transmission of UAV under conditions of active electronic suppression.

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ABOUT THE PROTECTED OF THE MILITARY CABINS OF MI-8 BY THE ARMOR INSTALLATION

According to the modern doctrine of ground-to-air combat, a modern helicopter should be a standalone multipurpose machine with increased impact capabilities, duration and range, and combat survivability. It must be capable of striking ground targets and conducting air combat at any time of the day, in any geographical area and in all weather conditions.

In addition to the above requirements for multipurpose helicopters is another important requirement, namely, the protection of the crew against the defeat of small arms.

According to the results of the conducted researches it is determined that the reservation of glazing of combat helicopters is an urgent and important task that saves the life of the crew and significantly increases the survivability of aircraft.

According to the results of the analysis of the characteristics of foreign helicopter technology, it is determined that the armor reservation is used on combat helicopters (Percussion, support ground forces and combat armor) types Mi-24P, Mi-28, Tiger, AN-64 Apache and others. However, information on the use of armored glass (which can withstand, for example, the hit 23mm, 30mm shells) on multipurpose helicopters type Mi-8, NH-90.

The total weight of the armored helicopter glazing must correspond to the weight of the regular glazing, in case of exceeding it the overall centering of the helicopter will be disrupted, which could lead to an aviation event (accident).

The cockpit glass of the Mi-8 helicopter must comply with the following types: upper right (left, front) - type 8AT-0200-00-63 (64, 65);

lower right (left), middle - type 8AT-0200-00-72 (71), 8AT-0200-00-553; average - type 8AT-0200-00-551; left (right) - type В8БП-000-1 (2); left (right) - type 8AT-0200-458-1 (2); manhole covers - type 8AT-0200-800-15 (16); crew cabin doors - type 8AT-0200-00-35.

The design of armored glazing helicopters must ensure compliance with their intended purpose and meet the requirements of GOST B 20.39.308 76, OTT Air Force-86.

The armored cockpit of the helicopter cockpit shall provide protection for the crew members when hit by a helicopter:

12.7 mm caliber bullets with a velocity of up to 750 m/s;

series of 7.62 mm caliber bullets with an encounter velocity of 750 m / s;

fragments weighing 3-9 g with a velocity of up to 2000 m/s.

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ABOUT THE DEVELOPMENT OF A HELICOPTER PROTECTION SYSTEM IN THE CONTACT OF ELECTRICAL WIRE

The helicopter protection system in the event of a collision in the air with electrical wires contains an upper cutter, a middle cutter, a lower cutter and deflectors (reflectors) of the cockpit glass with a cutting blade attached to each of these deflectors (reflectors). This part of the upper cutter includes a base element, a power cutter housing, the top deflector, saw blade, two blades, two supporting posts and additional amplifiers racks.

The composition of medium cutter includes a base element housing the power cutter deflector average, saw blade, two blades, two supporting posts and the right and left additional amplifiers. The structure of the lower cutter includes a base element, a power cutter housing, lower deflector, saw blade, two blades, two supporting posts and additional amplifiers. The upper and middle cutter is located on the fuselage above the helicopter cabin, and the lower cutter is placed on the bottom of the fuselage, which is in front of the front rack of the helicopter.

Additionally, the design of the system of protection in the collision helicopter in the air with electric wires are invited to enter the heating system. The heating system includes heating elements, VG-15K circuit breaker and control unit of the specified heating system, which is connected to the onboard power supply, whereby the heating elements are mounted on the cutting blades and on the blades of the upper and middle deflectors and connected with the control unit through the VG-15K circuit breaker.

Each of these paintings and the cutting edges placed one, two or more heating elements. Each of the heating elements is at least 0.1 mm thick.

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TOPICAL QUESTIONS ON INCREASING THE PROTECTION OF AIRCRAFT OF UKRAINIAN AIR FORCE FROM "AIR-TO-AIR" AND "AIR-TO-SURFACE" MISSILES

At the present, the protection of planes (helicopters) requires expanding capabilities and improving the characteristics of the opposition to the latest models of air defense systems. Controlled missiles, due to the high speed and range of flight, maneuverability, detection complexity, and precision guidance, have become one of the main threats to aircraft of various uses. Combat, transport, and helicopter-driven protecting from missile weapons is one of the more complex issues of aviation. Taking into account the nature of the air combat, the author considers ways to improve the onboard aircraft weapon control system of aircraft of Ukrainian Air Force, which will enable the aircraft crew to be protected from air-to-air and surface-to-air missiles with a high probability.

Existing weapons do not provide comprehensive protection of aircraft from guided missiles with different types of homing heads.

The analysis of existing systems of protection of planes of the leading countries of the world and aviation of Ukrainian Air Force is carried out.

Based on the analysis of existing systems of protection of aircraft of the leading countries of the world and aviation of Ukrainian Air Force, taking into account the prospects for the development of airborne defense aircraft complexes, the requirements for perspective systems of air defense protection from air defense means are determined.

Consequently, promising research in this direction is:

development of tactical and technical requirements for the complex of active protection of the aircraft and for the advanced air-to-air missile guided missiles;

determination of the accuracy characteristics of the complex of active protection of the aircraft;

improvement of the mathematical model and the development of an algorithm that provides detection, capture and support of the air target, guiding it to the promising guided air-to-air missiles and the destruction of the air target.

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ON THE USE OF THE FREQUENCY CONTROL METHOD YOUR VIBRATIONS WHEN CHOOSING AVIATION RECOVERY TECHNIQUE

In the course of performing a combat mission, the aircraft may receive combat damage resulting in either a change in the strength and stiffness of the structure or inadmissible deterioration of the aerodynamic characteristics of the bearing surfaces.

Therefore, one of the reasons for the defeat of the aircraft may be the destruction of its structure due to the reduction of the rigidity of the force elements. Another reason for the defeat of the aircraft is the deterioration of aerodynamic characteristics, which lead to the inability to not only perform maneuvers, but also to perform horizontal straight flight.

In terms of aerodynamics, damage to the wing ends is dangerous, although the stiffness of the wing has not changed significantly. At the same time, a small hole in the root of the wing, which does not affect the aerodynamic characteristics, can cause the destruction of the spar, the power rib, which can lead to the destruction of the wing as a whole. These facts indicate that the issues of structural and aerodynamic survivability are closely linked.

It is expected that in the conditions of hostilities, a large number of aircraft will be damaged during combat operations, as well as during enemy attacks at base aerodromes. On this basis, it is necessary to develop a set of measures aimed at ensuring the commissioning of as many damaged aircraft as possible. In this regard, great attention is paid to the development of methods of temporary repairs to damaged aircraft in order to use at least one combat flight, before sending the aircraft for long-term repair.

In this regard, great attention is now being paid to the development and implementation of non-destructive testing techniques capable of assessing the residual strength and rigidity of the damaged airframe structure.

Diagnostic methods should be based on methods and means of nondestructive testing using the achievements of electronics, acoustic emission, laser of technology. However, these control systems are, unfortunately, very cumbersome and unacceptable in operation at field airfields, especially during combat operations.

Of considerable interest, in terms of promptness of information on the state of the object under study, objectivity of diagnosis, mobility and economy, is the method of control of the frequency of natural oscillations (FNO) of the structure. This method of diagnosis is based on obtaining information on the residual strength and stiffness of the wing (plumage) of the aircraft on change (FNO). Having data on the FNO C of the undamaged structure of the investigated aircraft (reference data) and the experimental data on the FNO of the structure at the time of its destruction, as well as the intermediate data obtained on the structure with combat damage, it is possible to determine the residual strength and rigidity of the structure.

The FNO control method should substantially complement the currently widely used non-destructive control methods with penetrating radiation (X-ray and gammography). This method of control of FNO does not require coordination with the performance of another type of routine work on the aircraft. The need is to fulfill only some conditions: the object of control should not be subject to external influences (walking on the object of control, increasing its mass by foreign objects is not allowed).

The FNO control method is simple enough to operate, with a minimum time to check the technical parameters (10-15 minutes). The total labor cost savings in the FNO control method is 90-95% of the labor costs on visual inspection and up to 80%, with X-ray control.

The equipment developed for the purpose of diagnosing the design of the aircraft is light and small enough. Thus, the application of the FNO control method in determining the technical condition of the damaged structures of the aircraft will allow an objective approach to the decision of the choice of methods for their restoration and reduction of the time of the regulatory duration of repair.

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CONCEPTUAL INTRODUCTION OF THE SYSTEMS' LIFECYCLE MANAGEMENT SOFTWARE AND SOFTWARE PRODUCTS FOR USE IN THE MILITARY IN ACCORDANCE WITH A UNIFIED ARCHITECTURAL FRAMEWORK

To help complex systems managing, which encountered concerned parties, the concepts, principles, and procedures of the architecture process are increasingly being used.

Lay emphasis on the necessity of integrating of the product lifecycle management system with international systems engineering standards that determine the formation of a new, recognized industrialized country and a key player in the international armament market for systems and software development culture.

Implementation of approaches to the lifecycle management of military products in accordance with the architectural conceptual model is proposed.

The Report provides:

- Unified Architectural Framework (UAF) description;
- software technologies and standards that ensure the development in accordance with the architectural framework;
- conceptual introduction of the system lifecycle management software based on the anti-aircraft weapon system example in accordance with the UAF architectural framework.

The application of systems engineering approaches based on architectural models has become more important tool of necessity for the modern s complex military systems effective design.

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COMPENSATION MULTIPATH INTERFERENCE IN PASSIVE RADIO TECHNICAL SYSTEMS TIME AND FREQUENCY SYNCHRONIZATION

Frequency-time synchronization using a common source (CS) signal involves receiving in the main (primary) and secondary points of the radio signal of an arbitrary radiator at known distances with sufficient accuracy from the source of the signal to the points. As such sources, transmitters of terrestrial and space telecommunications systems, television and radio broadcasting systems, radio navigation systems, etc. may be used. Because such a system does not contain radiating devices and consists of several spatially spaced receiving points, it has been called the multipoint passive synchronization system (MPSS).

The report presents the results of theoretical and experimental studies on the possibility of suppression of multi beam interference (MPI) in frequency and time domains using known mathematical methods of signal processing.

For an arbitrary CS signal, the magnitude of the shift of the time scales in the BPSS is determined by the results of the calculation of pair cross correlation functions (CCF) of the samples of signals received in the main and secondary points. For each of the CCFs there is a temporal position of its maximum, which further participates in the statistical processing of the measurement results and the formation of the resulting evaluation of the comparison of time scales and frequency of standards.

One source of synchronization errors is the multi beam interference. MPI in the BPSS occurs during simultaneous reception by the antenna of the direct signal of the CS and the signal reflected from the surrounding surfaces (local objects). The presence of a multipath signal reduces the signal-to-noise ratio in the received signal of the CS, which in turn causes an increase in the timing error. If the delay time of the additional beam (s) is less than the duration of the signal sampling, the reception of the signal is further complicated by the presence of partially correlated interference, the level and degree of correlation of which increases with decreasing delay time and can lead to an increase in the probability of erroneous synchronization. Therefore, the development of theoretical and practical approaches to reduce the influence of the multiplicity of the CS signal on the accuracy of synchronization in the MPSS, as well as the experimental verification of the developed technical solutions is an important scientific and applied task.

In order to compensate for the multi beam interference, an algorithm was developed in the time domain, which provides:

determining the delay time of each of the additional obstacle rays according to the time position of the corresponding CCF maximums;

normalization (equalization) of amplitudes of CS signals at receiving points by comparing the estimates of CCF maxima obtained from the main signal;

the selection of the signal component at the point where there is no multipath signal and broadcast it to the point where the MPI is present;

obtaining a component interference by subtracting the received component signal from the mixture of signal and MPI at this point. At the same time, due to the selection of the initial phase of each signal sampling, it is necessary to ensure the maximum compensation of the signal component;

compensation of the MPI at the synchronized item by subtracting the inverted component of the interference from the mixture of the signal and the MPI.

To compensate for MPI in the signal of a general point source in the frequency domain, you must:

according to the available signal fragments recorded in pips, which are synchronized, to determine the real and imaginary parts of the spectral components of the received signals CS;

to calculate the instantaneous amplitude-frequency spectrum and phase-frequency spectrum (AFS and PFS) of these signals;

to determine the instantaneous ASF and PFS signal CS, where MPI is missing, or has a valid level;

to compensate for the signal component in the spectrum of the signal points, where there is a MPI and thus to the instantaneous ASF and PFS noise component;

get instant ASF and PSF, respectively, after subtraction of the ASF and PFS noise component;

to calculate the real and imaginary components of the ASF signal when compensated MPI;

to obtain a complex array for the reciprocal spectral power density of the signals in points and perform a Fourier Reverse Transformation Operation, which gives the pair CCF to further estimate the temporal position of their maxima.

To improve the accuracy of determining the temporal position of the CCF maxima during the formation of arrays, these values are interpolated.

The results of the theoretical and experimental studies have demonstrated the possibility of compensation for MPI in the MPSS when at least one of the synchronized items does not contain MPI or does not exceed the allowable level MPI. Mathematical models of compensation blocks in the time and frequency (spectral) regions are developed. Mathematical apparatus of spectral correlation analysis was used in the development of the models.

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MAIN TASKS AND PROSPECTS FOR THE DEVELOPMENT OF MODERN AVIATION ENGINE BUILDING

The main tasks of research and development at this stage of modern scientific and technological development of aviation gas turbine engines are:

improving efficiency;

reduction of weight and life cycle cost;

increased reliability and durability while simplifying maintenance;

reduction of emission of harmful substances and noise.

It is known that an important direction of increasing the fuel efficiency of the power plant is the transition to higher parameters of the thermodynamic cycle. Increasing the temperature and pressure in the flowing part of the engine requires the use of new materials, aerodynamic forms and power schemes of elements of aviation gas turbine engines, which are solved by deep research, design, technological work in various fields of science and technology.

The relationship of the efficiency of elements and fuel efficiency of the engine allows you to determine the directions of improvement and development of power plants. Further development of power plants aimed at reducing the specific fuel consumption is associated with an increase in the internal (thermal) and traction efficiency.

Characteristic features of modern engines are:

increase in fan diameter with high efficiency and low noise;

reducing the number of stages of the gas generator to reduce the weight of the engine, reducing the cost of production and operation;

application of technologies of creation of high-temperature structural materials and economic systems of cooling of heat-stressed details of engine design;

application of new perspective schemes of open rotor engines, gearboxes and gearboxes of the fan;

application of engines with complex thermodynamic cycles (motors with variable (adaptive) cycle and cycle with intermediate cooling);

the use of hybrid and electric distributed power plants that are integrated into the elements of the glider and provide increased aerodynamic performance of the aircraft as a whole;

deep integration of glider and powerplant.

The main modern directions of improvement of aviation power plants are: increase of gas-dynamic perfection of the engine with simultaneous increase of parameters of work process;

application of intermediate cooling systems;

the use of high-pressure compressors and high-load turbines;

providing a stereometric combustion process;

the use of hybrid distributed power plants;

increasing the traction efficiency of the engine by increasing the degree of double circuit and switching to the open rotor circuit;

reduction of the specific gravity of the power plant by the use of new alloys and composite materials;

the rejection of air intake systems from the gas-air path of the engine in favor of electrical systems ("electric engine" technology);

further integration of glider and engine and their systems.

Analysis of modern perspective technologies of world aviation engine developers (General Electric Aviation, Engine Alliance (USA), Pratt & Whitney (USA, Canada), Rolls-Royce (UK), SNECMA (France), ODK-aircraft engines (Russia), Ivchenko Progress (Ukraine), aimed at the realization of the basic tasks of aircraft engine building and the assessment of the possibility of their realization.

One of the important directions of improving fuel efficiency, reducing the level of harmful emissions and noise is the modernization of existing engines developed by the Ivchenko-Progress.

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TECHNOLOGY OF MANUFACTURE OF DETAILS OF COMPLEX FORM ON THE BASIS OF RADIO-TRANSPARENT CERAMIC

The development of aircraft engineering in our time is determined by the improvement of materials used in the construction of aviation and space technology. One of these materials is radio-transparent ceramics, which is used in the manufacture of aircraft parts, which determine the tactical and technical characteristics, taking the main thermal and energy loads. Creation of radio-transparent materials with a complex of high operational characteristics and development of technological parameters for the manufacture of parts of various shapes and sizes is an urgent task of modern aerospace industry.

In previous studies, the optimal composition of ceramics for the production of antenna fairing on the basis of the crystalline phase of Slavsonit was developed. The best specimen characteristics were achieved using a semi-dry pressing method and comprise: water absorption ~ 0,08%, compression strength ~ 72,3 MPa and dielectric constant ~ 4,93 ... 5,26 at frequencies 26 ... 37.5 GHz. The obtained performance characteristics meet modern requirements for radio-transparent materials, but the formation of a semi-dry pressing method allows you to create products of a simple form.

For formation of products from radio engineering ceramics of complex configuration with high accuracy of the sizes and cleanliness of a surface the method of casting from suspensions is used. The developed technological scheme of manufacturing of an antenna fairing by the method of casting involves the preparation of initial components, the preparation of a slurry in a ball mill, the formation of a ceramic shell in gypsum, drying, dipping the samples and further machining.

The smaller the moisture content of the slurry, the faster the formation of a layer of ceramic mass on the surface of the plaster form. It also reduces shrinkage when drying raw and deforming products. To prepare a slurry with low moisture, defloculants are added to its composition. The study of the influence of various types of surfactants on the rheological properties of the resulting slurry was carried out. For the experiment, defloculants of the Dolapix P 67 and Stellmittel ZS grades were selected in different quantities.

As a result of the analysis of the data, a defloculant Dolapix P 67 was selected and its effective amount was determined to be 0.1 wt. % based on dry matter. This allowed to reduce the yield strength from 31 s with no additives up to 25 s with the additive. It was established that the decrease in the moisture content of ceramic slurry from 25 to 21% improves the properties of water absorption and open porosity, reducing them from 11.53 to 10.22% and from 23.62 to 21.04% respectively, as well as increasing the apparent density of 2, 05 - 2.15 g/cm^3.

In addition, an experiment was conducted to detect the effect of a slurry temperature on rheological properties. A clear relationship between the characteristics was established, the experiment was conducted using a slurry with a moisture content of 21% in the presence of a diluting additive, as a result of the temperature increase from 20 to 35 ° C, the yield strength is improved and accordingly decreases from 27 to 22 seconds. However, despite the improvement of the rheological properties, the properties of the samples obtained at different temperatures of the slurry casting practically do not differ from each other.

The method of different variations of diluents was able to determine the composition of the slitter with optimal properties, but the resulting raw material was not strong enough, so the following studies are carried out in conjunction with the definition of the optimum additive and its amount to obtain the most reliable raw material while maintaining its operational properties.

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METHOD FOR ESTIMATING THE STORAGE MEASURES OF THE AIRBORNE EQUIPMENT OF THE SURFACE-TO-AIR GUIDED MISSILES WITH PERIODIC CONTROL OF THEIR PERFORMANCE

For the development and operation of surface-to-air guided missiles (SAM), the issue of assessing the storage measures is topical because the content regimes of the SAM include a storage phase. In this regard, a method for assessing the storage measures of airborne equipment of SAM (makes) with periodic monitoring of their performance is considered.

Periodic monitoring of the performance of makes is performed to obtain information for evaluation indicators of their storage measures. Makes may be those that are not serviced and controlled in operation, or that are serviced, controlled and restored in service. For makes that are serviced and controlled, estimates of storage measures are conducted based on the results of operational observations, and for makes that are not serviced and not controlled, these measures are estimated based on the results of periodic controls, which are organized according to a special program in the process of extending assigned measures SAM. In the first and second cases, the results of monitoring the operational state of the makes are presented as the results of reliability tests on the relevant plans.

According to the results of the performance monitoring of makes at each stage of control, the number of makes that failed has been determined and an estimate of the probability of failure of makes during this monitoring period is calculated. Possible situations of makes failure during several periods of control are considered. The calculated ratios for estimating the empirical distribution function (EDF) of storage duration to failure and the storage measures of makes are given. Due to the fact that the control of makes is a periodic assessment of storage measures, it is characterized by interval uncertainty at the moment of failure, which in turn determines the accuracy of EDF estimation and storage measures. The report examines the assessment of EDF and the storage measures of makes, taking into account the features of obtaining information.

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METHOD OF EVALUATION OF EFFICIENCY OF WORKS ON EXTENDING ASSIGNED MEASURES OF THE SURFACE-TO-AIR GUIDED MISSILES

At present, the development of a scientific and methodical apparatus for carrying out work on the continuation of extending assigned measures (EAM) is relevant, in particular, the methods of technical and economic evaluation of the effectiveness of such works in relation to surface-to-air guided missiles (SAM). The methodology for evaluating the effectiveness of work on the proposed EAM of SAM takes into account the cost of carrying out works to assess the possibility of increasing the assigned measures by more than the initially set values, the costs associated with the implementation for each SAM activities necessary to ensure its operation in the period , which continues, additional expenses, which are caused by the purchase of spare parts for restoration and maintenance of the work of the park SAM during their operation over time t in case of their failures.

The value of these costs, in accordance with the methodology, is limited to the customer's purchase of new SAM that must be purchased to replace SAMs with past EAM.

The report sets out the main provisions of the methodology by which it is possible to find the admissible value of increasing the EAM based on available economic resources for the continuation of the EAM and ensuring the exploitation of SAM for a prolonged period. The method takes into account the number of SAM park, the graphs of dependencies of new values of assigned measures on the cost of performing work on the EAM, which allows them to determine their rational values. In particular, it envisages taking into account the possibilities for the customer to purchase non-new SAM, and those in which the supplier performed work on the EAM and established the warranty period of service.

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APPROACHES TO THE FORMATION OF THE METHODOLOGY OF SYNTHESIS OF RATIONAL ORGANIZATIONAL AND STAFF STRUCTURE OF THE AVIATION ENGINEERING SERVICE IN THE SYSTEM OF ENGINEERING AND AVIATION SUPPORT OF COMBAT OPERATIONS OF UNITS AND UNITS OF TACTICAL AVIATION

The effectiveness of combat use of aircraft (LA) depends not only on their own tactical and technical characteristics, the quality of the equipment installed on them, weapons, but to a great erextent on the quality of the system of organization and implementation of engineering and aviation support (IAS) of combat operations.

The rapid change of tactical environment, constant maneuverby forces and means characterize the fighting of the present day, and encourage the search for a rational composition of forces and means of preparing the aircraft for combat use. Modern scientific approaches based on the study of complex dynamic systems and the use of simulation modeling methods are used to solve problems of this kind.

The report deals with the issue of forming a set of criteria and indicators for the development of a methodology for synthesis of organizational and staff structure of the aviation engineering service of the tactical aviation unit. The hierarchical structure of goals of functioning of the IAS combat system of aviation units (units) is considered, taking in to account its role and place in the combat system.

The examples show that the existing approach to the formation of organizational and staff structure of the aviation engineer service of units (units) of tactical aviation does not fully meet the requirements for IAS fighting on modern challenges and threats that arise before the state, and methodically ensure the formation of rational composition the forces and means of engineering and aviation service of parts (subdivisions) of tactical aviation is not sufficiently high scientific methodological level.

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PROPOSAL FOR INCREASING INFORMATIVNESS IN THE MIMO-RADAR SYSTEM ON THE BASIS OF THE TWO-COORDINATE SURVEILLANCE RADAR

The consumers’ requirements to the quality of radar information are constantly increasing. However, the existing radar equipment park, including the samples of two-dimensional facilities, does not meet the requirements for the quality of the information. The radar sensitivity of airborne objects in the continuous and dynamic process of their development is reduced, that makes it difficult to detect them. A factor that greatly improves the quality of radar information on aircrafts is the ability to identify all three coordinates of the air factor, including altitude. It follows from the analysis of the experience of conducting local and hybrid wars and the Joint Forces operation in the east of Ukraine, it is known that the main directions of the development of modern air attack means is increasing of the number of small-sized air objects, usually unmanned aerial vehicles (UAVs). In such conditions, a qualitative increasing of informativity will be possible not so much due to the increasing of the radar field, but due to the combination of separate radar into the multiple-input multiple-output (MIMO)-radar system.

The purpose of the paper is the analysis of the capabilities of improving of informativity in small-base MIMO-radar system based on two-dimensional survey radar. Consider the MIMO-radar system, created by spatially spaced, monostatic active surveillance two-dimensional radar, which are combined through a data exchange network and have a single coordinate and time scale. Radar measures two polar coordinates of the airspace (azimuth and sloping range) that are transmitted to a compatible radar information for cooperative processing into a single centre processing station. The methods of processing the radar of information that can be implemented in the MIMO-radar system depend on the multiplicity of overlapping detection zones and the peculiarities of constructing the equipment of the individual radar forming the radar system.

For an example, to analyze for a spatially-coherent MIMO-radar system of single-type radars spaced apart at a distance base. The overlapping area is formed when the synchronous rotation of three radars with antenna pattern beams. The main advantage of using the MIMO-radars to determine the coordinates of aircrafts is the ability to provide the required accuracy of the determination of coordinates of aircrafts without the using of accurate measurement of angular coordinates in the radar. The latter makes it possible to reduce the requirements for the antenna chart width and size. Reducing the size of the antennas allows you to lower the cost and increase the mobility of the radar.

The using of multistatic methods in MIMO-radar increase informativity is possible. The accuracy of determining the plane coordinates of the aircrafts without the using of angular measurements will increase, but only by measuring distances. In addition, it is possible to of classification at the altitude of the aircrafts provided at the intersection of the detection zones of the MIMO-radar system, which consists of three two-dimensional observations radars. . In this case, the accuracy of the determination of coordinates by means of a far-reaching measurement method depends on the mean square error of measuring the range of the individual radar, the size of the base, the position of the aircrafts in the zone relative to the normal to the base and the range to the aircrafts from the separate integrated radars.

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METHODOLOGY OF COMPLEX JUSTIFICATION AND PROVISION OF SAMPLES 'RELIABILITY REQUIREMENTS AT THE STAGES OF EXTERNAL DESIGN

The regulatory framework for substantiation of the requirements for the reliability of the sam and its provision considers the question of setting the requirements by the customer and separately the issue of ensuring the reliability of the developer from the stage of implementation of the advance project. The requirements for the methods of ensuring the reliability of the customer are not specified. Therefore, it is urgent to set the requirements not only for the reliability indicators, but also for the structural and operational ways of providing it in the part of the requirements for the combined control of the technical condition and the system of maintenance and repair. The report examines the notion of integrated justification and security requirements, and other provisions. The proposed methodology contains initial data, main tasks, sequence of their solution, a set of models, methods and techniques and outputs.

The outputs, in the general case, include requirements for failure-free, maintainability, durability and safety, for the system of maintenance and repair, the system of combined control of the technical condition in the system of functional use of sam. The use of the technique is illustrated by the example of a medium-range self-propelled sam.

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MODEL OF FUNCTIONING OF A MULTIPLE TECHNICAL MAINTENANCE AND REPAIR SYSTEM IN A MODERN EXPLOITATION SYSTEM

In accordance with the concept of a modern anti-aircraft missile system (SRO), state-of-the-art maintenance and ongoing repairs will be carried out by forces and means of military units, service and repair centers and industrial enterprises.

When implementing this organizational scheme, the task is to justify the requirements for performance and other indicators of military repair units and repair units of service centers, which provide the required level of combat readiness.

In this regard, the analytical and simulation models of functioning of the multilevel maintenance and repair system in the form of a multiphase multichannel queuing system, which takes into account, unlike the known models, the joint functioning of the maintenance and repair bodies of different hierarchical levels under different hierarchical levels under consideration , regiment maintenance crews, crews, on-site repair crews of service centers, factory repair bodies).

Examples of using these models to solve the problems of analyzing and synthesizing a maintenance and repair system are given.

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INTELLIGENT SYSTEM OF ELECTRICITY SUPPLY TO MILITARY EQUIPMENT IN FIELD CONDITIONS

The power supply of military equipment in field conditions is very important in the military actions in case of damage to stationary electricity networks. The use of diesel generators creates a noise that disguises troops, which allows the enemy to identify the masked positions of Ukrainian troops.

In order to provide power supply for military equipment in field conditions, the authors offer an intelligent power system consisting of solar panels, super-capacitors, accumulators, a device for tracking the position of the sun and a maximum power point tracking device for each solar panel.

An important element of the intelligent power supply system for military equipment in the field is a diagnostic unit for each solar panel, each cell of the supercapacitor unit and each cell of the battery. The peculiar feature of this device is the proposed new diagnostic algorithms based on the fractional number theory, impedance spectroscopy and elements of the theory of artificial intelligence.

A common feature of all components of the intelligent power supply system for military equipment in field conditions is that they all consist of serially connected cells, whose work depends on their internal complex resistance. For example, the solar panel consists of serially connected photocells, the supercapacitor battery consists of serially connected supercapacitor cells, and the rechargeable battery consists of a series of connected galvanic cells.

The use of smart Internet technology allows you to use the individual IP address of each solar cell, each supercapacitor battery and each battery. This allows for remote diagnostics of each of the serially connected photocells in the solar panel, each of the serially connected supercapacitor cells and each of the series of connected galvanic cells in the rechargeable battery. The received information is remotely transmitted to the laptop, processed and depending on the results of the diagnosis, control signals are generated to ensure the maximum efficiency of the system and its maximum efficiency and can be applied in the units of the armed forces, command posts, the rear units of the security, which will significantly increase their energy independence in field conditions and in military actions.

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TO EXTENSION OF TECHNICAL FITNESS AVIATION MEASURES OF IMPRESSION

The analysis of the design features, technical condition of the filling station and the results of research and work on the continuation of their resource indicators, the results of theoretical research, laboratory-bench research and testing, allows to identify a number of problematic issues regarding the serviceability of the filling station and to determine the prospects and feasibility of their further operation.

Aviation guided missiles (hereinafter referred to as AGM) of the air-to-air class R-27R (ER), P-27T (ET), P-73 (L, K), P-60 (M, MK).

Massive malfunction of P-73 type AGM is mass degradation of glued material, separation of jelly-like mass and detachment of the powder checker of gas generators 9-P-1028.

Given the similarity in the design and manufacture of AGMs on the technology of the 80's, it is likely to expect a similar malfunction in the AGMs

R-60, R-27 and corrected aircraft bombs throughout the nomenclature. The result of this malfunction is a reduction in guided flight.

However, the implementation of measures to eliminate the above-mentioned failure of the AGM and the positive results of the flight tests will allow to extend their assigned life to 30-35 years from the date of manufacture.

Air-Surface Class AGMs X-25, X-29, X-58U, X-59.

The experience of performing a complex of researches and works on the continuation of the established resource indicators of the X-25ML, X-29L, X-29T missiles and positive flight test results allow to predict their service life up to 30-35 years from the date of manufacture.

Aviation guided bombs (hereinafter referred to as AGB).

The main problem, in addition to the projected state of gas generators, is the large number of failures of their hardware parts, especially with the KAB-1500L-Pr, which caused the suspension of work to determine the possibility of extending the assigned life to 30 years.

Unguided rockets C-5, C-8, C-13, C-24B, C-25.

The experience of carrying out a complex of researches and works on the continuation of the set resource indicators of missiles of the C-8 type allows to predict the service life of these missiles up to 30 years, and when performing repair and restoration works and more. The main problematic issues for this class of URs are the gradual aging of the special chemistry materials, which results in a reduction in the total thrust of the engine thrust and the failure of the piezoelectric explosive devices of the URs combat.

HE aircraft bombs (hereinafter - HEAB) of general purpose of caliber of 1500, 500, 250 kg and fragmentation high-explosive aviation bombs (hereinafter - AFAB) of general purpose of caliber of 250, 100 kg.

Currently, the service life of nearly all aircraft bombs has been set at 35 years.

The simplicity of the construction and the high degree of hermetic housing, which prevents the physico-chemical changes of explosives, allows to predict their service life up to 40-45 years.

HEAB assault assignment of caliber 500, 250 kg.

Design features (the presence of a parachute brake, a built-in blasting device of a rather complex structure and the presence of pyro-automatics), the lack of design and technological documentation in Ukraine complicates the work on the continuation of their resource indicators. However, according to the results of the tests of some types of these bombs allowed for use in a special period, allow to predict their service life up to 30-35 years.

One time bomb cartridges (hereinafter referred to as RBC) and one time bomb connections (hereinafter referred to as RBC).

The main problem with the work on determining the continuation of their resource indicators is the presence of pyro-automatic in their design. At the same time, the experience of using them in ATO conditions has confirmed their high reliability and allows to predict their service life up to 30-35 years.

Aircraft cartridges for air guns of 23 and 30 mm caliber. and the blasters to them.

The main problematic issues for aviation cartridges and their blowers are the gradual aging of the special chemistry (powder) materials in their composition.

At the same time, the experience of performing a complex of researches and works on extension of the established resource indicators for aviation cartridges and their mines allows to predict the service life of these aviation cartridges and their miners up to 40-45 years.

Thus, it is advisable to perform maintenance and restoration of service station of the fleet by:

carrying out of researches and works on determination of possibility of continuation of resource indices (term of service, terms of storage);

development of repair of components, units and units of the gas station, the technical condition of which has reached the limit state.

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SELECTION OF AIRCRAFT RADIATION COMPLEX FOR A PERSPECTIVE TRAINING AIRPLANE

The onboard radar complex of the next generation of prospective combat aircraft (BRLB PNBL) should provide situational awareness of the crew when solving all tasks facing PNBL, that is, the BRLC should be multifunctional and multi-mode.

Multifunctionality implies the ability to inspect not only the airspace but also the terrestrial (water) surface.

Multi-mode is determined by the combination of modes used in the inspection of airspace and the earth's (water) surface. First of all, these include: options for reviewing areas of responsibility, modes of detection, recognition, support for single targets and multi-purpose support with ranking goals by importance, grouping goals by their tactical characteristics and a number of other features.

The BRLC is an integral part of the integrated avionics complex, which as a basic element includes a multispectral opto-electronic system, a state recognition system, radio-intelligence systems, electronic warfare and other systems.

Expanding the nomenclature of goals and providing the crew with relevant information requires an enhanced role for information exchange channels within the BRLC. The solution of the whole complex of information and management tasks actually transforms the BRLC into an intelligent system of automatic control of signal processing procedures.

The Ukrainian military-industrial complex of Ukraine currently has a number of initial developments that can be laid at the beginning of the development of the domestic aviation BRLC.

One of the possible variants of installation on the domestic PNBL is the aviation BRLC type "Esmeralda" of Ukrainian production.

Esmeralda-type BRLC is a multi-mode pulsed Doppler radar with a mechanical scanned flat antenna array (MESA), a solid-state power amplifier, adaptive signal processing and analysis, equipped with a backlight channel and radio correction 27 RAC. The radiation and indication characteristics are fully consistent with the RSLP of Su-27, Su-30, MiG-29 and MiG-29UB aircraft.

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IMPROVEMENT OF CHARACTERISTICS OF ARTILLERY SYSTEMS

Analysis of open sources of information showed that the following self-propelled guns (SPG) are armed with artillery units of the Ukrainian Armed Forces: 122mm SPG 2C1 “Gvozdika”, 152mm SPG 2C3 “Acacia”, 152mm SPG 2C5 “Giatsint-C”, 152mm SPG 2C19 “Msta-C”, 152mm SPG 2C7 “Pion”. The main SPGs are the 122mm 2C1 “Gvozdika” and the 152mm 2C3 “Acacia”. These SPGs were adopted in the early 1970s and have been in operation for over 40 years. Their tactical and technical characteristics, they are significantly inferior to self-propelled guns, which are in service with the leading countries of the world.

In order to improve the tactical and technical characteristics of domestic SPGs to the level of the best SPG models of the leading countries of the world, it is necessary to carry out activities, the main ones being modernization.

Modernization is a cheap and fast way to get improved tactical and technical characteristics of weapons samples or to acquire a product of fundamentally new qualities.

At present, the main directions of the modernization of the WG are:

improvement of maneuverability characteristics;

improving the accuracy of firing, firing rate;

improved performance;

ensuring adaptation of this combat system into a single management network.

One way to improve the accuracy of firing accuracy and firing rate is to use new propellant charges.

One of the most significant achievements of the leading countries in the field of artillery technology in recent years is the development of modular propellant charge (MPS).

Modular propellant charge (MPS) systems make it possible to automate the loading process of the gun, contributing to increasing the rate of fire, eliminating the presence of unused beams in the formation of reduced charges and simplifying production and logistics. MPS systems developed and adopted in many countries: the USA, Germany, France, South Africa, Great Britain, have close parameters. The MACS MPS system (USA) is presented as an example.

The MACS MPS system consists of a M231 module for forming the first to second zone charges and a M232 module for forming the third to fifth zone charges for 39 calibre systems and the third to sixth for 52 calibre. According to the tactical and technical task, the MACS MPS system should be optimized for the Crusader ACS (the development of which has been phased out due to the high cost of the project) to provide a range of 4-40 + km at a rate of fire of 10-12 rounds per minute and a standard deviation of the initial velocity of the projectile < 2 m/s, to replace the standard system from the four-type Agreement. In addition, MACS modules should be easily distinguished from each other both visually (by the color of the module) and to the touch in shape, and ignited from either end - to avoid the need to determine and set the correct orientation of the modules when charged with both manual and automatic. Experts note the following advantages of using the MACS MPS system compared to the regular NATO Modular charges :

17% reduction in cost of use;
40% reduction of occupied volume;
10% weight reduction;
33% increase in maximum range of fire;
120% increase in rate of fire;
Greater flexibility of application;
High utilization - no unused modules
Compatibility with traditional and laser ignition devices;
Ecological purity - the level of carcinogens is reduced, lead is absent.

The module M231 adopted on October 25, 1999, and deliveries to troops began in the second quarter of 2002. The module M232 adopted on August 8, 2001, and deliveries to troops began in the fourth quarter of 2003.

For use with MPS piston bolt guns are more suitable. The ignition of the metallic charge in such guns is due to the primer being installed in the shutter.

To use MPS on specific samples of artillery systems, such as the 122mm SPG 2C1 "Gvozdika" and the 152mm SPG 2C3 "Acacia", structural changes in the design of the gate or modification of the ignition charge of the propellant charge are required. The introduction of the MPS pallet with a capsule sleeve and axial ignition device will ensure the use on specific samples of artillery systems, such as SPG 2C1 "Gvozdika" and the 152mm SPG 2C3 "Acacia". Currently, the development of a promising MPS for domestic SPGs is relevant.

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THE ACTUAL ISSUES OF THE IMPLEMENTATION OF THE TECHNOLOGICAL OPERATION AND REPAIR OF THE ARMED FORCES AND MILITARY TECHNOLOGY OF THE AIR FORCE OF THE ARMED FORCES OF UKRAINE FOR THE STATE

At present, the basis of the technical equipment of the Air Forces of the Armed Forces of Ukraine is made up of weapons and military equipment (ATT) developed in the second half of the 20th century, are in service outside the established calendar (resource) indicators and are characterized by the absence, in the vast majority, of the author's support exploitation by the Producer and the Developer. They were developed for operation in the conditions of the existence of a single military-industrial complex of the Soviet Union provided that the Armed Forces is adequately financed. Thus, in the case of limited funding, the transfer of the weapons to a state of technical operation creates all the necessary preconditions for its intended use beyond the limits of the calendar and resource indicators established by the developer and the manufacturer (or increased by the operator) in order to ensure the necessary levels of HMV without performance of planned repairs. At the same time, individual calendars and resource indicators can be phased out, except for the established service life (resource)

The transfer of TBIs from a regulated strategy to a strategy for technical maintenance and repair by state requires the definition of the procedure for the release of TU specimens in average (major) repairs. The normative documents stipulate that the decision to carry out the repair of samples of vehicles during operation on a technical condition is taken on the basis of the results of monitoring their limit state, formulated general requirements for determining the frequency of the control of the boundary condition. At the same time, the order of release of samples of vehicles in average (capital) repair at intervals of time between the controls of the boundary state of the corresponding samples is not defined.

The main provisions of the procedure for planning the release of medium (capital) repairs of TBV samples at technical operation, which allow distributing weapons of the same type to two groups, are formulated. The first group includes samples of weapons that during the next year do not require medium (major) repairs. The second group includes samples of anti-personnel weapons, which during the next year require medium (major) repairs and is determined by the order of its conduct.

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APPROACHES TO IMPROVING THE FUNCTIONING OF THE STATE EXPORT CONTROL SYSTEM OF UKRAINE

Recently, the issue of improving the efficiency of improving the mechanisms of state export control over international movements and the use of technologies by individuals and legal entities that may affect the national security of Ukraine, in particular military technology, has become particularly relevant.

An important and very difficult task is to control the "intangible" - elusive technology transfer.

Elusive technology transfers are scientific conferences, meetings, discussions, exchanges, speeches, inspections, consultations, demonstrations, technical assistance, lectures, seminars, training, publications, technology transfer through electronic networks and more.

Elusive technology transfer is a form of technology transfer by which a certain part of technical knowledge and development is transmitted by means of modern communication in the form of information that is not physical, but subsequently helps to provide technical and informational assistance to the partner to create products that subject to export control.

For the Ukrainian export control system, the transfer of technology in an intangible manner is relevant and necessary. It is necessary to take drastic measures on this issue, because the lack of strict control over the transfer of information on military technologies is detrimental not only to the competitiveness of industry, but also to national security.

Particularly difficult task is the attribution (not attribution) to military products of the results of research and development work, which are intended for delivery to a foreign customer. In their execution, it is impossible to draw a clear line between scientific and technological, technological solutions, other intellectual activities that have a military purpose only and those that have a civilian (industrial) purpose but can be used (used) in the military sphere. The forms of intellectual output expected for export can be different: technical and technological documentation, reports on the results of research and development work, computer programs, technical data, databases, utility models, models, product samples, licenses on production of products and others.

In order to determine whether the results of research and development work are related to military goods, a comprehensive analysis is required with the participation of the relevant military authorities and specialized research institutions of the Ministry of Defense. Obligatory are the following areas of analysis of the availability of materials intended for export from Ukraine: information in the military-technical field or the results of intellectual activity related to military products; information constituting state secrets or official information (which is not openly disseminated); patentable technical solutions; excess information not provided for in the contract.

According to the results of the complex analysis, in case of attribution of the results of research and development works that are foreseen for delivery to a foreign customer, their export must be exported only within the framework of military-technical cooperation of Ukraine with foreign countries. Non-publicly available information and excess information should be excluded from materials provided to the foreign customer. All rights to patentable technical solutions must be pre-protected.

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APPROACHES FOR THE IMPLEMENTATION OF MILITARY AVIATION TRAINERS 'INTERACTIONS IN THE FRAMEWORK OF A SINGLE SYSTEM OF MODELING ON DREAMS ONTOLOGICAL TOGETHER

Simulation modeling as one of the areas in the field of systems analysis and computer mathematics has always maintained and continues to be the status of an effective toolkit for the study of complex systems, including high-tech military equipment, including aviation simulators.

Top-level international experts recognize the importance of communication capabilities of simulators to ensure high-level training, and emphasize the need for joint exercises involving different types of Armed Forces and international exercises.

Creation of such systems is faced with the decision of tasks of operational management of spatially-distributed structures (separate simulators, samples of OVT, units), as well as interaction of information processes within the framework of a single system of modeling (computational-modeling complex).

Simulation complexes and computer simulations of combat environment are combined with standard samples (complexes, systems) of weapons and military equipment (OVT) on the basis of globally distributed information and communication networks and high-performance computing complexes, providing qualitative training tasks of troops (forces) stationed in different geographical areas in the interest of increasing their level of combat and operational training.

Leading countries have long been working to create network-centric solutions that underpin an attempt to use ontologies, which are actually a tool for generating, managing, and displaying knowledge, by describing object semantics.

In particular, the effect can be achieved by applying a multidisciplinary approach, which provides a reliable and correct procedure for linking contexts of multifaceted multifaceted information resources.

However, there is no generalized solution to ensure effective integrated use of complex information systems (aviation simulators and aircraft of various types) and GIS-oriented application software with different attributes.

Integration of different network information resources into a single information space can be structurally carried out by implementing the principles of transdisciplinarity, which allows to consider all processes in the information space based on the category of multiple ordering of the states of interaction of the systems that make it up. In the case of creating a distributed network of training crews of aircraft (helicopters) under the transdisciplinary nature of the information environment, we will understand the multiple partial ordering of the sets of taxonomic and operational properties of ontological models of subject areas, reflecting the processes of functioning of individual training systems.

This approach of integration of polythematic information resources will allow to form a network of a single universal, orderly information environment by applying an ontological approach at the level of conceptual reflection of the interaction of network information processes and systems in different subject areas.

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PROBLEMS ISSUES FOR CERTIFICATION OF MILITARY AVIATION TRAINING COMPLEXES

The general trend of development of simulation is characterized by improvement of their characteristics due to the combination of modern imaging systems, modern mobility platforms, more sophisticated software and expansion of the range of simulated modes of operation, as well as ensuring the functioning of simulators in a single virtual space.

In Ukraine, there are no really valid regulatory documents that would define the modern criteria for the qualification of military aviation simulators and would be related to the certification support of activities of both manufacturers and users of simulators.

Thus, in the formulation of generalized tactical and technical requirements for military aviation simulators, in most cases, we have to use the normative and regulatory documents of the Soviet era, which today do not take into account modern scientific and technological achievements.

In these circumstances, there is a need to develop in Ukraine its own unified approaches to the formation of requirements for aviation simulators, as well as the criteria for evaluating military simulators and modern concepts of flight crew training, which will be based on international practices and standards, as well as take into account national peculiarities. It requires serious expert analysis, organization of the process of interaction between different interdepartmental profile structures, as well as concentration of financial and intellectual resources of developers.

On the other hand, direct borrowing from a foreign regulatory framework, such as STANAG standards, causes additional problems. In this case, even if manufacturers begin to produce products in accordance with these standards, the military consumer will need certified methods of checking it for compliance with modern advanced requirements.

International standard ICAO.9625 contains requirements for the technical characteristics of aviation simulators, and also standardizes all types of training.

An analysis of ICAO Doc.9625 as a normative framework for the criteria for evaluating flight training aids indicates that it can really be used to assess the flight capabilities of flight simulators, requirements for mathematical models of flight dynamics, and more. However, the mandatory military considerations of the factor of combat use of aviation remain unresolved.

The fundamental differences between military aviation simulators are related to the peculiarities of using navigation equipment, different weapons, maneuvering in combat conditions, and more. Talking about the initial training of the flight crew or the development of crew emergency response skills on military aviation simulators, this is a perfectly acceptable option. However, specialized training of military pilots is needed in the future, taking into account the specificity of refining the tactical tasks of a specific type of the Armed Forces.

Thus, the process associated with the creation of a modern regulatory framework for the procedures of requirements formation, qualification assessment and testing (certification) of advanced aviation simulators should be settled as soon as possible. Movement towards NATO integration requires compliance with the requirements imposed on NATO members and partners, including in the pilot training segments of advanced aviation flight simulators.

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TOPICAL ISSUES OF THE LOGISTICS SUPPORT OF UAV IN MODERN CONDITIONS

The experience of the operation of UAVs in the armies of the world shows that for example the analysis of accidents only in the USA Army 32 % of accidents are the results of human error and 45 % of accidents are the results of failures of technical means (either singly or in combination with other factors). Studies have shown that the reliability of system elements is becoming a greater threat to UAVs than is currently the case for conventional aircraft and require increased logistics support.

That is why it is necessary to understand the features of application and logistic support of unmanned aviation to ensure the functioning of the UAV in the airspace system. In this case, technical support as a component of logistic support is the activities which are performed on the land before and after the UAV flying for providing of successful and safely use of UAV. According to this general definition the UAVs logistic consists of storage, fueling, pre-flying check, repair and software update. In addition, the maintenance activities of UAVs also contain the use of

UAV transporter vehicle and UAV land control station. So the reliability of UAVs logistic system is essentially more important than in case of manned aerial vehicles.

The main features that need to be considered when organizing logistics support for UAV units are formulated:

assembling operations – tactical and operational UAVs, as a rule, is disassembled after the flying for transportation and storage, with the connection and disconnection of electrical systems that impose battery maintenance requirements and may increase the likelihood of damage and maintenance errors (batteries are the reason of a great number of failures of onboard and land elements of UAV system);

using information about modes and component failure rates, item tracking and flight times – in the absence of lifecycle information, information about the modes of failures of UAV components and its term of service or failure frequency and garbage cans, the maintenance program for reliability support can be created;

fuel blending – requirements of some types of UAV needs blending of fuel components with specialized dispensers before application.

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FEATURES OF DESIGN-DEVELOPMENT OF MODERN SECURE CLOTHING FOR MILITARY AVIATION PILOTS

Existing protective clothing for domestic production for the pilot does not meet the established lifetime for various reasons, does not provide adequate adequate protection of the military from the declared types of hazards, does not fully meet the specific level of requirements imposed on it, creates additional risk factors, does not always ensure the implementation of specific needs of the environment, and also has unjustified high cost.

Ergonomic imperfection of products for the protection of military personnel when carried by their service leads to physical overload due tolarge weight of clothing, complications and limitations of the typical movements of fighters, inconsistency of structural and technological solutions of products to the conditions of exploitation, and as a consequence, the imbalance of the thermal balance.

The urgency of the development of clothing for military aviation pilots has a great socioeconomic significance, which is conditioned by the need to ensure effective protection of the soldier in order to preserve his health and ability to work and properly fulfill his professional qualification duties. The work is aimed at increasing the effectiveness of the protection of servicemen, reducing their traumatism and death of fighters, forming a rational structure of the range of fire protective clothing for a given set of military accounting specialties with the introduction of modern information technologies, the creation and introduction of production of technologically rational and aesthetically ergonomic varieties of protective clothing, capable of providing the needs of the Armed Forces.

When designing modern effective protective clothing for fighters of various military-account specialties it is necessary to take into account the conditions of its operation and features of professional qualification activities, which include:

- the isolation and grouping of various types of protective clothing for pilots by different criteria;
- definition of common types of environmental hazards in the conditions of research of industrial and climatic conditions of the environment, their level of harmfulness and topography of influence on various segments of the pilot's clothing;
- identification of a certain number of sources of their occurrence and identification of the main risk factors for the use of protective clothing on the basis of hazard analysis;
- taking into account other items of military uniform, military equipment (oxygen masks, high-altitude compensating suits, hermetic suits, high-rise spacesuits, products for the protection of arms and legs, etc.);
- systematization of the information base of elements of existing protective clothing, their design and technological characteristics with the ability to forecast, expand the range.

The purpose of the project is to develop design ergonomic solutions for modern effective protective clothing of Ukrainian production for pilots serving under the influence of various types of danger, with specified requirements for operational reliability and ergonomics through the experimental selection of fire-resistant, heat-resistant materials and the formation of rational packet structures. To achieve the goal of the project, the following interconnected tasks should be solved:

- methodological approaches to solving problems of mathematical modeling and optimization of parameters, constructions and modes of use of protective kits for pilots are developed on the basis of a systematic approach;
- theoretical bases of definition of thermophysical characteristics of materials and packages of multilayer protective clothing have been developed; the physical model of the process of determining the thermal resistance of material packets is theoretically grounded in order to increase the accuracy of measurements;
- the methodological concept of risk assessment in the use of protective clothing has been developed on the basis of the study of statistical information on the causes of failure of products in order to provide the required level of safety of the serviceman;
- Theoretical substantiation and experimentally confirmed the formation of a rational structure of protective clothing packages for pilots from the influence of various types of hazards in order to predict the behavior of packages of protective

clothing materials;

- a zonal-modular model and discrete optimization method have been developed to substantiate the methods of increasing the effectiveness of protective clothing with predictable characteristics depending on the impact of various types of danger;

- rational structures of assortment series of protective clothing for military aviation personnel have been formed; constructive-technological solutions for products of various purposes, protective clothing elements have been developed; experimental samples of kits have been manufactured and introduced into industrial production.

Consequently, multifactorial and interdisciplinary development of the scientific foundations of designing protective clothing, a steady tendency for the emergence of new textile protective materials on the world market, modern technologies of making clothes exclude one-time decisions and exhaustiveness of the topic and provide for close fruitful cooperation between the authors of the team and specialists of other leading organizations and institutions.

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INCREASING THE EFFICIENCY OF PASSIVE INTERFERENCE COMPENSATION IN RADAR WITH EQUIVALENT INTERNAL COHERENCE

Radiotechnical troops of Air Forces of Ukraine are equipped by number of radars with equivalent internal coherence. Such type of radars are characterized by simple structure, high operational reliability, small mass-dimensional indices, and good mobility. The peculiarity of transmitting system of mentioned radars is the application of self-excited microwave oscillators (magnetrons for example) which have insufficient stability of sounding signal (SS) carrier frequency.

The low stability of the sounding signal carrier frequency is a dominant factor, which leads to a decreasing the protection of the radar from passive interferences (passive interference suppression ratio practically does not exceed 15...20 dB). Switching to the digital signal processing system will not improve the quality of the passive interference compensation, since the decorrelation effect of the frequency instability of the microwave generator is not eliminating. Reducing the influence of the sounding signal carrier frequency instability on the efficiency of moving-target indication system (MTIS) can be achieved by correction of received signals` spectra $S_i(f)$, ..., $S_k(f)$ for each period of pulse sounding. For this purpose special correction filters are applied in radar reception path. Their frequency characteristics $K_i(f)$, ..., $K_k(f)$ must provide qualitative (ideally – precise) matching of products

$K_i(f) \cdot S_i(f)$, ..., $K_k(f) \cdot S_k(f)$ for passive interferences in each sounding periods that are jointly processed in the MTIS. The peculiarity of the correction filters using is that their application results in the transformation of carrier frequency instability to the amplitude fluctuations of the received signals at the output of the filter.

Retuning of correction filter frequency characteristic is carried out in accordance with measured value of SS carrier frequency instability. Thus the value of signal amplitude fluctuations at the filter output is uniquely associated with the value of SS carrier frequency instability which makes it possible to take into account the change of received signals` amplitude in further processing by means of normalizing device.

The results of calculations concerning the use of correction filters indicate that the correction of the spectra of received signals can significantly increase the efficiency of the MTIS. When using typical SS with a rectangular shape of the amplitude envelope and a mean square deviation of the SS carrier frequency at 10 ... 20% relative to the width of the signal spectrum, the sub-interference visibility ratio for MTIS can theoretically be increased by 8...11 dB.

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INFORMATION TECHNOLOGY DEVELOPMENT APPROACH FOR THE AUDIO INTERFACES CONSTRUCTION FOR THE INTERACTION BETWEEN OPERATORS AND AUTOMATION TOOLS COMPLEX (ATC) ACS OF THE AVIATION AND AIR DEFENCE

With the goal of the maximum possible contradictory requirements for the special software (SS) of the ACS and for automated control systems in general, suggested to move away from the traditional architectural styles and approaches and take into account the following modern trends and perspectives of information technologies (IT) and open (service oriented) architecture:

1. The transition from classical computing to alternative possibilities of organization of computing process.
2. Using of the active object technology.
3. Focus on priority modes, not the algorithm.
4. Implementation of natural parallelism for calculations.
5. Productivity and self-organization of calculations.

All of these trends allow to migrate to application software systems which will be based on the model primary level (instead of algorithm), multi-agency and non-deterministic parallel computing process.

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TO EVALUATION ADHESIVE POWER OF THE CONTACT OF POLYMERIC COMPOUND-FIBER IN HIGH-SPEED COMPOSITES FOR AVIATING EQUIPMENT PARTS

The promise of the use of polymer composites in aircraft construction, namely, in the designs of the body, the wings, the horizontal and vertical plumes, the various roughnesses, is quite obvious. A large amount of relevant information is well-publicized. However, there is another promising direction in the use of polymer composites in aviation engineering, in which open publications are extremely limited. This is the application of fibrous composites on polymeric bonds in elements of the design of aviation gas turbine engines.

It is known that every kilogram of compressor weight savings provides a 3.75 kg reduction in engine weight, resulting in a whole range of positive effects, up to reduce the load on the wing and its connection to the housing. Therefore, the creation of high-strength polymer composites, allowing reducing the mass of individual parts by 20–50 % is an actual and important task.

Polymer composites, reinforced with fibers, are characterized by the highest strength and rigidity. Their properties essentially depend not only on the properties of the fiber filler and the matrix, but also on the interaction between the components, first of all, on the adhesion strength at the interface, as the strength of the coupling determines the efficiency of the transfer of stress between the bond and the fiber. Therefore, for the directed regulation of the properties of composites, it is necessary to know the adhesion of binding to the fillers and the patterns of its change under the influence of various factors.

The processes occurring on the surface are largely determined by its state. Therefore, in order to judge how adhesion affects the physical and mechanical characteristics of the reinforced material, it is necessary to investigate the adhesion of the real binding to the real fillers, that is to the fibers that are directly used in the manufacture of reinforced plastics, with the geometric and energy state of the surface, which they have in the material.

In most cases, the adhesive ability of rigid polymers is estimated by their adhesion strength. Determination of adhesion strength is carried out mainly on macroscopic samples. In this case, flat surfaces are glued, and the gluing area is tens and hundreds of square millimeters. However, it is well known that the strength value depends on the size of the samples. Moreover, there is no reason to expect that the laws of the change in adhesion strength, established on flat surfaces, will apply to cylindrical surfaces with a diameter of 10–100 microns (this is usually the diameter of the fibers used in the production of composites). It should also be noted that for most high-strength fibrous reinforcing fillers currently used (carbon, boron, organic, carbide-silicic), it is not possible to prepare bulk samples (in the form of plates, prisms, etc.) with a surface identical to the surface of fibers Therefore, the determination of adhesion strength directly in the fiber matrix system is the only way to assess the strength of adhesion with these fillers. The fiber, together with the surrounding layer of the binder, is an elementary cell of any fibrous composite. Therefore, in order to get as close as possible to the conditions existing in the system of reinforcement, one should study the adhesion strength in such an elementary cell, that is, in the polymer-fiber system.

In the study of adhesion on macroscopic level, the quantitative measure of the adhesion of the adhesive to the substrate in the case when the contacting substances are in a solid or highly elastic state, is the adhesion strength or specific work of adhesion. In the first case, adhesion is estimated by the stress required for the separation of components, in the second case, it is evaluated by the work required to separate (detach) the adhesive from the substrate.

To obtain the correct value of adhesion strength, it is necessary that: 1) the intersection of the fiber was round; 2) the diameter of the fiber submerged in the matrix is constant; 3) the fiber was uniformly covered (without violation of integrity) by a polymer; 4) the visible and actual area of contact of the fiber and the polymer were the same; 5) tangential stresses on the boundary between the binder and the fiber were distributed evenly.

In the Institute of National Academy of Sciences of Ukraine, prospective binders have been developed for the creation of high-strength fibrous composites based on epoxy polymers modified by complex metal compounds capable of adaptive behavior in response to sign-exchange loads.

The experimental method of determining the adhesion strength of the mentioned new binders with respect to different types of reinforcing fibrous fillers has been developed.

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METHOD OF MANAGEMENT OF RADIO FREQUENCY RESOURCES OF SAFETY AVIATION COMPLEXES

Continuous improvement of the devices of radio-electronic intelligence and radio-electronic suppression (RES) has led in recent years to increase the likelihood of suppression of channels of control and data transmission unmanned aerial systems (UAS). The analysis of the tactical and technical complexes of the RES of the technically developed countries shows that the most effective channels for control and transmission of data UAS are intentional frequency-manipulated noise disturbances in the part of the band, polyharmonic and imitation. In this case, the strategies for setting deliberate interruptions are dynamic or static. The existing scientific-methodical apparatus for managing the radio frequency resource does not sufficiently take into account the strategies of the RES complexes. It is proposed to develop a method for managing the radio frequency resource of the UAS.

The main stages of the implementation of the methodology:

1. Entering the initial data. The parameters of transceivers UAS are entered, as well as the values of the minimum required transmission speed and the probability of a bit error.

2. Assessment of the radio electronic environment (REE). With the help of estimation methods, the type of deliberate noise, the zone of continuous electronic suppression and the parameters of interference complexes are estimated.

3. Determination of the strategy of the RES complexes. At this stage the strategy of the RES complexes is determined. The strategies of the REP complexes used in the developed methodology are dynamic and unchanged during the transmission of the message in the channels of the UAS.

4. Formation of the working frequency network of the UAS transceiver. After analyzing and calculating the strategies of the RES complexes, determining the areas of continuous electronic wave suppression, determining the type and capacity of the deliberate disturbance of the formed network of workers for the transmission of messages.

The novelty of the developed technique from the known is that the developed method implements the management of the radio frequency resource taking into account the strategy of the RES complexes, the type and duration of intentional noise of the chosen optimization criterion, as well as the choice of weight coefficients taking into account the degree of suppression of frequencies. The use of game theory methods allows us to formulate the optimal control of the radio frequency resource of control channels and transmission of UAS data under various strategies for interference with the RES complexes. The use of the developed method allows to increase the noise immunity of UAS channels in the conditions of active RES by 15-25% in comparison with the existing scientific-methodical apparatus.

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MEASURES OF SCIENTIFIC AND TECHNICAL SUPPORT OF WORKS ON THE CONTINUATION OF AIRCRAFT AMOUNT RESOURCES

At present, the 23 mm and 30 mm caliber cartridges intended for aviation guns of the Armed Forces of Ukraine are 1985-1990 years of manufacture. The assigned service life of these aviation cartridges is almost exhausted. There is an urgent need to carry out work to extend the specified service life of the specified caliber aircraft cartridges.

The following measures must be taken when carrying out work to extend the designated service life of an aircraft patron:

to evaluate the technical condition of aviation cartridges at their places of operation and storage;

carry out necessary researches and tests of aviation cartridges and their components, including:

to evaluate the technical condition of aviation cartridges and the tightness of their closure;

disassemble aircraft cartridges and evaluate the technical condition of their components;

test the safety and integrity of aircraft cartridges when they fall from a height of five meters;

carry out transportability tests;

carry out physical-chemical studies of the powder charge;

carry out tests to maintain the ballistic characteristics of aircraft cartridges after firing a ballistic barrel;

to predict the technical condition of aviation cartridges for the duration of their assigned service life;

to carry out accelerated climatic tests;

to carry out physical and chemical studies of the powder charge after accelerated climatic tests;

to conduct safety assessment of aviation cartridges during the conduct of flight test;

to carry out the analysis and scientific and technical expertise of the results of research and testing.

The full implementation of these measures allows to extend the assigned service life of aircraft cartridges of 23 mm and 30 mm for periods of 1 to 10 years or more. At the same time, the issue of organizing the production of aviation cartridges by domestic enterprises of the defense-industrial complex of Ukraine is extremely urgent.

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MAIN TRENDS AND DEVELOPMENT DIRECTIONS FREE AIRCRAFT COMPLEXES IN THE CIVILIAN AND MILITARY SPHERES

The conduct of local wars in the world over the last decade has shown that autonomous and / or remote-controlled robotic systems will operate directly at the forefront of hostilities in the near future. And if for land and sea operations it is now limited to research and experimental development, then in the air, aviation of the leading countries in the world, militarily, uses serial samples of unmanned aerial vehicles (UAVs).

According to research published in the US weekly Aviation Week & Space Technology, the global market for UAV development and production in the next decade will be about $ 30.0 billion.

There are approximately 5,000 unmanned aerial, tactical, operational, and strategic unmanned aerial vehicles in the leading countries of the world.

With the development of technologies and microelectronics, UAVs are of great interest not only in the military sphere, but also in industrial enterprises for solving the tasks of these enterprises directly.

To date, UAVs can be used for the following purposes:

for commercial purposes - monitoring of objects of industrial infrastructure, agricultural and forest lands, spraying of chemical reagents in agriculture, geophysical aerial photography, aerial photography and video, aerial mapping;

for entertaining purposes - photo and film shooting, aviation model, sports and entertaining aviation shows with the use of UAV;

for research purposes - monitoring of climate and atmosphere, state of natural landscapes and vegetation, monitoring of glaciers, snow and ice caps of mountain ranges, exploration of the oceans, including observations of marine mammals;

to ensure the protection of critical infrastructure and public safety during public events.

The main tendencies and directions of development of military UAV:

increase of efficiency of application of shock UAVs of different classes and means of defeat to them;

increase in flight duration (in particular due to the use of power plants on heavy fuel, liquefied hydrogen, the use of solar panels and more);

application of stealth technology for the production of gliders and other elements of UAV structures;

improvement of control and data transmission channels for effective protection against the effects of electronic counteracting;

introduction of artificial intelligence elements into UAV management systems to minimize operator involvement in the management and decision-making process, or to enable UAV to operate offline;

expanding the range of intelligence tools, including the use of multispectral cameras, electronic reconnaissance facilities, radar stations for mapping terrain.

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ON METHODICAL AND RESOURCE SUPPORT OF FUTHER PARTICIPATION OF UKRAINE IN THE OPEN SKIES TREATY

On March 24, 1992, 25 European countries, the United States and Canada jointly signed the Open Skies Treaty (OST). Its main objective is to monitor the implementation by the Organization of Security and Cooperation in Europe (OSCE) states of their obligations regarding openness and transparency in military activities. Under the Treaty, each state - its participants are granted the right to conduct observation flights on specially equipped aircraft over the territories of other member states. Information obtained during such observation missions is used by the participating States to assess the state of fulfillment of mutual obligations in the field of arms control, the scope of military activities, etc.

The OST came into force on January 1, 2002, and Ukraine is a party to it. For observation flights, Ukraine has two An-30B aircraft, equipped with АФА-41/7.5 and АФА-41/20 photocameras. Unfortunately, both aircrafts have rather long operating period, and airborne survey equipment, including photocameras is obsolete. The problem is to use photographic film as recording media, since all its traditional manufacturers in the USA, Russia, Ukraine and other countries practically stopped producing as it and as chemical reagents for laboratory processing of photo-materials.

Hence, it is obvious that the Ukrainian OST observation system requires urgent and deep modernization. The first attempt to do this was undertaken back in 2000, when the President of Ukraine by Decree No. 1097/2000 approved the State Program for the Implementation of the Open Skies Treaty, according to which it was planned to equip Ukrainian observation aircraft with OST with new electro-optical and radar systems. But this Program has not been implemented. In August 2013, the Cabinet of Ministers of Ukraine, by resolution No. 867, approved a new State Targeted Program for the Implementation of the Open Skies Treaty, but the issue of its implementation has not been solved again.

Meanwhile, in recent years, the countries participating in the OST, primarily the Russian Federation, the USA, Germany, Turkey, Romania and Poland, have been working at a high pace either to modernize their OST observation systems or to create new ones. The analog observation cameras are replacing by digital ones, the processing of observation data is being computerized maximal.

The problem to modernize the OST observation system is also relevant for our country too, since not only the further successful participation of Ukraine in the OST, but our military security depend on its solution. The report highlited issues of resource and technological support of the modernization of the Ukrainian OST observation system.

Basically there are two approaches to modernization. In the frame of the first approach a new aircraft with a full set of digital sensors allowed by the OST is considered. The second approach is only the replacement of АФА-41 photocameras with electro-optical digital sensors without the replacement of An-30B aircraft.

The analysis carried out by the authors showed that the most prospective for Ukraine would be either the An-74TK-200 or An-74TK-300 aircraft. Some advantages of the An-74TK-300 one are the greater practical range and lower fuel consumption. Both aircrafts have a sufficient cargo and work compartments, a considerable load-carrying capacity, and a relatively small cost. The key issue is the justification of the tactical and technical characteristics of digital sensors.

At the same time, the following parameters are controlled by the Agreement:

• the minimum flight height at which the spatial resolution of the sensor on the ground reaches the limit specified in the OST for given type of equipment;

• The width of the observed area can not exceed 50 kilometers of each side of the flight path of the aircraft.

According to the OST, the spatial resolution of sensors with a working spectral range of 0.4-1.2 μm can not exceed 0.3 m, and for sensors with a spectral range of 8-14 μm can not exceed 0.5 m.

The report presents methods for evaluating the tactical and technical characteristics of sensors with a working spectral ranges of 0.4-1.2 and 8-14 μm and the results of their experimental verification.

This research was conducted within the framework of the Scientific and Technical Program of the National Academy of Sciences of Ukraine "Research and development on the issues of improving the state defense and security of the state" (Decree of the Presidium of the National Academy of Sciences of Ukraine of February 25, 2015, No. 51 and of November 9, 2016, No. 235).

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IMPROVING OPERATIONAL PROPERTIES AND MANAGING THE RESOURCE INDICATORS OF AVIATION TECHNIQUE DETAILS BY USING PROGRESSIVE SURFACE STRENGTHENING METHODS

One of the main problems that now face the domestic military-industrial complex is to maintain an established level of serviceability and combat readiness of the existing fleet of combat aircraft, increasing its reliability and durability while reducing repair time. This problem is solved in a number of areas, one of which is the widespread use of perspective technological methods of surface hardening of aircraft structural elements, which allows to manage their resource indicators and simultaneously improve the number of operational properties of hardened parts of aircraft, for example, wear and corrosion resistance.

There was held a study of the tribotechnical properties (wear rate and friction coefficient), corrosion resistance and one of the indicators of durability – the average technical resource – samples of steel 20Х13, 30ХГСА, 30ХГСН2А, 38Х2МЮА, 18Х2Н4ВА (which are widely used in aircraft industry) strengthened using one of the progressive energy-saving technologies – pulsed gas-thermocyclic ion nitriding (GTC IN). Studies have established that due to the use of a pulsed GTC IN, the wear resistance of aircraft structural elements depending on the material can increase by a factor 1,5 ... 2,1, the average technical resource – by a factor 1,7 ... 2,1, corrosion resistance – by a factor 1,6 ... 3,1 compared with similar properties of these parts processed according to traditional technology.

Consequently, the proposed technology of a pulsed GTC IN is advisable to use at aviation enterprises for multifunctional modification of a wide range of steel structural elements of aircraft during their production and restoration, which will provide a comprehensive improvement in the operational properties of hardened parts and, accordingly, increase their service life while reducing maintenance and repair costs.

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IMPLEMENTATION OF THE SAFETY TAKE OFF OF TACTICAL AVIATION AIRCRAFT FROM THE DAMAGED RUNWAYS

An analysis of military and political developments in the world shows that modern hostilities typically begin with missile strikes at state and military sites, including military airfields. The massive impact on a military aerodrome implies the destruction of runways and other objects, making it impossible to use aircraft and safely evacuate aircraft from a damaged aerodrome.

The damage to military airfield facilities cannot be predicted. There may be considerable damage that would prevent any evacuation of surviving aviation equipment. However, the destruction of runways after a massive air strike leaves, as a rule, the presence of centers of destruction of the runway and certain parts of its undeveloped areas. Therefore, these non-destructive runway sections can be considered as being further used as short runway aircraft by means of additional technical means.

The analysis of possible ways of realization of reduction of takeoff distances for planes of tactical aviation involves the use at takeoff of powder accelerators, catapults, jumps and so on.

One of the possible ways of realizing the short takeoff of tactical aviation aircraft is to use from the above-mentioned undamaged sections of the runway a universal mobile easy-to-dismount jump (UMLT), which can be transferred to aviation units on a full-time basis, or be landed, if necessary, by air, or relocated.

The presence of basic flight and tactical characteristics of tactical aviation aircraft makes it possible to calculate and select in advance the parameters of the intact runway and UMLT section in order to take off the runway airplanes partially damaged by the enemy. In order to solve this scientific problem in the future it is envisaged to carry out a complex of studies on a deeper study of problematic issues, features of the technical implementation of safe takeoff from restricted areas of the runway, the development of appropriate scientific and methodological apparatus, numerical calculations, their generalization of requirements for technical means of implementation from damaged runways.

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METHOD OF MULTICRITERIAL EVALUATION OF THE STATE OF THE CHANNELS UNMANNED AVIATION COMPLEXES

The issue of increasing the efficiency of channels of unmanned aviation complexes (UAC) special purpose operating in a complex electronic environment is an actual and not solved in full problem.

One of the possible ways to increase the efficiency of control channels and data transmission channels of special purpose UAC is to increase the accuracy and speed of their assessment in a dynamic signaling and interference situation.

In this work, an analysis of existing methods for evaluating the state of channels of UAC has been carried out, it has been found that existing methods do not allow to carry out a multicriteria assessment of their quality with an acceptable computational complexity and reliability of decision-making. The method of multicriteria estimation of the quality of channels of unmanned aviation complexes of special purpose operating in a complex electronic environment is carried out.

The report proposes to use a fuzzy logic device to conduct multicriterial assessment of the quality of unmanned aerial com-plex channels on the effects of deliberate interruptions and silence of the signal.

The essence of the proposed method is to assess the state of channels of unmanned aviation complexes of a special purpose for each of the indicators of evaluation, after which a generalized assessment of the state of the communication channel is formed. Also, in the proposed method, the correction of the weight of expert rules is made, which allows to increase the speed and quality of the evaluation of the state of the UAC channels in a dynamic signaling and interference situation. The obtained results should be used in promising UAC with programmable architecture, in order to increase the speed and accuracy of their evaluation.

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THE PROTOTYPE OF DIGITAL ADAPTIVE SYSTEM OF RADARS PROTECTION AGAINST MASKING CLUTTER BASED ON ADAPTIVE LATTICE FILTER

Masking clutter refers to radar echo signals reflected from the interfering sources: ground and sea surface, local objects, hydrometeors (fog, rain clouds or thunderstorm clouds, rain, snow, hail), and artificial dipoles (chaff).

Traditionally, among the differences between useful signals and clutter, the most important role is played by the difference between the radial velocities of movement of targets and clutter sources. It determines the difference in the shape and location, on the frequency axis of the Doppler spectra of inter-period fluctuations signals and masking clutter from the sources extended in range and azimuth. This difference makes it possible to realize non-trajectory moving-target indication against the background of masking sources at the stage of primary inter-period processing (IPP) of signals.

The prototype of digital adaptive system radars protection against masking clutter is created on the basis of a serial adaptive lattice filter (ALF) implemented at evaluation board MDSEVM6678L with a high-performance chip of an octa-core digital signal processor (DSP) TMS320C6678. Each of 8 DSP cores operates at 1 GHz clock frequency and provides for each core up to 44.8 GMAC and up to 22.4 GFLOP of fixed-point and floating point operations respectively.

The ALF form the functions of matrices being inverse to the covariance matrices required for signal processing tasks without direct calculating these matrices and provides a number of advantages compared to the known adaptive filters of a various structure, in particular:

- ease of use of possible a priori information about the specific structure of regimes of sounding to increase the efficiency (productivity) of adaptive signal processing against the background of clutter with a stationary range substantially limited in range and azimuth;
- increased stability to a bit-width finiteness;
- the special structure of the ALF and the highly efficient algorithms for estimating its parameters bring the quality criteria at protection against clutter on their basis closer to the potentially possible for training sample volumes, which are much less than the existing systems of similar purpose.

Preliminary tests of the prototype were carried out, which confirmed the compliance of its technical parameters with the requirements to the Terms of

Reference on the results of processing digital records of simulated and real signals and interferences, as well as a its efficiency compared to efficiency of non-adaptive systems of protection against interference of existing radars.

This analysis showed that the adaptive system of inter-period processing signals based on the ALF provides gains in the efficiency of radar protection against clutter compared to non-adaptive regular radar systems.

For instance, in a widely used X-band radar, the ALF-based system of interperiod signal processing against the background clutter under conditions of real reflections from the Earth surface and hydrometeors has increased the true detection probability from 0.25 to 0.8 (with equal false alarm probability). In the C-band radar, in conditions of strong clutter a regular radar systems has not detected about 30% marks from a target with specified trajectory of motion, the prototype has provided its practically "failure-free" tracking.

This allows hoping that the implementation of the proposed technology in air surveillance radars will essentially enhance their interference immunity and quality of detection of aerial targets including unmanned aircraft (UMAC) (drones, quadcopters, etc.). Due to early and qualitative detection of aircraft (airplanes, helicopters, cruise missiles, UMAC), the probability of the national strategic objects protection and saving lives of servicemen and civil people will increase. One should also hope on the competitiveness increasing of such radars at the world market, and on image enhancement of Ukraine as a state with a high scientific-technological and organizational-production potential.

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THE ANALYSIS OF THE STRUCTURE OF TYPICAL TRACKING SYSTEM WITH DIGITAL PROCESSING OF ERROR SIGNAL USED IN THE TRACKING RADAR OF ANTIAIRCRAFT MISSILE ARMAMENT

The destruction of air targets by antiaircraft missile armament means is possible only at their tracking on angular coordinates, range and radial velocity by tracking radar of antiaircraft missile armament. Measurement of these four coordinates is based on the properties of radio signal propagation. All tracking system of tracking radar of antiaircraft missile armament are built according to the feed-back principle but depending on the type of radio signal and its measurand parameter the tracking systems have a different functional structure. This structure also corresponds to the model of target moving which is used at the creation of the tracking system.

According to the theory of optimal filtering the accuracy of the estimation of target coordinates is better if the model of target moving is more adequate to its real moving. The foundation to the creation of the model of target moving is the second Newton's law and the kinematic equations which connect the acceleration and radial velocity vectors with target position. As the calculation of the resultant force which acts to the target is too difficult task the model of target moving is created based on the stochastic model of target acceleration in the majority of practical cases. The stochastic model of target acceleration must correspond to the features of the acceleration change with time.

The analysis of the typical tracking system of tracking radar of antiaircraft missile armament with digital processing of error signal is performed. It shows that the range tracking system, radial velocity tracking system and angular coordinates tracking system have the similar structure. The leading place of digital filter in the performance of defined model of target movement by tracking system are based. The state matrix equations for different model of target movement are obtained based on the estimation and extrapolation algorithms used in the typical tracking system of tracking radar of antiaircraft missile armament. It shows that the model of exponential correlated acceleration is the most advisable at the creation of the tracking system of tracking radar of antiaircraft missile armament.

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REALIZATION OF THE PERSPECTIVE DIRECTIONS OF DEVELOPMENT OF ARMS AND MILITARY EQUIPMENT OF RADIO ENGINEERING TROOPS OF AIR FORCES OF THE ARMED FORCES OF UKRAINE WHEN PERFORMING DEVELOPMENTAL WORKS

The purpose of development of arms and military equipment of radio engineering troops is ensuring its functioning in modern conditions by development (modernization) and purchase of new radar stations which have high rates of quality of identification, accuracy, reliability, maneuverability, security from hindrances, antiradar and self-guided missiles.

The main directions of development of arms and military equipment of radio engineering troops are:

- process automation of collecting and processing of radar information (RLI), received in different departments;
- creation of the automated radar-tracking system of collecting and processing of RLI;
- deep modernization of restoration of a resource and improvement of tactical technical characteristics of the existing means of a radar-location;

- updating of the park of the existing means of a radar-location by an intensification of purchase of new means of a radar-location;
- substantial increase of mobility of radio engineering troops;
- creation of the automated small-sized means of a radar-location.

For the purpose of development of arms and military equipment of radio engineering troops of Air forces of the Armed Forces of Ukraine by the enterprises of defense industry complex of Ukraine a number of developmental works on development (modernization) of samples of radio engineering means is performed, scientific and technical escort of whom is carried out by Central Research and Development Institute of arms and military equipment of the Armed Forces of Ukraine.

So, for example, at the Spark enterprise "NPK "Iskra" (Zaporizhia) performance developmental work on creation of radar station on a tower with automatic remote control is begun. It is expected that acceptance by the specified radar station on arms will provide continuous conducting radar investigation along frontier and around zones with a particular treatment in the lower tier of the radar field of the radio engineering troops of Air forces of the Armed Forces of Ukraine radar-tracking system of Ukraine, will allow to carry out the network principle of creation of radar station with realization of the modes of a multiposition location.

Also the enterprises of defense industry complex of Ukraine perform works on modernization of the existing radar station park. Performance by limited liability company "XIM-TEK" of developmental work on modernization of P-18 radar Station for current assets of the enterprise can be an example. Acceptance of a sample on arms will allow to accelerate deliveries to divisions of radio engineering troops of radar station of the next P-18 mode with the improved tactical and technical and operational characteristics.

Performance of developmental works on the perspective directions of development of radio engineering means of radio engineering troops, scientific and technical escort of whom it is assigned to CRI AME CF Ukraine, will allow to carry out the remote operated monitoring of airspace and to increase the quality of radar information received by radio engineering divisions of Air forces of the Armed Forces of Ukraine.

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THE ANALYSIS OF OPERATION OF THE NEW SAMPLES OF ARMS AND MILITARY EQUIPMENT OF THE NOMENCLATURE OF RADIO ENGINEERING TROOPS OF AIR FORCES OF THE ARMED FORCES OF UKRAINE TAKEN ADVANTAGE

The analysis of operation of the new and upgraded radio-electronic equipment (REE) of radio engineering troops showed that all samples on the tactical technical characteristics (TTC) correspond official to given and have higher reliability of work.

However at operation there are problems on electromagnetic compatibility with other samples REE. So, for radar stations of meter wave band "Malachite", 5N84AMA and P-18MA it is necessary to provide territorially time-and-frequency a rating with work of radar station of the old park P-18 and 5N84A. For radar station 35D6M the system of protection against the nonsynchronous pulse hindrances created by radar station 19Sh6, P-37 and the mobile radio altimeter needs improvement PRV 13.

For the purpose of scientific and technical justification and formulation of suggestions for improvement of operational properties of the new (modernized) samples of arms and military equipment the technique of justification of the improved operational characteristics of the new (modernized) samples AME was improved.

For results of work evidence-based methodical recommendations about implementation of the constant analysis of results of operation of the new samples AME taken advantage a number of suggestions for improvement of operational properties of the new (modernized) samples AME and the offer on modification in design documentation and determination of volumes completion of new samples AME is developed.

Introduction of suggestions for improvement of operational properties of new samples of the nomenclature of radio engineering troops of Air Forces of the Armed Forces of Ukraine will allow to support the necessary level of combat readiness, improvement of tactical technical characteristics of the new (modernized) samples AME.

Results of work will be used by developers and the manufacturing enterprises at modification in design documentation, determination of volumes completion of new samples of arms and military equipment of the nomenclature of Air Forces of the Armed Forces of Ukraine and specialists of research establishments when forming tactical specifications on development new and modernizations of outdated AME. The advanced technique of justification of the improved operational characteristics of new (modernizovany) samples AME of the nomenclature of radio engineering troops of Air Forces of the Armed Forces of Ukraine is given in the report.

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CHOOSING A TRAINING PLANE

Job pilot begins with the first flight on the training plane. What this aircraft will depend on is the whole process of flight training. Many years of experience in training cadets allow forming certain requirements for a “flying desk”.

First of all, the principle of "form of simple to complex," ease of management, sufficient stability in flight, tangible efforts on the control levers, reliability and ease of operation. In addition, training plane should be securely protected from entering hazardous flight modes, easy to get out of the dumps and corkscrews, "forgive" the cadet for gross errors, and have suitable flight specifications.

Subsequently, these requirements became quantitative in the form of norms by which designers build concrete designs. One of the first training plane was the U-2 (Po-2), and later Yakovlev built a whole line of aircraft with piston engines. During the transition of combat aircraft to jet propulsion, training plane also became reactive. However, it was later estimated that the training of pilots on jet aircraft was several times more expensive than on the piston, and they began to resuscitate.

At the beginning of 2018, there were 2364 turbo-propelled or piston-powered aircraft in service worldwide.

The cost of such an aircraft depends on its characteristics, on-board equipment and ground handling facilities. The most famous training planes are the Swiss PC-21 Pilatus, the Austrian DART-450 and a whole line of American light aircraft. Serial Pilatus has a powerful power plant (1600 hp) and is distinguished not only by a glider of high quality, but also by a variety of electronic equipment.

The Austrian DART-450 turboprop aircraft may be of interest to Ukraine in that it has a Ukrainian AI-450C engine installed. Catalogue price DART-450 $ 3 million The stated cost of the flight time is no more than $ 500. These circumstances may be decisive for the purchase of a foreign sample.

It is advisable to start the production of UTL in Ukraine by determining their need for aviation of the Armed Forces of Ukraine and the option of purchase (through procurement or own construction). This will justify the required tactical specifications and the amount of funding.

Now aviation enterprises of Ukraine created significant material base for the production of unmanned technology. In the near future it can be used for the development of training plane.

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CALCULATION OF THE ANGLE RANGE AND SPEED MEETING OF A HANDLING BACKGROUND TO MAKE A BLASTING DEVICE

The experience of practical application of unguided aircraft missiles type C-5, C-8 is not registered significant amount breaks missiles especially when dealing with dirt surface at large angles to the normal.

Therefore, the development of new NAR, among others, imposed requirements for reliable operation subversive device in a wide range of angles meetings missiles from surface (goal) (0 ° ... 80 ° to the normal).

In order to ensure reliable detonation of the missile in a wide range of angles with the surface, in addition to the contact blasting device provides a safety actuator principle of action which is built on the movement of the inertial mechanism under the influence of overload, namely cocked at the start; firing when a rocket hits the surface.

At the same time, during the testing of products, complications arise from the reproduction of the conditions of checking the operation of the safety actuator at significant angles (60 °… 80 °) to the normal meeting of the missile with the target.

Under such conditions, during the acceptance tests of the unguided aircraft missiles there is an urgent task of mathematical modeling of the process of the operation of the safety actuator under different conditions of meeting the unguided aircraft missiles with the surface to assess its compliance with the set requirements.

Mathematical modeling of processes functioning under different conditions safety actuator meeting of unguided aircraft missiles surface allows for assessment of uncontrollable parameters during acceptance testing specified aircraft weapons.

Next, the report proposes a methodical approach and presents the results of a numerical experiment to calculate and confirm the parameters of the functioning of the safety-actuating mechanism for reliable detonation of the warhead under various conditions of encountering an unmanaged aircraft rocket with the surface.

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DESIGNING PROSPECTIVE AIR DEFENSE SYSTEM AND MANAGING ITS LIFECYCLE

Ukraine is currently adopting national regulations harmonized with NATO and international standards. The issues of developing and implementing state-of-the art armament life-cycle management mechanisms in Ukraine and achieving technical interoperability of the Armed Forces of Ukraine with the armed forces of NATO member states and partners at all stages of the life cycle of weapons and military equipment (from development to disposal) are discussed among the main topics of defense cooperation.

The report examines the issues of using modern system engineering standards in the design of prospective air defense system (ADS), determines the need for adjustment and adaptation – lifecycle tailoring, argues the use of the evolutionary-helical model of ADS lifecycle and presents the results of the synthesis of the lifecycle model of prospective ADS.

In the course of the life cycle, a consistent change in the status of the ADS is carried out, which occurs within the framework of the relevant practices: defining the requirements for the ADS, development, creation of prototypes, serial production of the ADS, its operation, utilization. All these practices are carried out by the security systems: design bureaus, manufacturing enterprises, military units. In this approach, the control of the life cycle is primarily directed not at the target system, but at the security systems, which are now considered as an object of control. The life cycle of an ADS is considered to be the activity of all security systems leading the target system from its design to its decommissioning.

Modern systems engineering approaches involve the creation of an "extended enterprise" - an organization created through a system of contracts with legal entities and individuals involved in the project. At any one time, there is at least one organization that performs the management function for the entire extended enterprise and acts as the regulator. Particularly important is the creation of such an extended enterprise at the stage of project work. In Ukraine, there are no powerful specialized concerns on the design and production of ADS, so there is a need to create a system of collaborative design of prospective ADS.

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STRENGTH ANALYSIS OF MULTILAYER GLASSES OF AIRCRAFT WITH ACCOUNT OF THEIR BIRD RESISTANCE AND BULLETPROOF

The development of national aviation technics requires improvement of elements of glazing structures, introduction of new approaches and technical solutions to increase their strength and reliability. Increasing the level of bulletproof of the aircraft cockpit, ensuring its durability in contact with the bird and reducing the overall weight are urgent tasks for military and military transport aircraft.

The purpose of the study is to develop calculation methods for the assessment of bird resistance and bulletproof of multilayer glazing of cockpits of military transport aircraft.

The aircraft glazing has a multilayer structure which consists of layers of silicate and organic glass, polycarbonate, which are interconnected by adhesive layers. Glasses with different types of reinforcement allow you to create effective designs.

Evaluation of bulletproof of multilayer glass is based on the analysis of penetration depth of the impactor into the package and propagation process of deformation waves in a glass. To estimate the penetration depth of a impactor into a glass, an empirical relationship is used to calculate stresses on the contact surface of the impactor with an target, and to analyze wave propagation we use three-dimensional equations with Kelvin-Feucht damping.

The strength calculating method for a multilayer aircraft glazing under bird impact is based on a refined glazing model and an improved shock impulse model, which describes the process of collision of the glazing with a bird.

The estimation of the bulletproof of the real aircraft glazing at impact of one bullet is normal to the surface of the glass and at the angle of its installation on the aircraft. The stability of glass to impact by the bullets according to the durability classes SK 3 - SK 6 DSTU 4546: 2006 (EN 1063: 1999, MOD) is analysed.

Strength of AN type aircraft windshields under bird impact is calculated . Comparison of theoretical and experimental data showed good agreement and confirmed reliability of the obtained results and efficiency of the developed method. The calculation results will help to substantiate the technical solutions for a modification of the glass structure to improve its bird resistance and bulletproof.

The work was performed within the framework of the Project of the Scientific and Technical Program of the National Academy of Sciences of Ukraine “Research and Development on Problems of Increasing Defense Capability and Security of the State”.

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ESTIMATION OF A RADAR SCATTERING CHARACTERISTICS OF TACTICAL UNMANNED AERIAL VEHICLES

Tactical unmanned aerial vehicles (UAVs) are objects whose detection and tracking using any technical means is significantly complicated. Concerned to radars, the main factors of complication are small sizes, minimization of the number and sizes of metal structural elements, low flight speed and height above the surface. A considerable part of the radars, which are in service in Armed Forces of Ukraine, by their purpose are not able to detect and track these objects.

Due to this, tactical UAVs of short-range (10-30 km or 30-70 km) are widely used by the army, police and other units, as well as by illegal formations. These UAVs cause significant damages to units of the Armed Forces of Ukraine involved in Joint Force Operation.

In Ukraine, researches connected with the developing special radars designed to detect and track tactical UAVs are conducted. At this stage it is important to have information about the radar scattering characteristics of the mentioned UAVs. There is no enough such information in the accessible literature.

In this connection, our work is devoted to brief discussing the electrodynamic methods created by the authors, and which allow mathematical modeling of the radar secondary radiation characteristics of tactical UAVs for a given polarization, spatial and time-frequency parameters of the sounding signal.

Methods allow calculating the electromagnetic field scattered by UAV contained metal (components of engine, airborne control system, pay load, cables) and dielectric (fuselage, fuel tank) components. Also methods take into account electromagnetic interaction between mentioned elements.

The calculation results such as secondary radiation characteristics of a tactical UAV model are shown in our work.

The data that the developed methods allow to obtain are of practical interest at the stage of designing the radars for detection and tracking UAVs of various types. The proposed methods can also be used on the stage of developing advanced UAVs for the purpose of selection the design of the UAV and their simple elements, ensuring a reduction in their radar visibility, as well as in the development and improvement of methods for the UAV applications.

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ADVANCED MODEL OF HIGH-PRECISION SYSTEM FOR POINTING GUIDED PROJECTILES BY TERRAIN IMAGE

In order to defeat the enemy's objects at the tactical and operational-tactical depths, especially in the absence of the possibility to use the Air Forces of the Armed Forces of Ukraine, the issue of development and improvement of high-precision controlled means of defeating the targets appears urgent. Controlled rocket launchers of the Multiple Launch Rocket System (MLRS) can be used to perform their missions in their combat capabilities. However, the existing guidance system used in controlled MLRS shells does not allow to provide the circular probable deviation required for high-precision systems to defeat the ground targets of the enemy.

In order to ensure the accuracy and probability of defeating targets during the flight, it is necessary to correct errors of the marching inertial guidance system using correction systems of the best order of accuracy. It is proposed to use an optical-electronic correlation-extreme guidance system (CEGS) as a system capable of autonomously providing a precise definition of the spatial position of the projectile. When applying such a system, it is necessary to ensure a high degree of similarity between the reference images of the surface of vision in the area of application and the current images received by sensors on board the controllable projectile. One of the reasons for the difference between the reference and current images is the rotational movement of the projectile during the flight, the speed of which varies in different sections of the trajectory.

The rotational and translational motion of the projectile causes the blurring of the contours of objects and backgrounds in the current image of the sighting surface, which negatively affects the result of forming the decisive function of the CEGS as a command for correction of the flight path of the projectile.

To eliminate the distortion of current images due to the translational and rotational motion of a controlled jet, taking into account the change in the speed of the projectile on different sections of the flight path, an improvement of the existing model of the CESN was made. The advanced model provides an opportunity to study the effect of the forward and rotary motion of the projectile on the degree of distortion of the current image of the surface of the vision with different background-object composition, as well as the counteraction of the enemy, including the use of modern means of simulation, masking and reduction of visibility. The advanced model is the basis for developing methods for forming the decisive function of the CEGS as a team for correction of the flight path of the guided missile MLRS.

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LASER OPTICAL-ELECTRONIC SYSTEM HIGH-PRECISION TRACKING OF AIR OBJECTS

The problem of detecting, tracking, calculating their trajectory and protecting the airspace from undesirable objects is becoming high actually with the widespread use of unmanned aerial vehicles (UAV), drones and small civil aviation. Due to the small effective area of scattering (ESR) of these facilities, using of radar stations is inefficient or impossible. Moreover, radars have too high production cost and high maintenance costs. On the contrary, with the development of computer image processing technologies, optical electronic systems (OES) are becoming one of the most optimal means of obtaining spatial information about aerial objects. The task of high-precision tracking of aerial objects has certain peculiarities through which existing methods for the recognition and tracking of land transport and pedestrians cannot be effectively used for aerial objects. Therefore, further development of mathematical models, methods and modern information technologies is required for the detection and precision support of aerial objects.

The report examines the structure, tactical and technical characteristics and applications of small-scale laser OES airspace control in optical and infrared bands with non-inertia drive. The main components of the system:

1) Supporting and rotating device, on which are mounted: an optical range camera with a high magnification lens; thermal imager with telephoto lens; laser rangefinder; wireless system GPS receiver for geodetic anchoring; laser level of horizon for positioning of the support-rotary device;

2) An information-analytical system consisting of a x64-based personal computer and information and technology-based software (IAT). IAT is an orderly sequence of procedures for obtaining, processing, analyzing video information, making and implementing decisions to achieve a given goal in the context of high a priori uncertainty about the behavior of the object of observation and the environment. Software implementation of IAT is a hierarchically ordered set of libraries of methods of optimal processing of video stream and management. IAT consists of separate blocks containing many methods, each of which is optimal for the individual case of combining the parameters of the environment and the object of support. Multiple methods can be used to increase the sustainability of the accompaniment and to choose the best approximation at each stage of processing by voting or by heuristic estimation of the calculation results.

IAT provides video streams and controls for cameras and laser rangefinders; image filtering, automatic detection, recognition and classification of aerial objects; the choice of a specific object and the point of support on it; automatic calculation of the parameters of the trajectories of the object movement and root mean square error (RMS) of the support; predicting the coordinates of the escort point; search for a lost object.

Tactical and technical characteristics of the laser OES:

– viewing area: in azimuth, deg. 0 - 360; elevation, deg. 0 -90;
– maximum drive speed: azimuth and elevation - 100 ° / s; at circular inspection - no more than 5 Hz;
– optical range camera parameters: Full HD 1920 x 1080 with 30x Zoom; instant viewing angle 65 ° - 2.15 ° (1x zoom - 30x zoom); image refresh rate of 30-60 Hz;
– infrared camera parameters: image refresh rate - 50 Hz; sensor parameters - 640x480; area of interest - 160x120; measuring frequency range 5-30 Hz;
– detection range of the target size 2x2m2 - 5 km;
– range of measuring range to the target 32-32000 m;
– minimum distance between targets at a range of 1 km -32 m;
– number of moving targets detected at the same time 1-50;
– resolution in elevation and azimuth - 2.5 arc seconds;
– RMS escort at a range of 1 km under standard conditions - 0.5m.
– RMS angular coordinate measurements: less than 10 arc seconds in azimuth and elevation.

Laser OES is designed in two modifications: general and special applications. Areas of general application: protection of airspace from UAVs and drones over private property in order to counteract filming; prevention of drone flights in crowded areas and mass events; control of airspace near airfields; control of observance of rules of air traffic at sports events and airshows.

Areas of special application: external trajectory measurements at polygon tests of flying objects; targeting and control of fire, laser and electromagnetic weapons and air defense systems.

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OPTICAL-ELECTRONIC SYSTEM OF EXTERNAL TRAJECTORY MEASUREMENTS OF AIRCRAFTS

Increasing the efficiency of use of modern weapons leads to the need to expand the dynamic and functional characteristics of aircraft, cruise and anti-aircraft guided missiles, models of artillery equipment. Under these conditions, the problem of investigating the dynamic characteristics of aircrafts, testing and evaluating their extreme (maximum permissible) characteristics becomes extremely relevant. The small-scale laser optical-electronic station of trajectory measurements (LOESTM) of aerial objects, developed at KNURE, allows to conduct polygonal tests that provide detection of air targets in the visible and infrared spectrum, high-precision tracking and real-time target coordinates. Each such station can be used for various flight experiments, certification of aviation and rocket-artillery systems, providing trajectory and video information to control the characteristics of different aircraft with coordinate measurement, surveillance and recording of video information and subsequent detailed analysis of dynamic and functional characteristics of the investigated.

To improve the metrological characteristics and the length of the controlled flight aircraft path small-sized LOES with high-speed inertia drives are located along the flight path. All LOESTMs are integrated into a single optical-electronic trajectory measurement system (OESTM). Each LOESTM in its area of responsibility is programmed to support the target at the predicted section of the trajectory. The programming process is automated and carried out simultaneously for all LOESTMs. To synchronize and correct the issuance of a target for each LOSTM, the technology of wireless sensor infocommunication network is used in the process of aircraft tracking. Each LOESTM in the process of escort transmits via the communication channel the current coordinates of the target for the OESTM, which is next in line in the standby mode. Based on these data, the coordinates of the expected point of capture and the trajectory of the flight of the aircraft relative to the predicted are adjusted. The number of LOESTM in OESTM is determined depending on the length and width of the range at which the aircraft tests are performed.

The report presents the mathematical formulation and method of solving the problem of optimal placement of LOESTM along the most probable flight paths of aircraft over the landfill territory. Before conducting the flight tests, this task must be solved, and the relative location of the LOESTM in the test site is known. To determine the coordinates of each LOESTM, we use two-frequency GPS receivers mounted on the vertical axis of the LOESTM support and rotation device. The results of measuring the coordinates of each LOESTM and their errors are recorded in the LOESTM database and updated periodically, in accordance with the regulation. Thus, OESTM is a collection of spatially distributed, interconnected wireless communication network of LOESTM and other assistive devices information, its transformation, processing in order to present data about the trajectory parameters of the observed aircraft in the required form.

Significant spatial distribution of LOESTM in the landfill site, the need to take into account the errors of binding the coordinates of each LOESTM to the topographic basis with the use of global navigation satellite positioning system (GPS), errors of the horizon level of the platforms of LOESTM, errors of alignment (binding of each local geocentric system coordinate system), individual metrological characteristics of each LOESTM, detection and elimination of systematic errors and suppression of random errors s LOESTM several measurements have led to the problem metrological certification OESTM is extremely complex and urgent

The main focus of the report is on the construction of a mathematical model of external trajectory measurements of the parameters of the trajectories of the aircraft motion from several LOESTMs and its use for metrological attestation of the OESTM, depending on the metrological characteristics and statistical properties of positioning errors and the horizon levels of each particular LOESTM. It is shown that the error variances of the trajectory parameters (aircraft coordinates and velocity projections) for each moment of time depend significantly on the number of LOESTMs that measure aircraft trajectory parameters at a given time.

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THE REAL-TIME METHOD OF HIERARCHICAL TREATMENT OF IMAGE FOR THE ESTIMATION OF THE FIELD OF VECTORS OF MOTION OF THE UNMANNED AERIAL SYSTEM

Pair of shots of identical size which act from the unmanned aerial system, named levels. Accordingly the supporting and current shots of one level have an identical size. Then all pair of shots can be given by N levels. Will number levels in accordance with the size of shots which are contained in them, from less to anymore: there are shots of low-limit at first level, on N are shots of initial size. In accordance with such chart, the process of evaluation of motion consists of N steps. On every iteration the pair of shots of certain level is processed - from the shots of less size to anymore. Motion is thus estimated, and a starting point on every iteration is the vector field, got from a previous iteration. In other words, on every next iteration vectors, expected on a previous iteration, are specified. For providing of permanent amount of blocks in a shot on every iteration in transition on a next iteration sizes search and blocks areas which vectors are estimated for usually increase in 2n times. This method is proof to noise. It is explained by that at reducing, as a rule, high-frequency noises retire. But with moving away of high-frequency noises shallow details retire often. On occasion it is reason of wrong determination of motion in the gone into detail areas.
Essence of the hierarchical processing of images consists in such. Let there is N of levels of shots. Settle accounts at first N - 1 diminished "copies" of current and supporting shots. Thus every copy of less level in 2n times is less previous. Then all pair of supporting and current shots are presented by N levels.

The analysis of influence of previous filtration of image testifies to the increase of firmness of work of method at the simultaneous increase of time of calculation. Small changes of geometrical sizes and contrast of image insignificantly influences on firmness of the system through the small size of absolute error and compared to the size of block of image.

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FUTURES OF CREATION IN UKRAINE A MULTI-FUNCTIONAL GUIDANCE AND TRACKING RADAR FOR POINTING SURFACE-TO-AIR MISSILES

Considerable number of surface-to-air missile (SAM) systems which are in service in Air Forces of Armed Forces of Ukraine in long-term outlook reach their limiting lifetime. As result, number of SAM systems in combat readiness will be decreasing. More over, SAM systems which are now in service don't provide timeliness of destroying the modern air attack means in all ranges of their altitudes and speeds, and on necessary range. One of the ways to solve the mentioned problem is the equipment of antiaircraft missile troops of Air Forces od Ukraine by advanced means developed and manufactured in Ukraine.

At the moment Ukrainian enterprises and scientific institutes carry out a number of works directed to modernization of SAM systems "Buk-M1", S-300V1, S-125M1, S-200, "Cub" and designing the Ukrainian advanced SAM system of middle range. First in Ukrainian history some of this works include a full turnaround of designing the components for SAM systems.

One of the main components of SAM system is multi-functional guidance and tracking radar for homing the SAMs.

In our work we present analysis of tactical and technical characteristics and look-and-feel of considered type radars as the components of modern SAM systems which are in service in the armies of leading countries. We also analyze available experience of scientific organizations and enterprises of Ukrainian defense and industry complex on designing the radars of various types.

According to analyzing results, possible (rational) ways for designing the multi-functional guidance and tracking radar for homing SAM in conditions existing in Ukraine are proposed. It is noted that in conditions of financial, resource and time limitations, in case of realizing the active radar homing for SAM as the guidance and tracking radars can be considered either X-band radars (traditionally for radar of such type) or radars functioning in S-band.

Before making decision about design philosophy of advanced guidance and tracking radar, it is necessary to develop detail computer model which will be able to adequately reflect physical processes observed during SAM pointing.

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THE METHOD OF SYNCHRONIZATION THE ADS-B RECEIVERS SYSTEM FOR THE RADAR AIRCRAFT CONTROL WITH MLAT TECHNOLOGY USE

In present time the conditions of the airspace, the possibility of existing radar equipment (radar stations of different ranges) for the implementation of radar control and the issuance of radar information with increased requirements for the accuracy of determining the coordinates of air objects (AO) is somewhat limited.

In order to improve the accuracy of the AO positioning, it is possible to use the ADS-B receiver system with MLAT technology use, but there is a problem of time synchronization of these receivers. In present time, this issue is not resolved, so the development of the method of synchronizing the receiver system ADS-B is relevant.

The essence of MLAT technology is that the system of several receivers (at least three) is able to measure the coordinates of the AO, even when the AO does not transmit to the space information about its location. As a receivers the ADS-B transponders are used.

In comparison with modern radar, the current position of AO defined by the ADS-B system is significantly higher due to the fact that the coordinates of the AO are determined by the onboard GPS navigator.

Making the exact timer at each reception point is not an issue, this task can be solved with a quartz oscillator use. However, there is a problem synchronizing these timers.

Each received message is supplemented with a register value (time of reception of the signal, for example, it may be the front of the first pulse). These data are transmitted to the processing unit. If in the zone of action of the system ADS-B receivers there is AO that transfers to the space its coordinates, it is possible to use them as etalon ones.

Knowing the exact coordinates of the AO that are transmitted from the AO board according to the ADS-B system, it is possible to determine the etalon time difference between the arrival time of the signal between the individual receiving points and the difference in the values of the quartz oscillators between the same receiving points.

Using MLAT technology and having the correction value for each receiving point, you can take it into account whenever the AO located in the system's zone does not transmit its coordinates.

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DEVELOPMENT OF ARTIFICIAL INTELLIGENCE FOR THE TASKS OF SPECIAL HIGH-PRECISION DYNAMIC MODULAR SYSTEMS

The main areas of scientific activity of the National Aviation University, which is one of the most powerful aviation institutions of higher education in the world, are aerospace and information technologies.

The research activity of the university is directed towards the development of the Ukrainian system of scientific researches, oriented on the further realization of innovations in production and industry; introduction of artificial intelligence system, including new cognitive network-centric transport technologies (unmanned vehicles, management and planning of traffic flows in the city); creation of cognitive military systems (soldiers of the future, mobile mine clearance robots, intelligent weapons control systems, unmanned vehicles); the introduction of intelligent recognition systems (machine vision, speech recognition); creation of stratospheric unmanned systems for monitoring and communication; development of satellite communications, navigation and surveillance systems; development of theoretical and practical principles of creation of aerospace vehicles.

The university has established the Scientific and Production Center of Unmanned Aviation “Virazh” (SPCUV “Virazh”), which activity is focused on the designing, development and industrial production of modern competitive unmanned aviation machinery, complying with European and world-wide requirements. The products of SPCUV “Virazh”include Double engine unmanned aircraft M-7V5 «Nebesniy patrul», Mobile unmanned aerial complex M-56 «Module» (Patrolling ammunition), Multipurpose unmanned aerial complex M-6-3 «Zhayvir», Mobile unmanned complex M-10-2 "Oko", Training unmanned aircraft M-22D «Aerotester», Multicopters NAU PC-08 and PC -11, Multimotor helicopter for cargo transportation PKM-14 "Saturnia" and others.

In order to test the experimental current model of a high-precision dynamic modular system based on a small unmanned aerial vehicle for the tasks of multi-choise object detection, recognition and classification, the “Artificial Intelligence” Laboratory of the University has developed a system of object identification and tracking (OIT) using components of computer vision and artificial intelligence. The OIT system was developed and put into operation to automatically detect the searching objects on video-stream frames, to track an object selected by the operator (keeping it in the center of the frame using gimbal control) and, if placed on unmanned aerial vehicle, to determine coordinates of the selected object using the telemetry information of the flight controller or other telemetry sources.

The OIT system uses a computer appliance for object identification and tracking in an automatic mode that can be used for a high-precision system of guidance and control. For object identification the neural network with the state-of-the-art architectures was used. The efficiency of the OIT systems was experimentally argued using different types of vehicles.

The activity of the "Artificial Intelligence" Laboratory is accompanied by continuous research and development of new methods and algorithms for decision support systems, including nonparametric estimation methods and fuzzy logic methods.

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INFORMATION TECHNOLOGY OF DETECTION OF ELEMENTS OF OBJECTS OF URBAN INFRASTRUCTURE ON IMAGES OF ON-BOARD OBSERVATION SYSTEMS

Analysis of the fighting and conflicts of recent years in the cities has shown that the use of information from on-board surveillance systems allows for planning combat operations, reconnaissance and, as a result, significantly increasing the effectiveness of the use of weapons and military equipment. As it was established, the result of processing images of a city from on-board surveillance systems largely depends on the quality of methods for identifying elements of urban infrastructure objects.

The proposed information technology for detecting elements of urban infrastructure in images of on-board surveillance systems is based on a two-stage method. At the first stage, all borders are selected using a Canny border detector. On the second, only the selection of geometric primitives, namely, straight and curved lines, from the total number of obtained boundaries in the image using the Hough transform. And the method of multi-scale image processing of the city.

In information technology of detecting elements of urban infrastructure on images of on-board surveillance systems, unlike the known ones, the methodology of system modeling IDEF0 is used, which is based on the method of structural analysis and design SADT. And it provides for the determination of the number and scale of images, the color space for the representation of images, the selection of the brightness channels of each color space, the application and definition of elements of urban infrastructure objects using a two-step method.

In accordance with the syntax and semantics of IDEF0, information technology is presented in the form of a tuple, a contextual diagram of the top level and child diagrams.

The proposed information technology can be implemented in a special software and hardware complex for image processing of on-board surveillance systems in order to identify elements of urban infrastructure facilities.

The direction of further research is to assess the effectiveness of the use of information technology for the detection of urban infrastructure objects in images of on-board surveillance systems.

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THE METHOD OF DETERMINATION OF INVESTMENT PENALTY-BASED BLOCKS ON THE BASIS OF GENETIC ALGORITHMS

Currently, due to the widespread distribution of digital media content, high-speed Internet, local area networks, wireless network technologies, the issue of protecting information from theft, distortion, illegal use, etc. is topical. Videoconferencing, video, video surveillance, digital terrestrial, cable and satellite television - this far-incomplete list of relevant applications, in which the task of protecting information is relevant.

When considering these questions a class of problems arises, which is associated with block rearrangements of the pixels in the image. Existing methods for finding inverse pseudo-random block permutations require the use of additional a priori information, which is not always possible.

Consequently, the task of developing a method for determining inverse pseudo-random block permutations on images is relevant.

Existing methods for solving the problems of restoration of permuted (from the English "permutation" - permutation) images are based on evolutionary algorithms of optimization. There are ways to solve these problems using evolutionary optimization algorithms, in particular using genetic algorithms. Sometimes non-English language literature uses the terminology "(pseudo) holographic coding."

The main disadvantage of known methods for determining inverse pseudo-random block permutations in images is the need for additional a priori information on block permutations of pixels.

The purpose of the work is to develop a method of "blind" definition of inverse pseudo-random block permutations in images based on genetic algorithms with restrictions on the size of the block.

It is shown that the use of genetic algorithms is an extremely powerful method for solving the problem of finding inverse block rearrangements. An effective way of encoding permutations in the genome is proposed, such that the main operators of the genetic algorithm generated other permutations that uniformly cover the range of admissible values.

The target function, the minimization of which is carried out using the genetic algorithm, is chosen. Analyzing the target function, we obtain the condition of the principal solvability of this problem - the size of the permutation block must be less than the radius of the correlation of the original image, which is well consistent with the experiment. An alternative representation of the correlation radius of an agreed image is obtained, but does not coincide with the traditional definition (through the cross section of the main peak of the autocorrelation function).

Further interesting theoretical and experimental (for example, with the help of specially generated synthetic images) interesting studies in this direction are presented, separate consideration of the question of anisotropy and multimodality of the autocorrelation function is needed.

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AUTOMATED PASSIVE SYSTEM FOR DETECTING, MEASUREMENT OF OBJECT FLIGHT PARAMETERS, THEIR PHOTO PURSUIT AND NEUTRALIZATION

The creation of a comprehensive system for passive detection, measurement of flight parameters of objects, its photo capture and neutralization is a particularly important task nowadays, as unmanned aerial vehicles (UAVs) are used for online aerial reconnaissance, conducting artillery fire adjustments, radio interference, bombing. The purpose of the work is to evaluate experimentally and theoretically the possibility of passive detection of UAVs using sound, passive radar and thermal systems, measure the coordinates and velocities of these objects using a digital photosystem, to substantiate and experimentally explore own software methods of flying own UAVs by calculated coordinates, photo capture and pursuit during flight, as well as neutralization.

On the basis of the reviewed literature, it was concluded that this type of complex work with passive detection, measurement of coordinates and neutralization of the UAV of the enemy in photo pursuit has not yet been carried out.

The overall system consists of five independent subsystems. The first, the passive object detection subsystem, is investigated in the field of sound, radio and thermal radiation. This stage is the most completed in the sound scheme. The level of detection of small UAVs, such as Phantom-3, at a distance of about 1 km has been reached. Interesting correlations have been found that give the right to speak about an effective method of object type recognition. Special, self-designed sound pickups with high-sensitivity cardioid-type microphones are used.

The second subsystem of photographic measurement of flight parameters (coordinates, direction and speed) uses a modern digital camera with dual-core processor and a long-range lens. Compiled a program on Windows on a desktop PC to process the image of a captured object. When researching the video system and the algorithm for tracking moving objects in the video stream, we used approaches that satisfy certain requirements. Thus, the "optical flow" method was considered as an example of the Lucas – Canade algorithm implementations; the TLD (Tracking-Learning-Detection) algorithm was considered as an example implementation in the OpenCV library; algorithm based on statistical analysis was considered on the example of local binary templates. In this paper, we used the Lucas – Canade method for UAV recognition.

As a result, the Phantom-3 copter can be determined by coordinates with an error of no more than tens of centimeters at a distance of about 1 km. The object is captured and escorted automatically. To improve the reliability of detection and measurement of flight parameters, correlation ratios of two processes - sound and photo processing - are studied. Relationships are established between them and an automatic transfer of the measurement results aboard the pursuer. There is a system of automatic rotation of the receiver to the maximum sound of the object between the sound and photo subsystems.

The third UAV flight subsystem for measured coordinates with calculated advances is executed automatically after receiving the coordinates of the second subsystem and transferring them via Wi-Fi to an onboard Raspberry computer.

Quadcopters and hex copters were used for experiments within the fourth subsystem. It was used the on-board computer with Pi camera. The pursuit system uses the Pixhawk flight controller. It was created the own photo pursuit program.

When approaching a critical distance, the fifth subsystem performs the action of neutralization. The unit then returns to the point of departure or the certain point.

The control program allowed the following scenario: lifting the copter to a certain height - hanging for a while - rotating about its axis - flying to the object in case of its capture - performing the action of neutralization. The system was tested at distances of the copter from the ground station up to 500 meters and altitudes up to 4 m, as well as at flight speeds up to 5 m/s.

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ASSESSMENT OF THE READINESS OF AIRCRAFT TO FULFILL THEIR INTENDED TASKS

The current stage of aviation development is characterized by a fleeting change in the tactical situation that introduces certain corrections to the tasks facing the aviation of the Air Force of the Armed Forces of Ukraine. For a timely decision on the use of aviation and successful planning of the operation, it is necessary to determine the combat capabilities of the aviation group involved in the task. In this aspect, a significant role is assigned to the aviation engineering service, which should ensure the readiness of aviation equipment to perform tasks as intended.

Availability is estimated as the likelihood that the system will be operational at any time during the execution time of the task. To assess the availability of elements and systems, the availability factor is used, which relates the criteria of failure-free and recoverability. This coefficient is a criterion for the relative number of elements that will function normally during the flight without any interruption in operation that exceeds a predetermined time interval for eliminating failures. Therefore, this coefficient makes it possible to plan well the expenditure of forces and means in the course of ensuring flight operations. If you correctly select the calendar time for completing the task and the allowable recovery time during this task, you can always guarantee that the planned number of sorties will be completed one hundred percent. Using this coefficient, it is possible to plan the work of maintenance and repair units for the period after completing the flight mission.

The report examined and analyzed possible options for assessing the readiness of aircraft to fulfill their intended tasks. The systematization of indicators and criteria that can be used to solve this issue.

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BACKGROUND OF PROPOSALS FOR MODERNIZATION TRAINING FACILITIES ON THE RANGE AIR DEFENSE TROOPS OF THE ARMED FORCES AIRCRAFT UKRAINE

Principles of construction and application of computer training complexes and training facilities for providing theoretical training of anti aircraft missle complex (AAMC).

The existing fleet of AAMC simulators is a specific set of software and technical complexes built directly into the relevant combat samples of the AAMC. As a result, there is a need to include samples of weapons and military equipment during the training, which is a costly measure. In addition, built-in simulators do not always provide all kinds of training of combat services in the required operating modes and conditions of application with the task of practically harmonizing service numbers and assessing the level of their practical readiness.

In order to improve the level of training of the personnel of combat services, the simulators is proposed to modernize the corresponding simulators in the direction of the implementation of computer training technology taking into account regulatory, technical, information, didactic and organizational aspects.

The regulatory and technical aspect is that the development of computer-based simulators for AAMC must be performed in accordance with the requirements DSTU VP 15.203:2017. This standard applies to the research and components of the research work for the creation (modernization) of systems, complexes, samples of military equipment and their components, but does not take into account the design features of the simulators intended for the training (training) of combat services. No state standard spells out the tasks and requirements for didactic support for the development of the simulators, the terms and definitions, the general requirements for the content, style and design.

The lack of a regulatory framework can lead to different interpretations of the customer and contractors of the designation of the simulator under development and the expected results of their operation. Therefore, the issue of state standards required for the development of simulator is relevant and requires immediate resolution.

The informational aspect is that industry enterprises may not have closed documentation to develop scenarios for specific armament equipment tools, unless they have previously participated in any work related to these armament equipment under a government order or through military-technical cooperation. . Therefore, the issue of delivery of the required documentation in a timely manner should be a tactical and technical task for the development of the simulator.

The didactic aspect is that in the development of the simulator, in addition to the normative types of providing (technical, mathematical, software, information, etc.) it is necessary to work out the following issues of didactic support: fulfillment of qualification requirements for a specialist; implementation of curriculum and curriculum requirements, guidance documents; development of scripts of basic training computer programs; development of the necessary content (in the general case, the content means the content of the training course, various training materials, manuals, techniques, tasks, tests and control measures; definition of didactic requirements for the system as a whole and its elements.

The organizational aspect consists in the fact that the parties to the process of establishing the simulator in the course of the implementation of the research work by the customer are the military management bodies of the Air Defense, the Ministry of Defense of Ukraine and research institutions providing military-scientific support, as well as the military representation of the Ministry of Defense, from the executor - main performer and co-performers. Each of the participants solves a certain range of tasks, but only the main contractor and the subcontractors under the terms of the contract are legally responsible for the performance of works in accordance with the requirements of the tactical and technical tasks within the prescribed time. The existing organization of the development of computer-based simulator for theoretical training does not determine the legal relationship between the main creators of industrial enterprises and higher military educational institutions that have the necessary content and teaching staff.

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JUSTIFICATION OF PROPOSALS FOR IMPROVEMENT OF SPECIAL SOFTWARE OF SIMULATORS

Today, manufacturers of training complexes use a variety of software products (interface) on the basis of which their software is directly created.

The cost of developing special software is 30-70% of the cost of the simulator. At the same time, the developers of the training tools during development use different operating systems, software interface and mathematical models of functioning. It leads to significant financial losses: the inability to accumulate and reuse design solutions, models, prototypes, information technologies and, as a result of the software and hardware incompatibility of the training facilities.

There are ways to eliminate these contradictions and allows to reduce the financial cost of developing SDRs for simulators:

a) determining a single plan and approach to the choice of operating system and programming environment to eliminate the incompatibility of software modules from different manufacturers. The use of a single licensed software product makes it possible to unify the IT infrastructure, which will save money - both on the acquisition of new licenses and on the costs of maintaining it.

Unification of algorithms of software-mathematical software of simulation modeling, visualization of the environment and battlefield environment by creating unified software modules (UPM). UPM is defined as a set of software objects that take into account the features of the subject area, which are not separated from each other within the framework of a certain class of tasks, which have a unified interface that allows the UPS to interact with each other without additional coordinate code.

b) creation of UPM banks, which were designed by order of the Ministry of Defense of Ukraine during the creation of simulators for the needs of the Armed Forces of Ukraine. Use the developer ready UPM simulators can greatly reduce the complexity of creation, scientific and technical support to the development of SDR and protect from logical errors when creating software modules.

c) development of unified interfaces and exchange protocols to provide communication between typical unified software modules when creating simulators.

d) adherence to the requirements of the possibility of its expansion, improvement and further development during the development of the SDR.

e) providing for the possibility of integrating the various trainers under development into a single complex to provide training for crews, units, military units and military management bodies, which will reduce the cost of developing

SDRs by using a single software environment and common algorithms for operation in these complexes .

g) development and implementation in the Armed Forces of Ukraine of the methodology of calculating the cost of creating SDRs during the conclusion of state contracts for the development of training facilities.

h) conducting an SDS expertize by evaluating the cost of its development by independent companies.

The implementation of the principles of unification and modular construction, which are incorporated in the design phase of the SDR, adaptive software and open protocols of information exchange will reduce the financial costs for the creation of both individual simulators and simulation complexes.

The realization of all the proposed ways requires the development and adoption of a number of regulatory documents at the level of the Cabinet of Ministers and the Ministry of Defense of Ukraine with the involvement of the State Concern "Ukroboronprom", as well as the carrying out of relevant research work together with the profile enterprises of the industry.

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RATIONALE OF PROPOSALS FOR CORRECTION OF METHODICAL DEVICE FOR DETERMINATION OF TECHNICAL STATE OF RADIO-TECHNICAL MEANS

The methodical apparatus for determining the status and prospects of changes in the main samples of the radio-technical means (RTMs) of the Armed Forces of Ukraine does not take into account their existing features. In particular, the number of RTMs of the Air Forces of Ukraine is small compared to the number of samples of other types of armament of Ukraine, and the cost of each sample RTM is significant. Therefore, their status should be as detailed as possible.

Proposals to improve the technical condition of the main RTMs samples, which are armed with the Armed Forces of Ukraine, are developed on the basis of the analysis of the dependences of changes in the quantitative and qualitative composition of RTMs samples from the calendar duration of operation with the current system of technical operation and repair (TOR) and taking into account proposals for its implementation. For this purpose, a simulation of the dependence of the number of RTMs that have a resource (life span) on the calendar duration of operation under different TOR strategies is conducted.

The developed methodical apparatus for modeling the dependence of the number of RTMs that have a stock of life (service life), depending on the calendar duration of operation takes into account:

availability of actual reserves of RTMs Air Force resource indicators for the current year, taking into account the performed repairs and repairs;

set parameters of the repair system;

dynamics of change in the number of repaired RTMs;

the dynamics of changes in the number of repaired RTMs that have exhausted the established service life (the estimated number of RTMs from the number of repaired ones that will go to a state of limitation during operation according to the technical condition).

The data on the state of RTMs not only reflect the calendar duration of operation, but also contain the results of the work on the extension of their assigned service life (resources). The developed methodical apparatus for modeling the dependence of the number of RTMs that have a reserve of a designated life (resource) on the calendar duration of operation takes into account:

the magnitudes of the assigned RTMs service life, which are established as a result of work on the continuation of their assigned indicators;

productivity of repair company performing factory repair of RTMs;

the value of the intended post-repair life of products;

the magnitude of the RTMs service life.

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FLIGHT TESTS AND LIFE CYCLE AIRCRAFT

The process of aircraft creation is multifaceted and multi-stage and is aimed at achieving a unified system of goals aimed at ensuring high value of efficiency and airworthiness, as well as competitiveness with respect to existing or aircraft being created.

Creating new LAs is a very expensive process and requires increasing material and labor costs. At the same time, there is increasing technical and economic risk associated with the risk of choosing the wrong directions, possible mistakes, increasing the time of development, manifestations of defects that are not detected in the test.

To reduce the technical and economic risk, and with due consideration of such factors of time and financial (material, technical), a complex (systematic) approach is necessary, which allows to take into account all aspects of the development (creation) of the aircraft and its operation.

The complex system of design and evaluation of aircraft represents the only organization of the process of its creation. All stages of development and life cycle (tasking - designing - ground testing (testing) - flight testing - certification - batch production - operation - codification - modernization based on experience gained) must be performed on the basis of uniform criteria for the operation of the aircraft, its operation safety estimating factor and time characteristics.

Central to the flying tests that are being done in the process of creating the aircraft, belongs to the tests of experimental and basic objects.

Flight tests are subject to aircraft, power plant, control system, sighting and navigation complex, energy supply system, life support system, special systems that determine the purpose of the aircraft and other functional systems that provide the flight of the aircraft and the main indicators of combat effectiveness of its combat use.

The objectives of flight tests are:

at the stage of exploratory research - obtaining information about new or insufficiently studied physical phenomena, new areas of application of LA and its systems is necessary for design; testing new principles, ideas, design or schematic solutions, methods, etc;

at the stage of LA development - demonstration of the advantages of the design of its LA and its systems for decision making on prototypes, detection and elimination of fundamental errors and defects (design defects), which are revealed in the tests, variation of parameters of individual systems for determination of optimal (rational) values and their variants;

at the stage of commissioning - expanding the scope, identifying new opportunities, removing certain limits (values) of the characteristics of the aircraft on its systems, which were installed in the first stages (stages) of testing.

After the start of batch production, a specific batch of this type of LA (sometimes this batch includes pre-production samples) is subjected to operational tests, the purpose of which is:

mastering a new type of LA by organizational and service customers, checking the effectiveness of LA in real operations;

testing in the full range of operating conditions;

inspection and testing of service equipment, maintenance methods, working out recommendations on the operation of the aircraft and the rational execution of typical operations of onboard and ground crews, flight management services, etc .;

detection of defects and failures of LA systems, which were not detected during the trial of experimental and major LA.

At the stage of batch production and operation, control tests are carried out, which are performed both at each LA and selectively for the purpose of quality control by a method of comparison with the characteristics of the reference LA.

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THE MAIN COMPONENTS OF THE FLIGHT TEST PROCESS

Positive achievement of the purpose of the test requires a certain methodology and a set of tools that are combined by a comprehensive program and test methodology. Such a mechanism should ensure that the tasks are fully resolved with the least number of test flights in a timely manner. At the same time, a number of mandatory conditions must be fulfilled, the special issue being the issue of flight safety. As a result of the tests and refinement, the required level of effectiveness of the airworthiness of the aircraft must be achieved, the quality requirements are fulfilled, as well as the compliance of the aircraft with the given tactical and technical requirements.

In modern conditions, LA cannot be alone as a test object. The test process is essentially a complex system that brings together a number of interconnected components, each of which performs specific functions.

A typical complex flight test structure includes:

test facilities, prepared and equipped in a certain amount, in the amount required for the tests to be scheduled;

additional flight test facilities - auxiliary (auxiliary) aircraft, automatic or remote controlled aircraft;

a test base comprising an airfield with hangars and other premises, as well as facilities for the maintenance, repair and preparation of the aircraft for flights, flight zones, test routes, ground based air traffic control facilities;

test-information system, which includes measuring equipment (located on test sites, on the ground and auxiliary aircraft) and means of collecting information, processing it and presenting information on their results;

a test program that fully meets the purpose of the test, taking into account the technical requirements of the aircraft design, regulations, airworthiness regulations, etc;

a test methodology that must be sufficiently developed to include all issues that must be resolved according to the program and be compatible (agreed) with the measurement and information system;

electronic, physical, and semi-natural modeling tools that can be used to plan experiments, analyze the results obtained, verify flight safety, and obtain the final characteristics according to the tasks of the test under the specified conditions of operation of the aircraft;

crews performing flight tasks and service personnel (ground crew) as prepared for testing in accordance with the content and requirements of the test program and test methodology;

test team, which conducts the tests and is staffed with the specialists required for the tests.

A comprehensive test system requires clear control for efficient operation. Therefore, the control and planning subsystem must be included in its constituent components.

Thus, such a complex test system can provide high quality tests by obtaining a specific list of characteristics with the lowest values of all types of costs (costs).

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WAYS OF RESTORING THE STRUCTURE OF COMPLICATED MODULATED ECO-SIGNALS TO IMPROVE THEIR FILTERS

Active use of modern means of air attack and reconnaissance with the use of technologies to reduce radar visibility, in particular, the tactics of their use requires the operation of radar detectors at the limit of sensitivity of their receiving devices. In such circumstances, it is the weak echo signal of the radar object that is significantly affected by the distortions caused by its propagation features in the troposphere and the aircraft design. In this case, the frequency response of the set of curvature systems is unknown. The effect of these factors is to reduce the filtering efficiency of complex modulated signals.

The authors analyzed the possibility of restoring the spectral structure of the echo signal by using inverse filters, the frequency characteristics of which are the inverse of the frequency characteristics of the superposition of the curvature systems by solving the problem of incomplete deconvolution.

The ways of finding the optimum deconvolution filter with some a priori information whose metric approximation is smaller than that of truncated deconvolution filters are considered. An inverse filter, in this case, would be considered optimal in terms of maximally approximating the shape of the useful signal with some allowable noise dispersion enhancement factor.

The design of the filters was performed by computer simulation.

When designing filters, the statistical characteristics of the interference in the input signal and their correlation with the statistical characteristics of the most useful signal are taken into account. To obtain the statistical characteristics of the bending systems, digitized records of the radar signals of the modern radio station for the typical position of the radio engineering unit were used.

DEVELOPMENT PROSPECTS OF THE SPECIAL FORCES ARMAMENT AND MILITARY EQUIPMENT

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DEVELOPMENT TENDENCIES OF AUTOMATED CONTROL SYSTEMS BY ELECTRONIC INTELLIGENCE AND ELECTRONIC WARFARE

The analysis of military operations and local conflicts of the last decades is carried out. The analysis of the participation of the Armed Forces of Ukraine in the antiterrorist operation in the east of Ukraine is carried out. The enemy is used in the context of combat operations of radioelectronic means (REM). Therefore, electronic warfare (EW) is very important.

Means of EW are developed to fulfill the task of radio electronic impact on:

– a new generation of satellite, microwave, shortwave and ultrashort wave communication systems;

– satellite navigation systems;

– high-precision weapons (HPW) guidance systems, radar stations of reconnaissance-strike complexes;

– optical, optoelectronic and radar homing heads of HPW;

– multi-functional airborne radar on aircraft;

– computer radio networks Wi-Fi, Wi-MAX;

– mobile communication systems.

Modern trends in the development of the EW consist in the transition from a single use of the means of the EW to a massive application of them together with conventional weapons. This is the transition to conducting the combat operation of the EW. To do this, it is necessary to create an automated control system by means of radio electronic reconnaissance and EW. Such a system will allow the reception, processing of intelligence information and distribute this information between the means of the EW and conventional weapons.

Stable troop control is achieved:

defeat of forces and means of the enemy’s EW, radio-electronic suppression of control lines of these means;

timely introduction of restrictions (prohibitions) on the use of their funds EW and REM;

clear coordination of the frequency and territorial operating modes of the REM compounds and parts of the first echelon;

timely identification and elimination of sources of electronic interference.

Automation of these and other processes of managing the means of EW should be based on the creation of automated control systems (ACS). These ACS must provide electronic protection for their REM and electronic warfare against the REM of the enemy.

The structure of ACS means of EW should include:

subsystem for continuous monitoring of their own and others REM;

databases of their own and other REM, which are displayed on digital maps of the area (DMA);

knowledge bases that contain the necessary models, procedures and algorithms;

special software for modeling and solving computational problems;

automated workstations that display information about their own and other REM, and allow you to carry out the necessary calculations.

The creation of such an ACS provides:

electromagnetic compatibility of their REM;

setting tasks for conducting radio monitoring and processing results;

preparation of data on the allocation of frequency bands of their REM;

providing analytical information to officials to coordinate the tasks of electronic security of the REM;

automated distribution of EW funds for timely electronic suppression of the enemy's REM;

decrease in the effectiveness of enemy conduct of electronic intelligence;

ensuring the stable work of the REM of its troops.

Consideration of these trends will allow the creation of modern automated control systems by electronic intelligence and electronic warfare. This will significantly increase the level of electronic protection of their REZ from various interference and the effectiveness of the combat use of electronic warheads.

In modern combat operations, the use of means of electronic warfare can reduce the effectiveness of the enemy's use of HPW and the system of command and control of troops.

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THE METHOD OF FUZZY EVALUATION OF INFORMATION AND ANALYTICAL PROVISION OF THE ACTIVITIES OF EMPLOYED PERSONS

Nowadays, software solutions to support decision-making are actively developing. Among the factors that stimulate the development of this class of software systems, it is possible to note an increase in the role of their use in solving weakly structured and difficult formalized tasks in conditions of uncertainty, inaccuracy, incompleteness and inconsistency of output data, the need to take into account variably and dynamically changing parameters. In such conditions, the development of methods for multi-criteria evaluation of complex objects and alternatives to solutions for improving the effectiveness of information and analytical support for the activities of officials.

In the course of the information analysis, which was provided in the research, it has been established that there are a number of significant disadvantages, namely:

the complexity of the formation of a multi-level structure of evaluation;

the lack of consideration of compatibility of unevenly significant indicators;

the lack of joint execution of direct and reverse evaluation tasks with the support of choosing the best solutions.

In order to eliminate these shortcomings, in this research, the development of a fuzzy evaluation methodology has been developed to evaluate the information and analytical support of the activity of officials. To achieve this goal, the main provisions of the methods of artificial intelligence, complex technical systems, fuzzy logic and multi-parameter and multi-criteria optimization were used.

The scientific novelty of the proposed methodology is that the fuzzy estimation models that are the part of the proposed methodology are proposed to create software tools for choosing solutions, taking into account the hierarchical structure, mutual compatibility and different meanings of the evaluated indicators.

Also, development of fuzzy evaluation methodology, focused on the program implementation of the extended possibilities of fuzzy estimation models, taking into account the different nature of aggregation and the interaction of evaluated indicators, the choice of convolution operations and evaluation strategies.

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EXPERIENCE OF APPLICATION OF RADIO MONITORING SUBSIDIARIES SINCE THE BEGINNING OF ANTITERRORIST OPERATION

As a result of the annexation of the Autonomous Republic of Crimea and occupations of territory Donetsk and Lugansk regions system radio monitoring Armed Forces of Ukraine was partly weakened, which in turn caused the necessities and c b using new forms and methods of management.

During the execution of tasks by the units of radio monitoring of the Armed Forces of Ukraine, a number of deficiencies have been identified that have had a different impact on the quality of the tasks performed, including:

- there were no regular officials of the administration, which led to inconsistencies in task setting, targeting and coordination between units
- inconsistency of action during rotation of personnel;
- the order of the logistics and technical support was complicated, as the units of the radio monitoring were at a considerable distance from the database of security, and a separate unit for the provision of food and fuel and lubricants was not foreseen;

- the absence of the members of the radio monitoring units of persons designated for the protection compelled to be placed on the most secure positions that have not always been the best;
- units of radio monitoring were in one position up to 7 days, which is due to the repeated penetration of the local population into occupied positions;
- the lack of means for transmitting information with a temporary or guaranteed stability;
- the lack of mobile communication has led to difficulties in the rapid exchange of information obtained;
- use of outdated radio monitoring equipment;
- low level of training of radio monitoring operators;
- insufficient processing of the information received by the relevant officials.

The presented shortcomings of organization and work of the units of radio monitoring determine the directions of improvement of the system of radio monitoring of the Armed Forces of Ukraine.

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PECULIARITIES OF IMPLEMENTATION OF NEXT GENERATION NETWORKS

A characteristic feature of the modern telecommunication systems of special purpose development is the introduction of next generation networks (NGN), active introduction of multi-service subscriber access technologies, packet switching, which require qualitatively new technological development of the transport network.

The top priority for the development of the special purpose telecommunications networks is applying of Multiprotocol Label Switching (MPLS) technology. The application of MPLS technology on the trunk level enables efficient traffic transfer with QoS (Quality of Service) support.

The main feature of MPLS technology is the separation of the packet switching process from the IP address analysis in its header, which makes packet switching much faster. Any transmitted packet is associated with a particular class of transmitted information, each of which is identified by a specific tag. The tag value is unique only to the path section between adjacent nodes of the MPLS network.

The tag is transmitted as part of any package, moreover, the method of binding to the package depends on the channel layer technology used.

Today there are three main areas of the MPLS protocol application. These are traffic management, class and quality support and virtual private networks.

Traffic Engineering (TE) – it is the ability to control the direction of traffic flow to meet certain conditions (channel redundancy, distribution of network load, balancing and prevention of overloads). Streaming information management allows you to route data streams not through the shortest route calculated with the traditional routing protocol, but through less loaded nodes and communication channels. With proper modeling of the load flow across all physical communication channels, routers and switches have to be balanced so that none of these components is underloaded or overloaded. As a result, the network will be more efficient, stable and predictable.

2) One of the main advantages provided by MPLS lies in the ability to manage QoS. It is the tag-based switching makes MPLS so useful and unique. Frame relay and ATM provide QoS by choosing the route during which the network will support traffic requirements for QoS by allocating resources at each node of the line to ensure that traffic receives the necessary QoS resources. Fixed MPLS paths can be explicitly routed through the network along any desired path, and devices along the path can use different control resource to provide each MPLS path with the necessary resources. Thus, MPLS is capable of providing QoS control, equivalent to the provided frame relay or ATM.

3) Virtual Private Network (VPN) simulates the operation of a corporate geographically distributed network with a public packet network infrastructure. But corporate data transmitting over a public packet network is a clear threat to the security of any enterprise network. In addition, it is difficult to achieve the required level of productivity, reliability and quality of service in public communication channels. VPN technology is used to address these issues. It is based on the idea of public networks applying for the secure transfer of traffic to territorially removed branches of the customer, using the ideology of private networks building.

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AS TO CONSTRUCTING OF THE AUTOMATED COMMUNICATION CONTROL SYSTEM OF THE ARMED FORCES OF UKRAINE

Today, no one has any doubts about the necessity of creating and implementing of the automated command and control system in the Armed Forces (hereinafter referred to as “AF”) of Ukraine. Therefore, creating of the effective operative (combat) Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR) system is one of the priority directions to achieve strategic goals of the defense reform, determined by the country's leadership in the Strategic Defence Newsletter.

The basis of the national C4ISR should become the automated command and control system of strategic and operational levels, the development of which, is conducted by domestic scientific institutions and companies within the framework of the national defensive order (principal investigator – LLC “Everest Limited”).

As a result of the implementation of this system, the quality indicators of the automated command and control system is expected to increase, which significantly improve the effectiveness of troops (forces) employment.

At the same time, numerous criterions of this system (such as reliability, control continuity, responsiveness) are directly dependent on such important component as modern military communication system.

Rapid growth of “information-intensive” types of armament employment, implementation of robotic armament and necessity of achieving of information advantage over enemy together with complication and price increase of the control system technical basis elements, caused by ever-increasing information flows and operational requirements for the management process, – all this determine the necessity of more rational and comprehensive using of resources of the communication system of the AF of Ukraine, appointed within the framework of the unified plan of the AF control to meet such main challenges:

– proofing orders and centralized combat management signals with given probabilistic-temporal characteristics from the General Staff of the AF of Ukraine to the control posts of the armed services, operational commands and branches of the AF;

– quality and timely provision of information and communication services for the AF governing bodies officials;

– meeting the requirements of sustainable, continuous, operational and covert control of troops (forces) and weapons;

– creation of conditions for ensuring the safety, reliability and integrity of information, circulated in the AF system at the stages of collection, processing, transmission, storage, distribution and provision to users.

One of the ways to increase the efficiency of the communication system resources using, as well as the effective performance of specified tasks, is to develop and improve the communications management system (CMS) of the AF, which, on the one hand, is an element of the AF communications system, and on the other – the subsystem of the AF control system.

Herewith, the evolutionary development and improvement of the AF control system, as well as the necessity of increasing the efficiency and effectiveness of the communication management officials activities of the in meeting the communication challenges in the context of increasing of the communication system elements technological complexity, are determined the transition from the traditional (“classical”) CMS of the AF to the automated CMS of the AF with a gradual increase of the “depth” of the communication management processes automation.

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METHODS of the ESTIMATION of the OPTIMUM DISTRIBUTION RESOURCE In CONDITION of the RISK ON MILITARY OBJECT RAISED DANGERS by METHODS to THEORIES IGOR

The Actual question in condition of significant increasing to probability of the arising the threats terrorist, criminal, техногенного, natural and the other nature there is making the system of the provision to complex safety, as obligatory condition of the operation potentially dangerous military object, as follows arsenal, the bases and composition of the arms, rockets and amunition, on which is kept armses and military technology.

In condition of the improper financing the measures of the safe operation arsenal, the bases and composition and prevention exceeding situation, on base of the presentations game theory can be built mathematical model, which will allow to find optimum distribution a resource in condition of the risk and uncertainties.

Origin on potentially dangerous military object to exceeding situation is an event as casual so and earlier time planned, which can take place on p - a miscellaneous сценариям. Preventive work that prevention origin exceeding situation also must be conducted for m- different directions. Depending on distribution of power and facilities between measure, which directed on safe operation potentially dangerous military object exist the different mixed strategies to activity on such object. The Main by element to this activity there is optimum distribution resource between miscellaneous system to safety for the reason achievements minimum level risk in data condition.

The Purpose of the studies is a development to mathematical model of the estimation of the optimum distribution resource in condition of the risk and uncertainties on base of the presentations game theory.

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POSSIBILITIES FOR THE USE OF RADAR SYSTEMS FOR PROTECTION OF THE PERIOMETER OF MILITARY OBJECTS OF ENHANCED RISK

Abstracts are devoted to the study of the possibilities of modernization and re-equipment of perimeter security systems at military objects of high danger (arsenals, bases, warehouses) of the Armed Forces of Ukraine.

In order to retrofit the system of observation of the situation in the arsenals, bases, warehouses it is proposed to include in its structure the system of early warning, observation and identification of movement of people and technology (EWS), manufactured by the American company AEROS.

The uniqueness of the EWS system is that it can be monitored simultaneously by terrestrial, air and surface conditions. In addition, the radar system allows simultaneously to carry up to 200 goals and depending on the size, determine their behavior. The system includes many mode radar, Full HD multi-spectral video surveillance system, ground control system, fire detection system.

Multi-mode radar, connected with the multispectral surveillance system provides the ability to conduct terrestrial surveillance, navigation, beacon detection, mapping and classification purposes, mapping terrain and detecting moving targets. The radar can detect moving ground targets at a distance of 90 km, and air-to-air targets up to 140 km.

The multi-spectral video surveillance system provides visual observation of targets at a distance of up to 30 km per day and up to 20 km at night. The fire position detection system provides for determining and issuing azimuth and height position of the arrow using the built-in passive acoustic detection system, computer signal processing, audio and video indicators.

In general, given the above, it can be stated that American development, if implemented in the Armed Forces of Ukraine, should increase the level of perimeter security in arsenals, bases and warehouses. At the same time, it should be added that Ukraine also has similar systems that can be used for the protection of military assets and have already shown their effectiveness in the course of hostilities in the eastern part of the country. This, in particular, the radar "Barsuk" radar and the "Lys-M" radar, which together with American systems can be effectively used to enhance the protection of problem areas of the perimeter of arsenals, bases and warehouses.

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DEVELOPMENT OF TRANSPORT AND LOGISTICS COMPLEX FOR THE NEEDS OF THE ARMED FORCES OF UKRAINE

However, power of the key principles of quality performance of military units assigned tasks is their comprehensive operational support. Given the shortage of means of delivery of military property, various types of security, existing in the Armed Forces of Ukraine (AF Ukraine), taking into account the foreign experience of the leading military countries and the experience of organizing the day-to-day operations of troops (forces) and operational support during the ATO and the operation of the joint forces, the AF Ukraine working to create a system of transport and logistics support. It will in the short term operative to transport military equipment (including mobile modular support systems) and organize daily activity of military forces in the field (during training in landfills in areas withdrawal of troops (forces) in ISAF in the aftermath of natural disasters or man-made disasters) and the transportation of military equipment. Thus in systems of proposed place on the basis of the transport container along that incorporates includes the following elements are modular, residential area (tent, container or mixed type), mobile container kitchen with dining room, medical center, modules Sanitary second zones, modules community maintenance, transportation and storage modules forstorage of property, fuel, food, special modules: headquarters, guards and communications, power generator, water supply and sewage treatment system, etc. In this case, the individual elements (modules), depending on the functionality and some features may apply separately from other (independently).

Seeing the need for rapid transportation of modules without any additional loaders, considered necessary and sufficient equipment of heavy goods vehicles systems "Multilift" and provide on vehicle set a lifting device that allows loading/ unloading operations. It is proposed to use special platforms for transportation of equipment and various loads.

According to STANAG, all modules in their characteristics must be: uniform in size, resistant to external climatic factors, have protective paint, equipped with appropriate life support systems, etc.

This approach is the creation of transport-logistics system for the needs of the AF Ukraine will create organizational logistic independent transport system that will be provided and equipped by means of loading/unloading, and to ensure in the short term delivery military and special property consumers and deploy mobile infrastructure in the field.

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PROPOSALS FOR SCIENTIFIC AND TECHNICAL SOLUTIONS FOR MODERNIZATION OF TROPOSPHERE COMMUNICATION STATIONS

The report shows the scientific and technical solutions for upgrading old park troposphere communication station (TCS) reasoning which performed during the research work, the implementationof scientific and technical support to several development work, studies dissertations on the subject, of patent search, participate in comparative tested equipment for temporary storage of foreign and blightly production, the operation of the upgraded TCS type R-417MU and P-423-1MU during the ATO and the Joint forces operation.

According to the latest results of the work performed :

the principles of construction of the equipment and its design are determined, the choice of the direction of works on the modernization of the old TCS fleet is made;

identified technical solutions for the construction of equipment and carried out the necessary calculations;

the analysis and selection of the functional algorithm of the TCS operation;

analysis and selection of the element base of the component products;

preliminary calculations of the reliability, external and internal electromagnetic compatibility of the equipment, etc.;

proposed a technical solution for the manufacture of a new body a van for the TCS .

Due to the conducted researches it is determined that the following indicators can be achieved during the modernization of the TCS:

ensure the transfer of digital information at speeds of at least 16 Mbit/sec by using tropospheric modem equipment of foreign production;

the use of a solid state tropospheric transmitter with reduced output power operating in the radio frequency range of tropospheric propagation of radio waves, which will allow to abandon the running wave lamps and amplitrons of the Russian Federation production with liquid cooling system;

the use of full-time waveguide devices, the reliability of which is confirmed by the operational performance of the TCS, with appropriately established requirements for the range of operating frequencies of the TCS, which will allow to reduce the cost of work during upgrades.

The scientific and technical solutions is justified by calculations, which confirming the improvements performance of TCS to perform assigned tasks.

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ISSUES OF CYBER SECURITY OF THE OPERATOR WORKSTATION

The paper report analyzes cyber threats and provides recommendations for cyber defense at the workplace of an automated workplace (military PC) of operator on the experience by ATO and the Joint forces operation, as well as the results of Cisco 2018 cybersecurity study.

In particular, armed confrontation is characterized not only by the use of conventional weapons, but also by the high level of use of information technologies. Computerization of control systems, communications and security processes has led to the emergence of a new plane of confrontation - cybernetic. One of the effective tools for influencing an enemy in cyberspace is computer viruses. That is why the issue of protection against their harmful action in contemporary armed conflicts is urgent .

First of all, this concerns the units of the Armed Forces of Ukraine, which perform tasks in the area of the operation of the Joint forces in the east of Ukraine. Exposing defensive positions, loss of strategically important information, failure of equipment – this all is probably consequence of a reckless attitude to viruses protection.

The Armed Forces have number of guidelines, which governing the protection of information and cyber security, implementation of their demands - direct responsibility of each operator workstation according to revented Reference infecting by the computer viruses . Therefore, for maximum protection workstation must necessarily Instalwool licensed antivirus software, regularly update it and regularly Scan wool computer. If necessary, perform an additional PC scan. Only regular updates guarantee the reliable protection of the PC against most computer viruses.

The convergence of operational and information technologies requires the introduction of a single automated security system. Important information infrastructures are increasingly being targeted by cybercriminals. Successful attack on themcauses malfunction and even destruction of physical media.

Operating systems, like all software, are flawed and contain error codes that allow you to control your computer and infect it with a virus. In addition, the danger is compounded many times by the fact that after the release of all the vulnerabilities become publicly known. In this way, any hacker will be able to get acquainted with the list of vulnerabilities, identify outdated systems and launch a successful attack.

Today, removable media remain one of the most common means of spreading computer viruses. The specificity of using these devices involves multiple connections to a variety of systems, making them a very effective tool for attackers. Thus, it is necessary to carry out checks and removable media before using them. In no case should connect you to the official PC unregistered carriers.

By downloading and installing unlicensed ("pirated") software, the underlying system is at high risk. These programs may be completely different from the original ones and perform their tasks perfectly, but they are actually spying on the user - collecting and analyzing information, transmitting it to an opponent, controlling a webcam, a microphone.

Outside unlicensed software may not be different from the original and perfectly perform their tasks, but actually lardwool for the user - to gather around you and analyzing cotton information, before the wool opponent.

According to the above, the list of basic recommendations on cyber defense is defined, namely necessary and sufficient:

1. Making an analysis of the potential risks and assessing of potential harm/ expenses in the event of cyber attacks.

2. Collection and district information were possible protection options and also probable threates. Collaboration with system integrators, consultants, equipment suppliers.

3. Network Security Tracking. If there are weaknesses in network security, there is a greater risk of theft of valuable information and attacks on individual servers and network devices.

4. Use Reference difficult uniques passwords and regularly as they change.
5. Refusal of the factory setting some parameters options of network devices:
- Changes spare passwords;
- Self set up in a Reference option and security devices;
- turn off services, in which there is no need tofavor the bath.
6. Always use encrypted connections whenever possible, even on local networks.
7. Direct access to surveillance cameras should only be carried out as required by the surveillance system. Client access to videomaterials should be carried out only in management videosystem or media proxy-server.
8. Regularly check and record access logs for unauthorized connections.
9. Constantly monitoring and so on by equipment. Whenever possible, you only enable the messaging feature supported by the system.
10. Download the wool latest versions of the software, as they may contain security patches.

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APPLICATION OF STRUCTURAL RADIO INTERFERENCE FOR JAMMING RADIO COMMUNICATION WHICH ARE USING NOISE SIGNALS

An important role in ensuring the benefits of commanding troops and weapons in modern combat operations is the electronic warfare (EW). One of the components of the EW is radio-electronic jamming, which aims to reduce the effectiveness of the enemy's radio means by creating interference.

Modern electronic means, as a rule, use noise signals for radio communication. One of the methods of generating noise signals is the modulation of the carrier frequency pseudorandom sequence (DSSS - in English language literature). The using of such radio signals has many advantages, one of which is the ability of radio communication systems to operate in the influence of powerful radio noise.

The analysis of radio suppression of radio systems with noise signals of the specified type suggests that the application of known types of radio interference will be effective at a sufficiently short distance (up to 5 km) between the interference station and the radio system receiver. Such conditions are unacceptable in combat situations where the interference station has to operate radio suppression to a depth of up to 20 km.

It is suggested to use structural radio interference for jamming the radio systems with noise signals, which will increase the radio suppression range and reduce radio interference of the interference station. The use of such impulse radio

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INNOVATIVE TECHNOLOGIES OF MULTIFUNCTIONAL REGULATION OF SOLDIERS' MENTAL CONDITIONS

Among the most important moral-psychological and psychogenic factors that determine the behavior of a soldier in the service, it is necessary to discriminate: the degree of moral and physical fatigue, the presence of a sense of fear, the level of motivation, fighting mood, the impact of stress.

It is the stress experienced by the military not only in fighting, not only after receiving fight physical and mental injuries, but also during exercises in peacetime, when the soldier realizes the complexity or danger of the tasks assigned to him and in the process of their implementation. Stress also depends on the degree of mental and physical fatigue (weariness) of the soldier, when there is irritation and excitement, depressed mood and poor concentration, tension and inattention.

According to the results of an experimental research of the features of the manifestation of negative mental States in soldiers, domestic scientists such as O. M. Kokun, I. O. Pishko, N. S. Lozinskaya, it was noted that the military personnel who received fight physical and mental injuries, more than 80%, can be diagnosed with "acute stress disorder" and "post-traumatic stress disorder", that is diagnoses associated with acute stress response. In such circumstances, the ability of the soldier to active and conscious action falls rapidly, which can lead to complete physiological, moral and psychological depletion of the body, if you do not provide him with psychological assistance.

For relieve tension, to ensure optimal response of the soldier to stress, we can recommend the technology of multifunctional regulation of mental States of the personality by emotional means, based on sound color software systems consisting of polymodal structural education: sound therapy and color therapy, combined, emotional impact which occurs on various analyzers (auditory, visual), on different parts of the brain (the structure of the limbic brain) and conduct commands from the Central nervous system to the working functions of the body (sensory, motor, associative.) Now let us clarify the conceptual apparatus on the problem of research. Multifunctional regulation is a potential possibility to perform several functions (activation, relaxation, neutralization) in the same ways, as well as a potential opportunity to influence the regulation procedure in different ways (trophotropic, ergotropic effect).

Emotiogenic methods in our research is different emotive techniques, which are evaluated by the person as significant, which can change the state, to generate, to develop, to cause the subject to a particular emotion, emotional experience, and emotiongenic depends on the purpose of regulation (relaxation / activation), motivation and needs of the individual, is determined by the force of the impact method, the significance of the stimulus that causes the emotional reaction of a person: changes in autonomic systems, behavior, expression, etc.

In our research, emotiogenic ways of mental states regulation we present two integrated parts of perceptual psychotherapy: a part of sound therapy, presented by methods such as music, biosimilars and binaural sounds, and a part of color therapy, presented by methods such as Yak colors (chromatic and achromatic), objects (natural and man-made), graphic methods for clear and blurry images that determine the regulation of military conditions.

At developing the method of sound-color regulation of mental states, *three types of software complex* sound-color regulation were identified: two main (relaxation and activation) - for relaxation and mobilization and one auxiliary (neutralization) - to stabilize, balance and harmonize the internal processes of the Respondent, which allows in the process of regulation to avoid sharp contrasts, the effect of disharmony, frustration and gradually, smoothly change the existing mental state of the type "relaxation"/"activation".

When developing the *content and software systems* were taken into account: preferences of the respondents; the period of training; temporal features of regulation of the type "Relaxation"/"Activation"; the specifics of their influence; structural and functional quality of components; full immersion in the regulatory complex, as well as *seven criteria* for describing the impact of the used emotional methods of regulation: objective (the achievement of catharsis, the phenomenon of inertia, the coincidence of the criteria of influence, time patterns in the creation of software systems) and subjective (expressiveness, activity, dynamism), which provided the maximum effectiveness of the influence of the proposed CD-Discs.

Thus, a fundamentally new method of solving problems associated with emotional experiences is considered, the author's technology of multifunctional sound-color regulation of mental states of the individual, which will provide an optimal response to the stress of servicemen in the emotionally-colored period not only in fight, not only after receiving fight physical and mental injuries, but also during training in peacetime, when the soldier realizes the complexity or danger in the performance of his tasks.

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METHODOLOGICAL AND TECHNOLOGICAL BASIS OF DECISION-MAKING SUPPORT

The support and decision support systems (DSS) are intended for informational, methodological and instrumental support of decision-making processes and decision-making by decision makers (DM) at all stages of management.

The methodological principles of the creation and functioning of the DSS should include the principles: insufficient solutions; absorbing diversity; hierarchical compensation and additionality; polymorphism and multicriteria; self-similar recursive description and simulation of research objects; homeostatic balance of interaction and overcoming the principle of division; the principles that underlie the creation of ontologies; the principles of Le Chatelier-Brown (any external influence generates an appropriate self-organization response aimed at attenuating this effect); principles of decomposition and aggregation; the principle of rational multicriterial compromise in the presence of irresistible limit information and time constraints; the principle of interactive iterative decision making in the conditions of uncertainty and contradiction of the source information.

The technological principles of the creation and operation of the DSS should include:

object-oriented approach to the description of the domain DSS;

service-oriented technologies for the construction of systems for the collection, processing, analysis of data, information and knowledge distributions;

personalized user interface, which is automatically adjusted to the conditions of the equipment used;

organizational, informational and functional unity within the framework of a single information space and unified software platform based on a single data model;

the technology of distributed development, personal participation of experts (analysts) and knowledge engineers in the conceptual and logical design of ontological-oriented knowledge bases, construction of intelligent intelligence operational and analytical processing scenarios;

open source code and lack of license fees to foreign producers; cross-platform support.

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TEXTILE MATERIALS WITH ANTIBACTERIAL AND FUNGICIDAL PROPERTIES

Textile materials with antibacterial properties are intended for the manufacture of clothing, textile products for medical, departmental and special purposes. When using textile materials with these properties is achieved human protection from external infection, reduced the risk of infectious process on the skin at the expense of autogenous infection and the transmission of infection to the environment is minimized.

Developed the method of obtaining bactericidal textile materials by obtaining dye on the fiber with specific antibacterial properties. This allows to maintain sufficient resistance to wet and dry friction of dyed textile materials and has a prolonged action. The working substantially expands the range of textile materials for special purposes for example, (to reduce the risk of epidemics). The introduction of the drug with antimicrobial and fungicidal action in the process of textile finishing is possible at the modern enterprises of the textile industry without significant changes in technological design.

State intellectual property protection - Patent of Ukraine57136, 2011 y.Method of processing of fibrous materials.

The state of readiness of working - the technology for obtaining antibacterial and fungicidal fibrous materials has been developed, and experimental samples have been obtained.

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THE WAY OF DEVELOPMENT OF THE WEAPONS SYSTEMS OF AIR (LAND) MOVING OBJECTS

Analysis of the fighting of armed conflicts of the XXI century confirms the widespread use of air (land) robotic systems.

The main purpose of using robotic complexes is to test them in combat and determine the likely ways to improve them.

Anti-terrorist (ATO) analysis shows the widespread use of small aircraft or low altitude aircraft to inflict fire on important ground objects. In most cases, it is impossible to counteract such UAVs.

Thus, there is a need to find new and effective means of defeating them.

To solve this problem, it is proposed to use guided minefields with directional engineering mines in combination with means of detecting air (ground) targets. This approach should ensure: monitoring of the designated area; early detection of airborne (ground) targets in a designated area; determination of coordinates, distances and other geoinformation data; support, assessing the level of threat, transferring the information received to the command and control of troops and weapons, and the possibility of defeat air (ground) targets without the participation of the operator or under the guidance of the operator and the possibility of self-liquidation in the event of capture by the enemy.

In this way, the introduction of small-scale air targets into a managed minefield management system will allow early detection, fixation and remote sensing of airborne (ground) targets and reduce the likelihood of impacting important ground objects, thereby increasing the effectiveness of the minefield being managed.

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PROSPECTS OF USE OF ARTIFICIAL INTELLECTUAL ELEMENTS IN AUTOMATED CONTROL SYSTEMS

Automated control systems should be considered as a key component in the use of the armed forces at the present stage.

Given the rapid development of artificial intelligence and machine learning technologies, the following possible areas of application of automated control systems for the exchange and processing of artificial intelligence data should be outlined:

1. Service forecasting. The use of tactical networks will allow units to be deployed using artificial intelligence to streamline maintenance and improve troop readiness.

2. War Games. Artificial Intelligence will help commanders explore several possible areas of action, develop placement scenarios, and deploy forces to ensure that tasks are successfully completed in future operations.

3. Operational (combat) support. For optimal planning of the use of troops, a number of information flows are used: GPS data, traffic, weather, terrain information as well as information about local friendly and hostile forces. Rapid analysis of such information is impossible without the use of artificial intelligence.

4. Direct use. The use of artificial intelligence elements will allow the analysis of data management capabilities, their interpretation and use by both commanders and individual soldiers.

As there is a need for constant coordination of information, collective planning, changes in the conduct of modern transient operations while reducing the number of people in dangerous areas of the battle using special software will provide: streamlining of technological requirements for control points;simplification of hardware aspects of military deployment;reducing the load on the communication system and sharing information.

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PROBLEMS OF CREATING A MODERN INTEGRATED DATABASE

The modernization of automated (information) systems is accompanied by the introduction of new technologies that require improvement of the data system of the respective systems. When moving from one data system to another, usually the same problems arise.

Modern analytical systems should rely on an integrated database to house aggregated information, but databases created over the past 20 years using classical methods have not been built for use in modern 21st century information processing systems.

The experience of the US Defense Intelligence Agency (DIA) shows the need to create a comprehensive, adaptable and scalable data environment. Due to the large amount of data that needs to be processed (analyzed), it is necessary to create a modern system that will provide marking and ordering of information and allow analysts to use applications to sort and process such data to obtain the desired result.

However, there are four significant issues to consider when building such an integrated database:

resolving data discrepancies;

data storage;

black box problem;

hereditary systems.

1. The most urgent problem with creating a single resource is that the data entering the system is marked and processed evenly, since the data collected by different sources of information is not always compatible.

2. Because of the staggering amount of data that can be processed, the placement, such as images and videos, takes up a lot of space. Because of this, the system does not actually have to store all the data itself. Instead, such a system should be able to index this information through a link to access data hosted on other servers.

3. When creating a massive dataset, it is advisable for all information to be understood, which means that users should be able to see the source of the information. In other words, whether users and systems can get their results, and sources explain the history of information without relaying that information. who do not want to disclose their methods or their own information.

4. Many legacy systems will not be able to automatically integrate into the integrated database, and some legacy systems will not be able to use the new system, but will remain robust separately.

Therefore, when creating a modern integrated database, it is advisable to support the financing of both areas of database creation. This is necessary until these legacy systems can be replaced or upgraded.

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BASES OF CYBERPOLYGONS CREATION FOR CYBERSECURITY EXPERTS PREPARATION

Until recently, it was believed that there are four types of battlefield: land, sea, air and space. In this case, information technologies had only supporting role:

communication, automation of control, etc. However, in modern world, a significant part of combat actions has already been transferred directly to the cyberspace, that means it is already considered as a separate space for warfare. Its exclusiveness is due to the fact that he is the only one of all five currently mastered spaces of an extraterritoriality, since almost devoid of geographical constraints.

Cyberthreats and attacks are becoming more widespread, sophisticated and devastating. The task of developing the new forms, variants and methods of cyber threats counteracting, protecting critical infrastructures, society, government and state security sector with the implementation of a complex of information security measures in cyberspace is set. Thus, there is an actual problem of the creation of cyberpolygons for the study of complex cyberactions and the training of cyber security experts in order to accomplish tasks of development of methodological support for automated monitoring, analytical processing of information, forecasting, planning and implementation of passive and active countermeasures against information threats in cyberspace.

The development and production of effective cyberpolygons is carried out from basic discrete components. The structure of the cyberpolygon must consist of two or more identical in purpose, composition, functional capabilities of sets of special software and hardware complexes: a set of tools simulating the forces and assets that carry out cyberinfluence and fulfill the tasks of cyberdefense; a set of testing tools.

A set of tools that imitating the forces and assets that carry cyberinfluence and perform the tasks of the cyberdefense, is designed to study actions in cyberspace, provide cybersecurity for services of cyberpolygon data center, as well as an assessment of the influences on personnel via cyberspace.

A set of testing tools is designed to assess the functional stability of services of cyberpolygon data center.

The testing complex is comprises a powerful data center, which services are protected by forces and assets that simulating the forces of cyberdefense, but on the other hand they are tested for the cybersecurity by forces and assets of the second set.

The cyberpolygon kit must include components as follows: a subsystem of cyberspace and its components analysis; subsystem of analysis and research of domain activity in cyberspace; subsystem of determination and analysis of technologies of cybersecurity on the control systems, network (physical and logical) topologies, software and hardware data center services support; subsystem of simulation of measures and assets of cyberdefense, wired and wireless networks of the data center; subsystem of modeling technologies of data protection of data center operators via cyberspace; subsystem of modeling and simulation of actions in cyberspace; subsystem testing data center services for cybersecurity; subsystem of analysis and support of actual databases of cyberincidents and cyberthreats; subsystem of activity analysis in the blogosphere, social networks and e-media; subsystem of determination and analysis of technologies of information influence on operators of the data center via cyberspace; subsystem of cryptoprotection; subsystem of cyberattacks on the data center cryptosystem simulation.

The main tasks that can be worked out on the cyberpolygon.

Cyberintelligence task: OSINT-intelligence; network intelligence; computer program intelligence; intelligence of C2 systems; intelligence and getting access to wireless networks.

Setting up and testing a telecommunication network task: setting up network devices; measurement of telecommunication network parameters; simulation of a telecommunication network with losses.

Cybersecurity task: detecting of port scanning; control of network data traffic size; interception and analysis of Internet traffic.

Cyberinfluence task: DoS- and APT-attacks; influence via cyberspace and in cyberspace; carrying out of SMS-attacks; interception of the session; control of remote computers in LAN.

Therefore, when using such cyberpolygons, the training of the relevant experts will be carried out in the fulfillment of specific practical tasks on the software and hardware of the cyberpolygon. In this case, the method of semi-real modeling with principles and techniques of game theory will be used, the antagonistic conflict between the conditionally opposing sides acting on its basic discrete components of the cyberpolygon will be implemented. Depending on the research objectives, scenarios of action are developed. Documenting the results of the cyberpolygon actions, its aposteriori analysis supports creation of new forms, variants and methods of counteracting the challenges and threats of terrorism, protection of critical infrastructures, society, state and military leadership, specific individuals.

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FEATURES OF TRAINING OF PROFESSIONALS AND SCIENTIFIC RESEARCH ON CYBER SECURITY AND CYBER DEFENSE IN LEADING COUNTRIES OF THE WORLD AND UKRAINE

To date, cyberspace has become a separate area of struggle, where multiple incidents and multiple destructive incidents are ongoing. According to the purpose, tasks, forms and methods of providing cyber security in the military sphere and the implementation of the cyber defense involved in this force and means, typical structures of governing bodies have been formed in the leading countries of the world. A feature of their formation in the leading countries of the world was the combination in cybercomponents of activities related to each other the space in which the actions are carried out and the ultimate goal.

Practically each of the leading countries in the world has military educational institutions, which focus on the training of specialists of all levels and conduct research on these issues in the interests of national security and defense.

In the leading countries of the world (Great Britain, the Federal Republic of Germany, the Republic of Poland, etc.), the effectiveness of solving these problems is achieved by forming and ensuring the functioning of technological military higher education institutions that carry out educational and scientific activities in a high-tech direction on a single basis. For example, such integration of military education and science in high-tech areas has been successfully implemented at the Military University of Technology (Poland), where all high-tech areas (including cybersecurity, information technology, electronics, robotics, aerospace, etc.) are concentrated on one base. The same has been implemented at the University of the Bundeswehr in Munich (Germany) and at similar educational institutions of other NATO member countries. Currently, a military institution of higher education - the Cybersecurity Academy in Hungary - is being formed. Due to the integration of high-tech areas of specialist training and research in a single educational institution and at a single base in the leading countries of the world, they ensure the elimination of duplication and dispersion of efforts in solving the same tasks, rational use and saving of resources and personnel potential, polygonal base effective execution of orders for the training (retraining) of specialists and the implementation of research for all ministries and agencies of the security and defense sector AVI.

Based on the priorities identified in the Strategic Defense Bulletin for the Armed Forces of Ukraine, taking into account the experience of military operations in the East of Ukraine and the best world practices, Ukraine needs a single higher level tactical education institution to train military personnel in high-tech areas similar to NATO member states.

At the tactical level, training should be provided to improve the training of non-technical military personnel to gain a fuller understanding of the technological aspects of cybersecurity and a sufficient understanding of cybersecurity policies, both in national security and defense, and internationally. At the same time, in order to improve the effectiveness of training specialists in high-tech areas, to provide a constant update in line with the development of science and technology knowledge in all spheres of cybersecurity (cyber defense, cyber defense, cybercrime, counter cybercrime, protection of critical infrastructure objects, etc. in the sphere of critical infrastructure, etc.) subject to best practices of EU and NATO member states.

For the Armed Forces of Ukraine it is also necessary to provide training of operational and strategic level officers for the cyber security and cyber defense system and acquisition by all officers who receive operational and strategic education regardless of the industries, specialties and specializations of training, competence and knowledge not only from the basics of cyber security spheres, cyber defense and cyber intelligence, but also in relation to: the state and tendencies of development of high and information technologies and their application in the fields of security and defense us; information-analytical activities and simulation modeling in these fields;

organization of the use of automated systems of control of troops (forces) and systems of type C4ISR; organization and application of technical systems for monitoring (intelligence) of operational (combat) space in the interests of troops (forces); application of modern geoinformation technologies and systems in the interests of the troops (forces); covert military command and comprehensive counteraction to technical intelligence; basics of information protection; strategic communications in the field of defense and the like.

Scientific research in the Armed Forces of Ukraine should be conducted on the development of cyber security and cyber defense systems in Ukraine, definitional and regulatory frameworks, transformation of military management bodies in this field, training, development of cybersecurity and cyber defense concepts and strategies, forms, methods and technologies of cyber security on the basis of an analysis and integration of experience in these matters and in cooperation with NATO countries.

Thus, the improvement of training and research on cybersecurity and cyber defense in Ukraine remains relevant.

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MODERN STATE AND DEVELOPMENT DIRECTIONS OF AUTOMATED ARMED FORCE MANAGEMENT SYSTEMS OF UKRAINE

The current military and political situation in the world, and in particular in Ukraine, proves that in today's high-tech war, the one who is quicker to identify the enemy and deal a preventive blow wins. According to some experts, one battalion tactical group equipped with effective means of automated military control systems (AMCS) is equivalent to three similar, unsuitable equipment.

If one considers in detail the situation in the area of the Operation of the Joint Forces (OJF), it becomes clear that the enemy of the Ukrainian side has the advantage in terms of numbers and firepower. The main goal of such systems is to increase the efficiency of management by automating the basic management processes, as well as integrating the intellectual objects of the system into a single information space and real-time display of the operational environment.

Having analyzed the experience of the leading armies of the world, we can identify the following perspective directions for the development of AMCS: unity of software at all levels of AMCS; control in different configurations; simplicity of interfaces; use of wireless, self-organizing networks (Mesh; Ad-Hoc; MANET, etc.); development of nanoelectronics; work in real time; the availability of the necessary information at each tactical level of the classifier; training of highly qualified specialists for operation and maintenance of modern AMCS.

Obviously, due to objective and subjective factors, the successes in the design and implementation of the AMCS of the Armed Forces of Ukraine will not be achieved soon. Therefore, it is proposed to start with the development of the system of detachment of individual troops, by analogy with the Armed Forces of the Russian Federation. In the face of hybrid warfare, the most challenging tasks lie with the Assault Troops (Special Operations Forces) and the Missile and Artillery units. Therefore, the construction of a unified control system should start with the automation of units of these sorts of troops

Therefore, the information system of the Armed Forces of Ukraine should be based on a global information system.

This infrastructure should be based on a single three-tier system, in which the strategic, operational and tactical levels and governing bodies are interconnected vertically and horizontally behind the strategic prince of a single information space.

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ALGORITHM OF DETECTION AND FORMATION OF RADIO INTERFERENCE TO RADIO COMMUNICATIONS WITH BROADBAND SIGNALS

In recent years, the level of development of electronic equipment intended for the management of military equipment and equipment armed with foreign states has increased, and the capabilities of electronic means of combat of the Armed Forces of Ukraine have increased. This determines the need for the modernization or development of new electronic warfare tools that will provide the required promptness and quality of radio suppression of enemy radio communication channels during combat.

To date, the undetermined task is to detect and suppress radio channels with broadband signals.

A variant implementation of the algorithm for detecting and forming radio interference to radio channels with broadband signals is proposed. This will increase the likelihood of detecting radio channels with broadband signals, determining radio parameters and generating effective radio interference.

It provides mathematical support for the algorithm and the algorithm for detecting and forming radio interference to radio communication channels with broadband signals. The results of researches of the developed algorithm for detection of broadband signals and formation of radio interference by radio communication channels with such signals are presented.

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GENERATION OF POWERFUL EXTENDED ELECTROMAGNETIC UHF PULSES: PROBLEMS AND THEIR SOLUTIONS

In accordance with the order of the Cabinet of Ministers of Ukraine of June 14, 2017 No. 398-r "On Approval of the Main Directions for the Development of Arms and Military Equipment for the Long-Term Period" the army needs equipment of electronic warfare for unmanned aerial vehicles, as well as means of functional damage (electromagnetic weapons) of radio-electronic means.

Generation of powerful microwave pulses allows for the application of electronic and combined electron-fire strikes to eliminate the failure of a semiconductor elemental base used in radio-electronic devices (RED) of weapons and military equipment at distances from hundreds of meters to tens of kilometers. In addition to a temporary violation of the functioning (functional suppression) of RED, which allows further restoration of their efficiency, powerful ultrashort microwave pulses can carry out physical destruction (functional damage) of semiconductor elements of RED, including those in the off state. And this effect is greater than the lower level of integration of the electronic component base used in the device. Thus, it may be possible to influence the electronic ignition systems of internal combustion engines of cars, electric or radio detonators installed on munitions such as missile, bomber and artillery shells, their operation or disturbance of control mechanisms or unmanned aerial vehicles, for withdrawal they are out of order.

Such electronic systems should have output power ranging from tens of MW to units of GW. For this purpose, as a prescriptive generator, powerful vacuum microwave devices (classical and relativistic magnetrons, winders and others) are used. In order to form a short output signal of required power, the microwave device is loaded on a resonant microwave compressor (the principle of resonant compression of the energy of microwave pulses), which, in turn, after accumulation of the required energy level, gives it in a pulse of nanosecond duration (up to 1 ... 10 ns) One of the problems in creating such an installation is to reconcile the work of the microwave device and the resonant microwave compressor, and, also, the creation of such a compressor, which will allow the safe accumulation of microwave energy.

The main task of this report is to create a concept for the implementation of the installation to generate powerful ultrashort microwave pulses for its use as one of the main elements of the system of functional damage.

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METHOD OF THE STATE EVALUATION OF THE MIMO SYSTEM CHANNEL

MIMO technology has been found to be practical in many modern telecommunication systems, in wireless LANs of the IEEE 802.11n standard, as well as WIMAX and LTE mobile wireless networks, and others.

The most commonly used methods are the practice, the essence of which is that the alignment and estimation of the impulse response of the channel (IRC) are based on a known learning sequence receiver, transmitted by the transmitter at the beginning of each communication session. However, in multi-user networks, the transfer of learning sequences to each user connected to the network results in a sharp drop in average transmission speed. In this case, the methods of blind alignment and IRC evaluation are used.

The method of blind leveling in comparison with suboptimal blind IRC evaluation algorithms require much less computation in practical implementation, but have higher convergence time by 1-2 orders of magnitude. In addition, many methods of blind leveling can not function fundamentally if the channel transfer rate has zero in the frequency domain.

However, in most cases, the evaluation of only the impulse characteristics of the channel does not allow with the given reliability to conduct an assessment of the channel MIMO status in the dynamic signaling and noise situation, therefore, it is proposed to assess the status of channels MIMO system for several indicators.

The method of assessing the status of the MIMO system channel consists of the following steps: input of output data; calculating the impulse channel characteristic metrics; calculation of the last elements of impulse channel characteristic; defining a vector of errors; updating impulse channel rating estimates; formation of channel evaluation.

The scientific results of the research presented in the report make it possible to formulate the following conclusions: the computational complexity of the proposed method of invariant length of the IRC and for large lengths yields a significant gain compared to the search algorithm for a grid with a reduced constellation.

The computational complexity of the proposed method for the invariant length of the IRC and for large lengths yields a significant gain compared to known algorithms for searching on a reduced-constellation lattice.

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METHOD OF SELECTION TOPOLOGY AND MODES OF WORKING MILITARY RADIO COMMUNICATION SYSTEMS ON THE BASIS OF IMPROVED GENETIC ALGORITHM

Military radiocommunication systems (MRCS) represent a set of autonomous mobile radio links that connect to each other through radio channels. Conducted analysis showed that the existing methods of selecting the topology of MRCS and operating modes, developed to date, mainly use as a source data a limited number of possible variants of the actions of electronic warfare. Investigation of the entire space of decisions in determining the rational structure of the MRCS was complicated by the large amount of necessary calculations and the impossibility of an analytical description of the objective function.

For this purpose, it is proposed to develop a methodology for choosing the topology and operating modes of MRCS on the basis of an improved genetic algorithm.

Genetic algorithm is based on the idea of evolution through natural selection and represents an artificial simulation of such properties of wildlife as natural selection, adaptability to environmental conditions and hereditary properties of parents. Essence of the genetic search is the cyclical replacement of one population with the following, more adapted.

Main stages of the implementation of the methodology:

input of output data;

formation of a plurality variants of the topology of the MRCS;

reformatting the vector of alternative variables of each variant in the chromosomal set of genes, characterizing the topology of MRCS and the modes of operation of each radiocommunication facilities;

choice of cross-curriculum scheme

choice of training scheme for reproduction

transition to a new parent pair

restriction of the plurality of the reproduction group;

determining the degree of fitness;

inclusion in a reproductive group option or exemption from the reproduction group.

The structure of the MRCS was presented as two-dimensional incidence matrix. This matrix was used as a chromosome by operators of the genetic algorithm.

So, the developed method allows to increase the noise immunity of MRCS due to the formation of rational topology and operating modes of radio communication by 25-40%.

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METHOD OF BEAMFORMING OF ADAPTIVE ANTENNA ARRAYS OF MILITARY RADIO COMMUNICATION MEANS IN THE AD-HOC NETWORK

Modern military UHF radio communication means provide work in the MANET mode – Mobile Ad-Hoc Network. In particular, these are radio stations produced by the companies Harris and Aselsan. In this case, as a rule, work is carried out on an antenna with a circular radiation pattern. It is expedient to use such an antenna in the circular transmission of voice information and data; however, in the Ad-Hoc network in the point-to-point connection mode the use of such antennas does not allow for the maximum efficiency of both individual radio lines and the network as a whole, since most the energy of the transmitter is spent to transmit the signal in unnecessary spatial directions.

To improve the efficiency of the Ad-Hoc radio network, it is advisable to use adaptive antenna arrays. This will reduce the level of interference, increase the overall bandwidth of the network due to the possible reuse of the time-frequency resource and increase the signal-to-noise ratio at the receiving point, increase the network connectivity, increase the noise immunity of radio equipment by adaptively generating the zeros (failures) of the diagram direction of the antenna in the direction of the source of interference.

The paper describes the method of adaptive beamforming on radio links of the Ad-Hoc network in conditions of jamming.

The main stages of the implementation of the method:

input of output data (transmitter power, receiver sensitivity, operating frequencies, antenna array type and its radiation pattern);

estimation of the signal-interference situation, determination of azimuths from neighboring correspondents and jammers;

calculation of the indicative values of the signal-to-noise ratio at the receiver input for neighboring correspondents and for different orientations of the antenna array radiation patterns, taking into account detected jammers;

selection of the correspondent for packet transmission and antenna array parameters optimal for the signal-to-noise ratio at the receiver input.

The developed technique allows to increase the signal-to-noise ratio at the receiver input of the Ad-Hoc network in conditions of jamming due to the rational selection of the correspondent for the transmission (reception) of information and selection of parameters of the adaptive antenna arrays depending on the network topology, location of the jammer station's and their characteristics.

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FEATURES OF DEVELOPMENT OF COMMUNICATION SYSTEMS AND INFORMATIONS OF ARMED FORCES OF GUIDING COUNTRIES

Providing information superiority over enemy control systems, improving the quality of providing information and telecommunication services to the authorities is considered as one of the priority areas for increasing the combat capabilities of troops.

The analysis of the construction of communication systems of operational, operational and strategic parts of the management of Israel, Austria, Finland, Sweden shows that their common integration with the communication networks of civilian operators, the high level of branching and technical equipment of the stationary systems of military communication.

The military leadership of the Russian Federation (RF), as the main ways of improving communication systems, sees the complex development of the territorial communication systems (TCS) of the regions, the construction of public communication systems (PCS) of associations that integrate all types of information exchange, automatic switching of channels and messages and secrecy of them with guaranteed stability. The main component of the PCS will be the reference (transit) communication network, the high structural survivability of which will be achieved by providing the necessary density of spatial coverage of the operational construction of the troops of the association.

Thus, the characteristic features of the development of communication and information systems of the armed forces of the leading countries today are as follows: application of the same architectural principles of network construction for all levels of the control system; application of unified technical devices of communication and automation and standards at all levels (providing interoperability); provision of typical telecommunication services at all levels of the communication system: language, data (IP data), video (from low to high speed); the possibility of creating operational (situational) networks depending on the tasks set; creation of interconnected automated control systems capable of functioning in a single information space; widespread use of civil standards, protocols and technical solutions; observance of uniform (for NATO) standards, agreements and recommendations; ensuring the full integration of military and civilian systems and communication facilities and the use of communication lines leased to civilian agencies of NATO member countries.

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GROUNDS OF FACTORS, WHICH AFFECT THE PLANNING AND MANAGEMENT OF THE RADIOELECTRONIC DEVELOPMENT

The military-political situation around Ukraine is characterized by high dynamism and instability of events and processes. Against the background of the main task of the Armed Forces of Ukraine at the present stage of development is the intensification of intelligence in order to timely prevent the top leadership of Ukraine about possible armed aggression of the Russian Federation, bringing its troops (forces) to higher levels of combat readiness and preventing the active actions of illegal armed groups.

Providing information superiority over the enemy today is becoming a prerequisite for conducting military operations. The main kind of information support is military intelligence, and its basis is radio-electronic intelligence. The authors of the above-mentioned research carried out an analysis of the influence of external and internal factors influencing the efficiency of conducting radio-electronic intelligence.

In the course of the research, the authors used the basic provisions of the theory of radioelectronic intelligence, the theory of communication, the theory of electronic warfare, the theory of signals, and general scientific methods of analysis and synthesis.

According to the results of the research, it can be concluded that the effectiveness of conducting radio-electronic intelligence is influenced by:

the state and level of combat training and combat readiness of the personnel of the maneuverable group of radio-electronic intelligence;

operational and technical capabilities of electronic intelligence tools and complexes and communication of the maneuverable group; the need to move a maneuverable group of radio-electronic intelligence;

fire influence of the enemy; restrictions that take into account the influence of electronic warfare devices; natural, meteorological, geographical conditions, and so on.

The influence of these factors leads to incomplete realization of the objective capabilities of the maneuverable group of radio-electronic intelligence, and in a number of cases, to their significant decrease.

Taking into account the above, the direction of further research should consider the development of a scientific and methodical apparatus for improving the efficiency of conducting radio-electronic intelligence by maneuverable groups of radio-electronic intelligence.

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METHODICAL APPROACH TO THE EVALUATION OF THE EFFICIENCY OF THE DEVICES OF RADIOELECTRONIC STRUGGLE

The intensive development of information technologies and their integration into a single information space leads to an increase in the role of these technologies in the processes of troops (forces) and weapons control in the course of conducting operations. At the same time, a large part of the material basis of the information infrastructure created within the framework of the concept of a network-centric warfare constitutes radio-electronic devices that are potentially vulnerable to radio electronic suppressing (RES). The analysis of the experience of the use of RES tools has shown that in practice there are cases where the level of effectiveness of the use of these devices is lower than necessary.

One of the primary objectives of increasing the efficiency of the use of repos equipment is to provide an objective and accurate assessment of this effectiveness, taking into account the influence of all weighty factors and real conditions (including inaccuracies or uncertainties about the objects of suppression and their elements). Thus, the development (refinement) of methodical approaches to the evaluation of the effectiveness of the use of RES is important and relevant scientific and practical task.

In accordance with the above-mentioned task, in the course of the research, an approach to the selection of rational indicators for assessing the effectiveness of the use of RES equipment was substantiated. At the same time, the potential of these devices for fulfilling the tasks is proposed by describing the corresponding vector space, each point of which is determined by a vector, which includes a set of indicators that describe the main capabilities of the RES.

The proposed methodological approach to the evaluation of the effectiveness of the use of RES tools in the course of conducting operations (combat actions) allows using a combination of system-resource approach to calculate indicators on the basis of the principle of multilevel description of the composition of the RES, when the multi-dimensional structure of its integral index (level of functioning) is gradually filled with parametric content, which is an advantage of this methodological approach. Also, the proposed approach allows to quantitatively develop recommendations on the choice of rational indicators of the combat composition of the RES, which are the most suitable in line with the tasks set, to determine the level of functioning of the RES devices by converting their partial indicators.

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ELECTROMAGNETIC COMPATIBILITY GROUP ESTIMATION CONCERNING GROUND BASED COMMUNICATION SYSTEMS

The conditions of electronic system functioning are characterized by considerable level of mutual interference that is impacted by the large number of electronic systems operating simultaneously, undesired radiations of their transmitters, and also by receiver's ability of receiving radiations that differ from working frequencies of electronic system in frequency domain. As a result, the abilities of mutual, simultaneous, and independent electronic systems operating are confined. Increasing the number of traditional electronic systems and appearing new radiocommunication services of different assignment (cellular networks, trunked radio systems, wireless broadband networks, and so on), that have been taking place during the last decades, evoke abrupt worsening electromagnetic environment.

In this work we consider forming electromagnetic compatibility (EMC) group estimate concerning ground based communication systems to create radiofrequency monitoring informational system operating within group of troops (forces). Operational efficiency of radiofrequency monitoring informational system is defined by its processing speed and accuracy that depend on complexity of the models used for calculations, inasmuch as estimation involves mutual influence of thousands of electronic systems operating within entire group of troops (forces).

The obtained results of EMC group estimation are intuitively comprehensible, thus that confirms the adequacy of mathematical apparatus creating the basis of the proposed technique.

The developed technique of forming EMC group estimate allows obtaining adequate results concerning tactical level communication system group without using considerable computational resources having at one's disposal minimum prior information on communication systems: main specification (transmitted power, frequency band, channel bandwidth, level of out-of-band emissions, and level of spurious emissions) and their coordinates (or electronic objects deployment zones).

The developed technique of forming EMC group estimate provides possibility of simulating communication systems operation under complex mutual influence conditions, that, first, allows saving considerable both material and financial resources when prior exploring necessary EMC level within group of troops (forces), and, second, allows substantiating technical requirements with respect to communication systems to be developed concerning the required EMC level when they operate within common group of troops (forces).

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PROVIDING INTERFERENCE IMMUNITY OF GLOBAL NAVIGATION SATELLITE SYSTEM SIGNAL RECEIVERS

The problems of increasing interference immunity are rather important but till nowadays could not be solved within a lot of applications related to developing global navigation satellite system (GNSS) signal receivers for military needs. These problems are elucidated by quick and effective development of electronic countermeasures systems, abrupt increasing mutual interference level due to electronic system number growing, and also by increasing the level of interference of industrial origin. Analysis of Russian Federation electronic warfare (EW) systems implies that jamming military GNSS receivers of ground platforms can be provided by both multifunctional land based EW systems with considerable energetic potential and small-size small-powered both land and aerial based EW systems specially designed for GNSS terminal jamming.

The twofold goal of the work is, first, estimating necessary level of electronic counter countermeasures of GNSS terminals taking into account possible jamming from adversary side, and second, establishing the ways of providing GNSS terminals efficiency under severe jamming conditions.

We estimate necessary level electronic counter-countermeasures of GNSS signal receivers providing land platform exploitation operating under conditions when the enemy creates electronic counter measures by means of land and air electronic warfare platforms. Taking into account necessary calculated level of noise immunity that is characterized by jam suppression coefficient of 86 dB, we conclude that formulated problem can be solved by employing GNSS signals space filtering algorithms based on using antenna arrays.

We consider adaptive space filtering algorithm, built on the basis of recursive method of forming inverse covariance matrix estimator, processing the signals of GNSS under severe jamming conditions. On the basis of this algorithm we create mathematical model of anti-jamming GNSS signals receiver functioning under jamming conditions. By created mathematical model with help of computer simulating signal receiving and processing in circular antenna array we estimate the efficiency of anti-jamming GNSS signals receiver functioning under jamming conditions. We make a conclusion that desired jam suppression coefficient can be achieved by employing 25-element circular antenna array with special configuration based upon recursive method of forming inverse covariance matrix estimator when prior forming initial values of weight coefficient vector of antenna array to provide initial necessary antenna patterns.

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PROVIDING INTERFERENCE IMMUNITY OF COMMUNICATION AND INFORMATION TRANSMISSION SYSTEMS

Providing interference immunity of communication and information transmission systems is the most important problem taking place on their developing and exploiting. The necessity of solving this problem is elucidated by continuous increasing the level of intersystem interference between communication systems within created group of troops (forces), and on the other hand, is connected with fast developint electronic warfare systems. Providing interference immunity problem is rather topical and until now it could not find its own solution within communication systems added to Armed Forces munition.

It is possible achieving the essential increasing channel capacity of information transmission systems by enlarging channel bandwidth without increasing carrier frequency.

Thus, when developing multiaddress information transmission systems for the purpose of providing necessary channel capacity and decreasing signal power spectral density, and at the same time, increasing interference immunity, the spread spectrum methods found their application.

For the purpose of implementing spread spectrum method taking into account electromagnetic compatibility requirements when developing multiaddress information transmission system it is expedient to choose the system with Code Division Multiple Access based on Direct Sequence with Continuous Phase *M*-ary Frequency Shift Keying and Quadrature Phase-Shift Keying (DS-CDMA-CP-MFSK-QPSK).

Perspective trend of increasing interference immunity of modern communication systems is based on exploiting spread spectrum signals and also on dynamic radio frequency (RF) spectrum use.

The necessary degree of interference immunity is achieved by providing reticence of operating communication systems and also by the corresponding difficulties during RF jamming them by the modern electronic warfare systems.

The considered technologies of modern communication systems with high interference immunity degree could be used when developing perspective command, control, and communication systems and also multiaddress information transmission systems.

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DEVELOPING PERSPECTIVE INTERFERENCE-RESISTANT TACTICAL SIGNAL INTELLIGENCE SYSTEM

Fast pace of spreading electronic systems within all spheres of human activity and continuous technological progress in the branch of developing communication systems that operate on the basis of collective utilizing certain parts of frequency band and using the signals with complex modulations causes considerable complicating electromagnetic environment that is characterized by essential overloading frequency bands and its speed changes in space and time. Under these conditions, the efficiency of search, surveillance, and location, which are realized for the purpose of radiofrequency monitoring of reconnaissance objects, depends on time that is spent to detect signal intelligence sources, their location accuracy, and interference immunity of receiving system; that imply the necessity of continuous developing and upgrading signal intelligence systems.

The most important principles of constructing modern signal intelligence systems are exploiting digital signal processing, utilizing multichannel antenna systems (generally based on antenna arrays) and multichannel receiving systems, that provide high sensitivity and location accuracy.

The goals of the work are, first, generalizing main specification of modern signal intelligence systems within ground-based class, second, determining their main development trends, and also developing the structure of ground-based interference resistant tactical signal intelligence system.

Working algorithms of the system imply exploiting the following known methods: multiple signal classification (MUSIC) for the purpose of quick direction finding under weak and intermediate interference conditions; linear constraint minimum variance (LCMV) for the purpose of slow signal search under strong interference conditions; recursive method of forming inverse covariance matrix that is used when tracking moving objects; minimum-norm (MN) for the purpose of signal frequency resolution and measuring signal carrier frequencies; transformation of signal parameters space into intelligence object signatures space for the purpose of determining the current tactical situation and hostile group of troops within tactical depth; wavelet analysis for the purpose of signal recognition to classify the type of the emitting intelligence source.

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DEVELOPING MULTIFUNCTIONAL ELECTRONIC WARFARE SYSTEMS

Since the beginning of the 21 century we observe the trend of developing multifunctional electronic warfare (EW) systems (MEWS) designed for the purpose of providing Army mobile operations integrating several functionals that never were combined within one system before, for instance, radio frequency (RF) jamming and electronic counter countermeasures with respect to both radiocontrolled munition and electrooptical control system (EW system “Infauna”, Russian Federation), or RF jamming combined with RF monitoring and communication systems functioning imitation (EW system “Leer-2”, Russian Federation), or RF jamming different electronic systems, such as, for instance, satellite communication systems, global navigation satellite systems (GNSS), mobile communication systems, trunking network systems (EW system “Diabazol”, Russian Federation), so that the majority of MEWSs are capable effectively strive against unmanned aerial vehicles (UAV), and some of them are capable to disorganize controlling unmanned ground vehicles (UGV) (EW system “Repellent”, Russian Federation).

Within state-of-the-art MEWS development we can observe the tendencies of widening operational frequency band (up to 10…14 GHz) and increasing their energetic potential.

Taking into account the world trends concerning developing and producing MEWS, one should consider to be expedient of foreseeing R&D measures of developing mobile multifunctional automatic RF jamming system for the purpose of providing Army mobile activity and special operations based on combat armored vehicle platform with operational frequency band 30…14000 MHz that is capable to provide RF jamming for: (1) VHF communication systems and trunking network systems within frequency band 30…1000 MHz; (2) mobile ground-based terminals of satellite communication systems in L, S, C, X, Ku frequency bands; (3) mobile ground-based terminals of GNSS NAVSTAR and GLONASS; (4) mobile and base stations of 1G…4G cellular communication systems; (5) Wi-Fi and WiMAX networks nodes and terminals; (6) on-board communication terminals with state-of-the-art modulation including designed for the purpose of UAV and UGV; (7) radio controlled improvised explosive devices.

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DEVELOPING COMPACT ELECTRONIC WARFARE SYSTEMS FOR UNMANNED AERIAL VEHICLES

During the last decades exploiting unmanned aerial vehicles (UAV) took the leading positions among other warfare systems and munition in a lot of Armed Forces of the foremost countries of the world. The leading military experts consider UAVs, being in the contemporary stage of military art development, are capable to carry out their tasks including radio frequency (RF) jamming of communication systems within a tactical depth. UAVs carring compact electronic warfare (EW) systems specially designed for aerial platforms, which recently considered to be rather exotic, are widely used in armed conflicts now. Expediency of exploiting the compact EW systems for aerial platforms based on UAVs is elucidated by, first, avoiding considerable energetic losses when jamming land-based communication systems; second, substantial difficulties in organization of electronic countermeasures under complicated topography relief conditions; third, enemy’s exploiting the latest technologies in communication systems.

The most important principles of developing state-of-the-art aerial compact EW systems based on UAVs are: using multichannel wideband antenna systems; exploiting wideband transmitting sets; using wideband receiving sets with digital signal processing.

The goals of the work are: first, generalizing main specifications of the modern compact EW systems designed for UAVs, second, exploring main trends and tendencies of their development, third, synthesizing spatial-energetic models of UAV compact EW systems functioning which can help us to substantiate main their specifications.

As a result of the comleted calculations based on the synthesized spatial-energetic models of UAV compact EW systems functioning, we have selected optimal variants of antenna systems in the form of wideband circular antenna arrays based on Vivaldi elements with 120°-wide cone-shaped antenna pattern, have substantiated main specifications with respect to jam transmitters including optimal time-frequency structure and parameters of jamming signals, and also have substantiated main variants of UAV compact EW systems combat exploiting.

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PRACTICAL APPLICATION AND USE OF ASSEMBLING METALLIC CORRUGATED CONSTRUCTIONS, MODULAR GABION STRUCTURES AND OTHER MODERN CONSTRUCTION TECHNOLOGIES FOR ENGINEERING ARMY PURPOSES

Assembling metal corrugated structure (AMCS) is a natural geotechnical construction, which together with the surrounding earth fill forms compound structure and takes the load onto it. AMCS is the main alternative to reinforced concrete structures while construction artificial structures in various fields.The strength of corrugated metal structures is ensured via interaction of the corrugated structures with the well- packed soil around it. Under the same load, metal structures are less sensitive to plastic deformation, which is unacceptable for reinforced concrete structures. AMCS consist of separate elements - corrugated sheets, curved under a given radius and connected in a lineal (along axis of structures) and the transverse (circular) direction by means of high strength bolts. AMCS have anti-corrosion protection (hot-zinc cover 85-90 microns).

The advantages of AMCS are: - a large selection of profiles of construction; - reduced labor costs during installation; - elasticity that allows the structure to redistribute tension depending on external load; stability to external actions; - durability of at least 100 years; - simplicity and speed of construction; - convenience and economy of transportation; - economy during exploitation, costs are minimized; - for closed AMCS structures you do not need to build foundations; - low cost of AMCS construction , 15 to 40 percent savings compared to reinforced concrete constructions.

The history of the use of AMCS in the military field began when it was patented by Canadian engineer Peter Norman Nissen in 1916 year, and production during World War I of light, prefabricated buildings, and namely the corrugated steel mobile barracks which by the end of this war were manufactured in number of more than 100,000 units. During the Second World War, the Great Britain built more than 2 million shelters of this type to protect the population from bombing.

NATO armies now widely use AMCS facilities , from which the underground storage facilities, war rooms, hospitals, hangars for supplies and vehicles, ammunition depots, and even bunkers for the president of the USA were built and this list of AMCS application is far from being complete .

A practical example of the application of the AMCS in Ukraine in the military field is a corrugated steel shelter (css) developed by VIACON UKRAINE . In 2017, successful state trials of this building were conducted. CSS can be used as housing for military personnel, headquarters, medical center, staff and. etc. Depending on the purpose of the CSS may be different in configuration.

2. Another product that is successfully used as engineering building in the defense sphere are modular gabion structures. Gabion protection structures were first referred to as "wicker baskets" with soil filling. This type of simple reinforcement was used during the Russian-Turkish wars, the Napoleon wars and many others. Wicker baskets had several advantages over other types of fortifications – small weight, low cost and high mobility. When changing the front line the basket used to be emptied and transported to another place.

In 2014-2015, VIACON UKRAINE developed light gabion- type fortification. State tests were conducted, this product was put into service by the Armed Forces of Ukraine and put into mass production. Since 2014, about 60 km of these structures have been delivered to the Armed Forces of Ukraine. The modular fortification folding gabion has a simple construction, low weight, is quickly mounted, protects against small arms and fragments. It is used for equipment of block posts, war rooms,positions at the front.

3. Something new for the use of engineering support for troops may be the use of geosynthetic materials for the separation of carriers bases and reinforcement take for example the reinforcement of bases by means of geogrids.With modern materials it is possible to increase the carrier ability of weak bases, to arrange passageways, logistic sites,parking for vehicles, warehouses, temporary roads in no time without use of concrete, which increases the term and cost of construction.

The use of geogrids makes it possible to arrange earthworks obstructions (retaining walls of any angle, noise shields, engineering barriers) as an example for anti-tank equipment earth barriers. Retaining walls have high resistance to exterior influences, can have a considerable height, perform various functions. The benefits of their application is:

- higher slope (up to 90%); increased stability;
- cost-effectiveness, since it is possible to use local material;
- saving time as there is no need for settlement of the soil.

Also, VIACON UKRAINE developed a technology that allows to hold walls of trenches upright and prevent their destruction. The walls are held by clamping rings, geotextiles and net, which saves wood in conditions of its deficit in eastern Ukraine.

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INTERFERENCE-PROOF TERAHERTZ BAND RADIO CHANNEL FOR SUPERHIGH SPEED DATA TRANSMISSION AND REMOTE CONTROL

Because of the expansion of the volume of telecom systems which use electromagnetic radiation of various explored radio frequency bands, serious problems occur. From one side, radio frequencies for new telecommunication equipment are lacking, and from another side - the electromagnetic radiation level continuously raises and approaches critical level, which can harm human health. Therefore, there is a necessity for new telecom technology and systems, which would have allowed expanding the transmittable information volume, and would have been doing it on ecologically safe level. Terahertz technologies and wireless broadband with gigabit broadband for superhigh speed telecom networks, and wireless HDTV/UHDTV transmission (which requires up to 6 Gbps bandwidth), fit in these requirements. They also apply to wireless broadband Internet access with superhigh speed as well.

The development is based upon new scientific ideas, research of which is especially important right now for the creation (especially first time in Ukraine) and development of wireless broadband 4G/5G networks using terahertz wireless channels with gigabit bandwidth. During the research, the problem of creating a wireless channel in terahertz band with high (more than 1 Gbps) transmission rate at high spectral efficiency of radio channel use, and the indirect visibility efficiency, was solved. The problem is being solved by the use of data transmission channel according to 802.11n standard use, as well as use of OFDM modulation, which is specified by the standard and ensures decent quality in the conditions of echo signal impact (indirect vision conditions). Besides, the QAM64 modulation use allows high spectral efficiency of radio channel use, therefore high transmission channel rate at lower used radio frequency band. Also, the cascade coding use - LPDC internal code and BCH external code - allows maximal approach to Shannon's limit.

Terahertz wireless channel with 1 Gbps bandwidth has transceiver stations which have receiver and transmitter antennas, linear paths, and signal processor units. Besides, as a signal processor unit a special group streaming unit is used. It uses multiple-frequency OFDM modulation. A structural wireless terahertz band network scheme, which covers a broadband access zone at 360 degrees area, was developed and its transmission-reception line parameters were also researched. Therefore, the hereby provided development of wireless connection channel in terahertz band, which can effectively be used for backhaul new generation network construction for wireless telecom systems, including superhigh speed networks, and for remote control function, is relevant.

Such development can be used in high speed distribution wireless telecom systems (i.e. new generation cell phone connection). Also, it can be used for wireless interference-proof connection channel for high speed data transmission using terahertz band with gigabit bandwidth, and remote control of portable missile launchers, anti-tank guided missiles and drones etc. in the high intensity radio interference conditions.

Potential customers for such systems are telecom providers, cell phone operators, the military, the police special forces, and the emergency services.

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MICROFIBER MATERIALS WITH ANTISEPTIC PROPERTIES OF MEDICAL AND HOUSEHOLD APPLICATIONS

One of the priority areas for obtaining materials with antiseptic properties is modification of microfibers used for manufacturing of primary health care, hygiene products and filters for drinking water cleaning. Increased requirements for the properties of fine-fiber polymeric materials and the expansion of their applications have led to investigation of ways to modify them. To date ultrafine fibers are formed by several methods: aerodynamic, processing of melts of polymer mixtures and electrospinning. Introduction of functional substances to the structure of microfiber can effectively solve tasks of increasing strength, elasticity, providing incombustibility, electrical, magnetic, optical, sorption, antimicrobial properties, etc.

Thus, new fine-fiber precision filtering materials and complex yarns from nano-filled polypropylene microfibers were obtained by processing polymer mixtures filled with silver-containing nanoparticles.

The developed filtering materials are characterized by high efficiency of filtration and bactericidal properties and can be used to clean drinking water in everyday life, as well as when creating mobile plants for cleaning and disinfecting water from natural reservoirs.

By electrospinning method were obtained nonwoven fibrous materials with antiseptic properties from a mixture of water-soluble polymers with the addition of starch and a complex of polyvinylpyrrolidone with iodine or decasan.

The developed complex threads of nano-filled polypropylene microfiber and nonwoven fibrous materials obtained by the electrospinning method can be used for creation of new products for medical and household purposes.

Microfiber materials retain all the positive properties inherent in products made of synthetic fibers: strength, high wear and tear strength. At the same time, due to the very small diameter of individual filaments, in the napkins made of them there can be a lot of air cavities. Thus, there is a free exchange of air between the skin and the environment, and these materials have high hygienic properties.

Domestic microfiber materials with antiseptic properties will provide military personnel with clean drinking water and primary health care aids in the field.

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EXPERT SYSTEM OF RECOGNITION OF STATES OF RADIORADIATION OBJECTS BASED ON THE FORMAL-LOGICAL APPROACH

The introduction of intellectual expert systems is possible taking into account the real needs for decision-making problems, including problems of recognition of different objects and states, and increasing the level of intellectualization of existing information and control systems of different level and purpose, possibilities of integration of components of intellectual analysis and logical inference any existing or projected information-analytical system.

The need for improvement and development of decision-making technologies in information-analytical systems, in the process of modeling and analysis of results in the system of complex recognition (SKR) of radio-emitting objects (REO) and their states is conditioned by the continuous increase in the complexity of objects and recognition processes with simultaneous time to analyze the problem situation, forecast the situation, evaluate the consequences of the decisions taken. This process requires a lot of time and high skill to accurately and objectively evaluate the situation. The analysis of the world experience shows that the most promising in the automation of the decision-making process is the use of information systems based on knowledge, formalized within the framework of artificial intelligence technologies and the experience of highly qualified specialists, which he accumulates in the knowledge bases of expert systems.

The purpose of this study is to develop an expert system of state recognition of REO, which will provide: increase of the degree of intellectualization of existing information SKR of REO by their radio-electronic means and results of data processing by existing statistical methods; the process of adapting to changes in tasks and goals of functioning; accumulation and re-use of knowledge when performing tasks in the process of modeling in the SKR of REO.

According to the monitoring data, the intelligent ESRS of REO is created using the development toolkit, which is an easy-to-use platform that provides support for all stages of the creation of intelligent systems of various purposes based on knowledge bases and their adaptation to solve applied problems in any subject areas.

The instrumental environment of ESRS creation provides the filling, adjustment and updating of the knowledge base of the intellectual system in the course of its evolutionary development. The ESRS provides modes: dialog question-appropriate (natural language); automatic for the formation of decisions on recognition of conditions of REO and recommendations in the process of modeling; explanation of the results obtained and others. Automatic simulation is used in the WRF SCR simulation process. When analyzing the simulation results, the question-appropriate mode can be used in conjunction with the mode of explanation of the results as the most effective with minimal time costs.

Knowledge Base - includes a rule base or axiom and a question base and is designed to formally describe logical tasks in a simple internal language of expert knowledge description. The basis for formalizing the problems of the system domain is based on the logical calculation of first order predicates. Logic Output Module is a central element of the core of a software complex designed to deduce the consequences (responses) from a system of rules (axioms) found in a BR using a modified resolution method.

Flexible open structure of the environment allows to expand the functionality of the system and the range of tasks that are solved in the process of its operation, as well as constantly improving the accuracy of analysis, planning, organization, coordination and control of decisions made through the use of accumulated experience in the database. The presence of fairly complete models of knowledge in a specific subject area, such as ESRS E REO, provides diagnosis and prognosis of their behavior with a high degree of certainty. On the basis of these rules and the fact base, in the process of logical inference, the results of the recognition of the possible conditions of REO are formed.

The ESRC decision-making process is performed on the basis of an analysis of the situation or situations that are determined and related to the parameters of the REO of income, different models by primary characteristics in the SKR. On the basis of these data, in the process of logical conclusion, the ESRS generates the results of recognition of the possible conditions of REO.

The development of the ESRS REO is carried out with the use of modern intellectual information technologies that provide for the collection, processing of display of heterogeneous information, their analysis and making recommendations for its use. The results of the conducted researches and practical implementation of the developed system can be used in the development of complex systems and facilities for radio monitoring, evaluation, control, and forecasting of the development of radio-electronic-object environment. The implementation of the expert system of recognition of the states of radio-emitting objects in practice confirmed its high efficiency. Further improvement of the ESRS can go the way of creating a universal system of object recognition of any complexity and physical nature.

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METHODS OF NON-CONSTRUCTION CONCRETE OF CONCRETE DENSITY

The strength of concrete is its main characteristic, which determines the bearing capacity of concrete and reinforced concrete structures. The degree of strength is the limit of strength - the maximum stress at which there is a destruction of the material. The strength of concrete is determined by measuring the forces that lead to the destruction of specially made, as well as vibrated or drilled from the designs of samples at loading at a constant rate. Along with direct methods for determining the strength of concrete samples, various methods of indirect determination of its strength directly in products or structures without their destruction are used. It is these methods of determining the strength of concrete appropriate to use to control the quality of concrete fortified buildings.

The strength of concrete in the application of non-destructive methods is determined by the pre-established grading dependencies between the strength of the samples on compression by indirect strength characteristics. There are mechanical and physical non-destructive methods.

Mechanical methods are based on the correlation between strength and other mechanical properties of concrete (hardness, elasticity, ability to plastic deformations, etc.), as well as the forces that cause its local destruction.

In physical methods, the correlation connections of concrete strength with the speed of its propagation in ultrasonic waves and some other characterizations (frequency of oscillations, intensity of gamma irradiation during passage through concrete, etc.) are used from physical in practice, the ultrasonic method is used. Non-destructive testing methods for concrete: methods of local destruction (cutting off with scraping, riveting ribs, tearing off steel discs);

methods of shock waves on concrete (impact impulse, elastic rebound, plastic deformation); ultrasonic methods. Indirect characteristics of durability in the application of mechanical non-destructive methods can be: the value of rebound from the surface of the concrete (or pushed to it by a drummer); impulse impulse parameter (impact energy); the size of the impression on the concrete (diameter, depth, etc.) or the ratio of the diameter of the impressions on the concrete and the standard sample when the impact or pushing the indenter into the surface of the concrete;

the value of the stress required for the local destruction of concrete on the edge of the structure; the value of the effort required for cutting the concrete area on the edge of the structure; the value of the local destruction of concrete in removing anchor device from it.

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MAIN ADVANTAGES OF GABIONAL STRUCTURES

The use of gabion structures is one of the most effective and versatile methods not only for strengthening the slopes, strengthening, stabilizing and protecting the underground, which is in operation, submerged cones, bridges, regulating dams, coastal and other structures, but the creation of fortifications and fortifications.

The analysis of the possibilities of gabion construction has shown that in some cases they are more expedient and more economical than traditional protective fortifications.

The main advantages of gabion construction

Flexibility. Gabion buildings are classified as flexible. This means that these structures perceive the possible precipitation of the soil, responding to it with minor deflections. At the same time, the gabion structure itself does not collapse and the structure continues to fulfill its basic functional purpose. Typically, such processes take place during the time of consolidation and the main factor of confrontation with precipitation is the net that perceives the main load.

Strengthandstability. Upon completion of the consolidation, the gabion construction acquires maximum strength and stability through natural processes. This means that the main calculation loads donot play any role any more. However, during the time of consolidation, the gabion construction isunder the in fluence of the seloads, therefore, the material from which it is composed must meett here quirements of strength and durability. And gabion designs meett hese requirements. The proofofthisis the experimental and natural tests.

Permeability. The porous structure of the gabion gives the building excellent drainage properties. High permeability of gabion structures eliminates the possibility of one of the main factors of instability of structures - hydrostatic loads. The connection between soil and surface water (in the case of shore-based buildings) is also excluded. Consequently, there are practically no processes of suffusion under the sole of such structures.

Long service life. Many years of experience with the use of gabions allows us to attribute these structures to a class of permanent, rather than temporary. Gabion structures contribute to the restoration of the state of the natural ecological balance in the zone of their erection, so that the structures are affected by loads lower than those for which they were calculated initially. Thus, the effectiveness of gabion structures does not decrease, but increases with years.

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INFORMATION AND CYBER TECHNOLOGIES – DRIVE OF TRENDS IN THE AREA OF DEFENCE

The leading countries in the area of defence pay particular and special attention to artificial intelligence, information, cognitive, robotics and cyber technologies. At the same time, the development of information and cyber technologies has been the driving force behind the following trends in the military sphere:

1. Global informatzation and the beginning of robotization of military forces (in 2015 the Russian Federation, and in 2016 the United Kingdom (NATO Unmanned Warrior 2016 military exercises, part of the largest Joint Warrior exercises in Europe) conducted training with comprehensive and the mass use of combat robots and other innovative developments, air, ground and maritime bases that do not require human control) and the creation of highly integrated control systems, which in turn become objects of cybernetic impact and require, accordingly, the development of forms and methods of conducting cyber-counteraction.

2. Increasing of the intensity of conflicts in the information and cyber space with the participation of specially created specialized structures and formations. Conducting terrorist acts through the information and cyber space and directly within them.

3. Dominance of more developed countries and conduction of destructive actions precisely through information and cyber space on the one hand, and increasing vulnerability to the growth of high-tech – on the other.

4. Application of global information networks and electronic media to manipulate the consciousness of both the global community and the populations of individual countries.

5. Allocation of information and information-analytical support in an independent form of providing troops (forces) and formation of appropriate structures for its implementation.

6. The steady increasing of the number of computers and electronic tools

involved in the planning stages of operations and during management decisions in the course of hostilities. Increasing of the simulation modeling role in operations planning and combat operations. Further integration of artificial intelligence into military systems.

7. Integration of intelligence, control and defeat systems from unit (unit of military equipment) to the command of all units of management on the high-tech products basis. Miniaturization of computer and electronic equipment, their use in virtually all weapons and military equipment (from high-precision weapons to small arms and equipment).

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TRENDS OF COMMUNICATION SYSTEMS AND FACILITIES DEVELOPMENT IN THE ARMED FORCES OF NATO COUNTRIES

The experience of communication systems and facilities development in the armed forces of NATO countries shows that the united ways they can be developed are identified with the prospect of providing of full integration of military and civilian communication systems and facilities. For example, NATO Integrated Communications System (NICS), which provides functioning process of the NATO unit's senior command and control units, includes NATO satellite, tropospheric, radio-relay, wire and radio link systems, as well as the lines of communication leased from the civilian offices of the countries participating in the bloc. The NICS system is aligned with the national military systems of strategic and operational-tactical links of NATO forces.

An important trend in the development of special purpose telecommunications networks in NATO countries is the introduction of TACOMS POST-2000 standards, which are seen as a methodology for intelligent telecommunications designed to provide NATO with the ability to conduct coalition-centric operations. An appropriate set of standards is being developed by scientists and industry in 15 countries, including Belgium, Canada, France, Germany, Italy, the Netherlands, Norway, Portugal, Spain, Turkey, the United Kingdom, the United States, and Poland. TACOMS POST-2000 standards are based on support for tactical Internet protocols (from Ipv4 to Ipv6) using land, air and space repeaters.

Among the main advantages of TACOMS POST-2000 are:

the ability to transfer files, video and other multimedia data;

global mobility support by absolutely addressing all users in the Ipv6 address space;

higher capacity of subscriber channels, their compatibility;

data channels security at high speed of traffic (up to 1 Gbps).

The TACOMS POST-2000 standards implementation project aims to implement the concept of belonging to combat systems as an integration of sensor networks, unit control networks, and effectors (fire complexes). They are built on SDR systems, and within the NATO NIAG Industrial Advisory Group, options are being explored to create an appropriate SDR technical base by 10 NATO countries.

The main advantage of SDR technology at this stage is the ability to achieve interoperability of different types of devices. However, to realize the full potential of SDR, it is necessary that developers clearly adhere to the NATO standards for converting source code into SCA format. This applies not only to the high-level language, but also to the programming of FPGA architecture (such as VHDL), as well as to third-party FPGA IP blocks.

SCA implementation rules for an SDR project require modular software construction and structure modular interfaces.

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PERFORMANCE INDICATORS NON-EXPLOSIVE AND COMBINED ENGINEERING

In the field of military engineering, one of the most difficult problems of today is to limit the maneuverability of enemy troops and cover the barriers of important objects that are defended by troops in combat areas. Ensuring the cover of troops and facilities is achieved through complex arrangements and maintenance of engineering barriers. One of the effective ways of achieving the goal of these measures is still the use of non-explosive barriers and combined engineering barriers in the conditions of limiting the use of mine and explosive barriers.

With the rapid development of means of overcoming engineering barriers in the armies of the leading military countries of the world, the problem of ensuring sufficient effectiveness of cover of important objects of non-explosive barriers and combined engineering barriers was reflected, which was reflected in NATO standards. In Ukraine, the issue of ensuring the required level of effectiveness of such barriers is receiving insufficient attention. This is due to the fact that minefields are still considered to be the main type of barriers.

Therefore, there is a need to clarify the totality of the performance of engineering barriers such as non-explosive barriers and combined engineering barriers.

Overall, there are a number of indicators and benchmarks to evaluate the effectiveness of non-explosive enclosures and combined engineering enclosures. At the same time, it is emphasized the need to justify the required time, probabilistic indicators of combat functioning of non-explosive barriers and combined engineering barriers as a system that provides a reduction in the rate of attack of the enemy, stifling his actions and increase the attendant losses of the enemy due to delay.

In a general approach, a system of engineering barriers is designed to stifle the enemy's actions, reduce the pace of his advancement, and inflict losses on engineering ammunition. An additional component of the purpose of the engineering barrier system is to increase the efficiency of firearms by delaying the barriers, mainly at non-explosive barriers and combined engineering barriers.

The effects used in the planning of the system of engineering barriers are: the destruction of the combat order, turn, lock, delay.

Accordingly, the effect of destruction aims at the use of fire and the effect of barriers to force the enemy to divide their formations, disrupt combat order, spend time, change the plan, hasten demining and disrupt the attack. The turning effect directs the enemy to maneuver in the desired direction. The blocking effect combines fire that covers obstacles and barriers to stop an enemy from approaching or obstructing his or her passage through the war zone. The detention effect is aimed at planning fire and barriers to detain attackers in a particular area, usually in a combat zone.

These effects are the main difference between the design of a system of engineering barriers by NATO standards in comparison with the classical post-Soviet planning of a system of barriers. Specifically, the design of the system of engineering barriers by effects allows for greater flexibility and compliance with the design of the all-military commander for combat compared to the permanent transit system of the area.

An analysis of the performance of elements of the system of engineering barriers showed that the main indicators of non-explosive barriers are the delay time at the barriers, the probability of collateral damage to the forces and means of the enemy, and the mathematical expected increase of the enemy's collateral losses due to the delay at the barriers. For combined engineering barriers, there are two more indicators: the probability of damage to the enemy's forces and means, and the mathematical expectation of the enemy's damage from blasting on mines and other explosive devices.

In a general approach, non-explosive barriers can be anti-tank, anti-vehicle, anti-personnel and mixed. Such obstacles impede movement, but do not cause damage to the enemy. For this reason, each of these barriers is characterized by a time delay on the barriers. This value is random, it depends on many factors. Its distribution law is not known in advance.

If the enclosure is covered by fire (which must be the rule!), Then it is characterized by another characteristic - the likelihood of concomitant damage to a single target by the fire of the appropriate fire means that cover these enclosures.

The mathematical expected increase in the enemy's incidental losses due to the delay on the barriers can be determined using the average dynamics method and is a function of the probability of collateral damage and the number of tanks (BMPs, APCs), infantrymen who overcome barriers.

Combined engineering enclosures include explosive, mine-explosive and non-explosive enclosures. They can be anti-personnel, anti-tank, anti-tank and mixed. The simplest kind of combined engineering barriers are anti-personnel, anti-tank, and mixed band (zone) barriers.

As an indicator of the effectiveness of such barriers is additionally accepted, as for minefields, the probability of hitting a single target. But, unlike minefields, there are some peculiarities. In fact, in a minefield, the target is mostly affected by mine blasting, the losses from fire during the minefield overcoming are insignificant and in some cases they can even be neglected. In the zone (zone) of barriers the situation is different: the enemy will bear losses not only from blasting on mines (on minefields and groups of mines entering into the field of barriers), but also from fire of fire-fighting means of defense, as non-explosive barriers entering into the composition of the band (zone) of barriers, significantly increase the delay time of the enemy at these barriers and, therefore, significantly increase the fire time of fire defense means. For this reason, the bar (zone) of barriers (and in general any combination barrier) it is advisable to characterize the probability of hitting a single target at the same time due to fire and blasting at mines.

In more complex combined barriers, in which, alongside mine-blasting, wire, tree-earthen and other obstacles, electrified and water barriers can be used, as well as forest blockages (ordinary or mined), as a means of defeating the respective purposes, as in strips. (zones) of fences, mines and fire of means of defense remain.

Combined Combined Engineering Barrier Combat Effectiveness is evaluated separately for relevant purposes. In this case, dual-use barriers (mixed minefields, landmines, landmines, non-explosive barriers, etc.) may be counted twice if they can delay the advance of infantry and combat vehicles.

Thus, taking into account the relevant dependencies in the design of the system of engineering barriers will greatly improve its efficiency as a whole.

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CONCEPTUAL MODEL OF A SPECIALIZED GEOINFORMATION SYSTEM

One of the most important directions for solving the problem of improving the process of providing geospatial information on the systems of command and control of troops and weapons is the introduction into the practice of the Armed Forces of Ukraine of the management of geoinformation systems (GIS), representing software and hardware complexes, intended for collecting, processing, storing, simulation and visual display of geospatial information necessary to support decision-making on the management of troops (forces) in peacetime and wartime, and digital (electronic) cards and perform military applications (settlement) problems associated with the assessment of operational and tactical planning properties of the terrain and the use of force (devices).

The mentioned report proposes a conceptual model of a special-purpose geoinformation system. This model allows us to combine into a single the views of researchers on the creation and operation of special purpose geoinformation systems. In the course of the research, classic methods of analysis and synthesis, methods of decomposition, mathematical statistics, modeling, complex technical systems, and others were used. According to the results of the rsearch, a conceptual model of a special-purpose geoinformation system was obtained. The given model allows to combine separate theoretical researches, complete and improve them and reach a new scientific level.

This research may become a new scientific basis for the development of new and improved existing special-purpose geoinformation systems. The proposed model allows describing the functioning of the special-purpose geographic information system as a whole and its separate subsystems.

The practical implementation of the above conceptual model of GIS will provide the consumers with geoinformational resources with all the information necessary for the management of troops and weapons. A distinctive feature of GIS will be the differentiation of the provision of geospatial data for various parts of the control of troops and weapons systems. In other words, one or another body of military management will be provided only with the set of geospatial data that is necessary and sufficient for the purpose of the task.

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SOFTWARE OF RADIO SIGNAL PROCESSING AND FORMATION OF RADIO INTERFERENCE

The experience of recent military conflicts and wars, in particular in Georgia, Syria and eastern Ukraine, shows that electronic warfare has become an integral part of combat (operations). This is due to the use of electronic means when performing tasks in exploration and control in the electromagnetic space.

With the aim of destroying or introducing false data into the radio channels of systems of information extraction, control of troops and weapons, electronic warfare devices are constantly being improved to ensure the advantage in the electromagnetic space.

The report proposes a variant of implementation of a digital adaptive radio interference station by applying special computing devices and new algorithms (programs) for estimating radio signal parameters in order to determine the bearings for radio sources, to identify radio electronic means and to form quasi-optimal radio interference.

The structural diagram of a digital adaptive radio interference station and the principle of its operation are presented for discussion.

The list of algorithms for processing and estimation of parameters of radio signals, radio direction finding of a source of radio emission and identification of radio electronic means, decision making, and also formation of radio interference is given. Their essence and features of practical implementation are explained.

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METHOD OF DETERMINING THE SIGNAL OF UNCERTAINTY FORM WITH USING THE NEURAL NETWORK

The task of detecting a signal is relevant in the field of radar, radio direction finding, in the construction of modern radio communication systems. Currently, this problem is solved within the framework of the statistical theory of signal processing. But, given the current trends in the field of radiocommunication, the problem is increasingly encountered where the shape of the signal is unknown. Then the synthesis of the classical detection algorithm meets a number of difficulties. Overcoming the a priori ignorance of the shape of the signal is possible through the use of the neural network.

Several papers presented neural networks that act as devices for detecting a signal against white Gaussian noise. At the same time, some issues remain unresolved, firstly, this is the justification for choosing the architecture of the neural network to solve all the tasks.

Most of the works used such neural networks as multilayer perceptron or networks with radial basic functions that are redundant. Secondly, it is a choice of educational implementations, through which the network was trained. It is often not indicated whether the noise was applied to the training sequences, and if the noise is present, what is the signal/noise ratio. Third, the possibility of using developed networks for various forms of useful signal.

In this article we propose a signal finder based on a single perceptron, validate the choice of such a scheme, provide information on the learning process, and compare the performance of the trained perceptron with the classical correlation signal detection method on the white Gaussian noise background.

The scheme of detecting an unknown form is proposed in the article, based on the neural network in the form of a perceptron. The similarity of the decision by the perceptron and the algorithm of optimal detection is the main justification for choosing the architecture of the neural network. The model of such a system was collected. Training was conducted on different forms of the signal, experimental graphs of the probability of a complete detection error were given. The simulation results were compared with theoretical calculations of the optimal detection algorithm using the maximum likelihood criterion. The main features are noted, such as: the necessary signal/noise ratio, which is superimposed on the training sequences; variation of results from training to training and initial values of weight ratios of perceptron.

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SMALL-BASED SINGLE ACTION LASER RADAR

The problem of increasing the accuracy of measuring coordinates and parameters of motion of high-speed objects at small distances with the use of a laser sensor of an optimal signal processing algorithm in the conditions of a hard time deficit is solved in this paper. The nanosecond laser radar (LR), which produces high-precision measurements with high spatial resolution, was created.

The structure of the LR includes a pulsed laser emitter capable of forming the infrared range light pulses of short duration. For high-precision operation in high-speed mode, it is necessary to provide a significant pulsed current at a nonlinear load, a laser diode serves for this. The principle of an avalanche breakdown is used in the generator of the laser emitter pumping. The hardware implementation of the generator included the following functional nodes: a voltage enhancer (from 5 volts to 120 volts), a clock generator, a key cascade that produces a powerful nanosecond current pulse. In this case, the implementation of the pumping circuit of a semiconductor laser emitter allows forming a powerful pulse.

In order to ensure the reception of optical impulses nanosecond duration the circuit solutions using high-speed avalanche photodiodes were developed. The gain of the amplitude of the photo-response signal from the target surface is provided by a pulse amplifier.

A diagram of the orientation of the optical system of a LR with the possibility of its correction in space is created. Fiber optics with the required shape was located to form a target detection zone in the focal plane of the transmitting and receiving lenses. Using fiber optics allowed getting an increase in pulse light power by combining radiation from several laser diodes.

On the basis of the conducted research the advanced phase-pulse method of measuring the parameters of reflected laser radiation by the photodetector in the mode of direct photodetection was developed. The method of optoelectronic distance measurement based on compensation of phase shift was developed. The method is based on the fact that the automatic system, covered by the loop of negative feedback, compensates the run of the phase, which receives a stimulating sinusoidal signal in the total span of double-range optical beam. On the basis of the computer modeling the patterns of the developed advanced precision longitudinal measurement method were carried out and theoretically justified, in which the modulation of the parameters of the light signal was applied, which allowed to determine the parameters of the motion of high-speed objects.

Based on the results of the simulation of the directivity patterns intersection, the design of the receiving and transmitting LR lens was developed.

A new method of processing the received signal was developed also, which will allow to carry out high-precision distance determination of parameters of motion of high-speed objects by the method of laser location. Improvement of the method of location by improving the optimality of the structural-functional division between the elements of optoelectronic laser systems was made.

It has been experimentally shown that the intercanal phase shift in different modes of operation during time-spatial processing of signals does not allow to completely suppress the interferences acting on the side petals of the antenna pattern.The use of spatial differences between the useful signal and the obstacle is realized by means of a spacious reception.

The LR, which connects the functions of radar and lidar is developed, ie simultaneously measures the position and speed of objects. Developed LR emits the unshaken bundles of laser pulses. Given how this radiation is reflected from surrounding objects, the device is able to more accurately determine the distance to the object, while calculating its velocity. Reflected radiation from non-fading bursts of laser pulses enables the LR to operate in adverse weather conditions. LR detects an object in conditions of lack of visibility, for example, through such obstacles as artificial smoke and fog, it does not interfere with obstacles that create reflective objects. LR is capable of detecting small speed objects at distances up to 15 m, and also with the help of a specialized processor can monitor moving objects, measuring their speed and distance to them.

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ANALYSIS OF CONDITIONS AND FACTORS INFLUENCING THE EFFICIENCY OF THE SYSTEM OF LOGISTICS OF THE COUNTRY DEFENSE FORCES

The experience of the history of wars and military conflicts shows that in every successful military company, operation, battle, as in every defeat, it is necessary, along with other reasons, to look for positive and negative aspects in the work of the logistics departments, their organization, opportunities and ways of providing.

The development of the logistics system was carried out in parallel with the development of the armed forces and methods of warfare, operations and combat. New types of weapons, military equipment, methods of conducting military actions put forward their requirements for the logistics system, forced to develop more modern forms of organization of the logistics system and ways of providing.

In the course of the research, it was found that a detailed analysis of the conditions and factors affecting the quality of the logistics system operation is not sufficiently complete. That is why, within the framework of this research, a detailed analysis of the conditions and factors that affect the quality of the logistics system's operation is conducted.

During the research, the logistic support systems of the United States Armed Forces, the Armed Forces of the Russian Federation, the Armed Forces of the Federal Republic of Germany, the Armed Forces of Turkey, the Defense Forces of the State of Israel, the Armed Forces of France and the Armed Forces of Ukraine were considered in detail.

In the course of the conducted research used as general scientific and special methods of research: semantic was used for the development of the essential part of the definitions categorical apparatus of military logistics; methods of economic analysis were used for assessing trends in the military provision of the Armed Forces of Ukraine; methods of system analysis were used to assess the preconditions and integrate goals in the process of forming a military logistics system; methods of economic-mathematical modeling were used for optimization the structure and internal processes of the military logistics system.

Based on the results of the analysis, the main deficiencies of the logistic support system of the Armed Forces of Ukraine were identified and the reasons for improving the logistic support system of the Armed Forces of Ukraine were substantiated.

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METHOD OF DETERMINATION OF THE BASIC (OPEN) MILITARY COMPOSITION OF THE OPERATIVE PLANNING OF THE WAR

In modern conditions, the military authorities, which are tasked with determining the composition of troop groups for operations, spend a lot of time to substantiate them. This is due to the fact that the scientific-methodical apparatus used is to take into account the complex character, as well as to allow the determination of such a troop that ensures the achievement of a specific purpose of the operation.

The analysis carried out by the authors of the study shows that at present, the existing scientific and methodical apparatus for substantiating the rational combat composition of the operational grouping of troops needs to be improved.

First of all, it concerns the choice of the basic (reference) version of the combat personnel of the operational grouping of troops. Researchers, as a rule, the choice of the basic (reference) variant of the military composition of the operative grouping of troops in the operation was carried out by choosing the already established grouping of troops (as an example for conducting command-and-staff exercises) or by comparison of combat potentials. This, in turn, makes it impossible to compare the grouping of its troops and enemy forces, taking into account the specifics of the use of shock drugs.

Taking into account the aforementioned, the report developed an improved method for determining the basic (reference) version of the combat composition of the operational grouping of troops, which would improve the methodology of substantiating the rational combat composition of the operational grouping of troops for a defense operation.

The main stages of the implementation of this method are: input of initial data, determination of forces and means of the enemy, calculation of coefficients of reducing the effectiveness of the use of weapons and military equipment, calculation of the effectiveness of fire damage of own troops and the enemy, determination of the basic composition of forces and means of operative grouping of troops.

The results are planned to be used in further research to obtain input data for assessing the predicted efficiency of the operational grouping of troops, and to improve the methodology for justifying the rational combat composition of the operational grouping of troops for a defense operation.

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MULTIFUNCTIONAL HYBRID HYDROGEN STATION

Due to the threat of a global energy and environmental crisis, alternative technologies and devices using renewable energy and energy saving technologies are being developed in the advanced countries of the world.

In addition, the hybrid hydrogen station can be used as a personal energy source for military personnel or a group of people to support energy supply in conditions of performance of service operations in various climatic conditions and repair of military equipment in field conditions.

The project relates to hydrogen power and devices for the production of hydrogen and oxygen by electrochemical water decomposition and the rational use of renewable pure energy sources. An experimental model of an autonomous mechatronic hydrogen complex has been developed to provide electrical energy and hydrogen (for example, to use solar energy to produce hydrogen in the daytime, and at night to use it to generate electricity through direct conversion into fuel cells for generating electricity and refueling hydrogen vehicles). Also, the proposed solution can be used as a high-temperature energy source (with a flame temperature of up to 2500 ° C) for processing materials (cutting, refractory metals soldering and welding under water due to the use of a specially designed burner).

readiness:

- Confirmed by laboratory studies to increase generation efficiency.
- Testing hydrogen generators with the subsequent introduction of technology in various production processes (using renewable sources).
- A patent application for Ukraine for the invention "mechatronic cell for the production of hydrogen and oxygen" is filed no. A201804271, dated. under 04/18/2018 Luhovskyi O., Nocnichenko I., Zilinskyi A., Kostiuk D. (Formal examination).

Offer. For further implementation of the project, technological equipment and manufacturing of a batch of industrial samples are required. Conduct joint in-depth studies with specialists in the field and certification of the device, the launch of pilot industrial production.

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EXPERIENCE OF ACTICAL MOBILE NETWORK PLATFORM ASSOCIATION

It is important to note the application of the SEMAN secure protocol for Tactical Mobile Networks MANET (Mobile Ad hoc Network) – wireless decentralized self-organized networks from mobile devices. Each such device can move independently in any direction and, as a consequence, often break and set connection with neighbors. The concept is characterized by careful consideration of the issues of multi-level hierarchical protection of the process of merger and division of interacting networks, as well as counteracting attempts of unauthorized access in the course of hostilities.

In general, the subject of secured protocols is one of those areas where the specifics of the military communications of the world leading countries give rise to unique solutions that outperform civil service.

Multilevel architecture of communication network for real-time applications LARA (Layered Architecture for Real-Time Applications) for the NATO Navy. The LARA project aims to improve the organization of the radio network, demonstrating the capabilities of current network technologies and Ipv6 protocols to distribute real-time applications (with a delay of less than 50 ms) in a unified military context using distributed sensors, weapons networks and MANET.

It is important to note that when developing scenarios of combat, it is necessary to focus on the information needs and capabilities of current “digital children” and the “Net” generation as commanders and soldiers of the future. In particular, such a contingent requires new intelligent training and combat training systems.

MIDS (Multifunctional Information Distribution System) – is a tactical communication system, which capable to integrate different types of platforms into a common tactical data network. According to the STANAG 5516 standardization agreement, Link-16 is defined as one of the digital MIDS services. Use of appropriate terminals on F-18, Tornado, SAMP/T air-defence system, Horison frigate and other combat vehicles.

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DEVELOPMENT FEATURES OF SOFTWARE-DETERMINED RADIO SYSTEMS

It is essential that the radiocommunication tool will not be able to be certified by NATO standards without providing appropriately designed open source software codes of SDR (software-determined radio systems) and firmware of programmable logic integrated circuits (PLIC). Open-source description of PLIC architecture will not only ensure the reliability of the device, but also simplify interoperability compatibility issues, especially under multinational developments. In addition, they are more effective in intellectual property rights protecting because it is easier to identify borrowings from fragments of someone else's code. Of course, such level of openness shall be accompanied by prior patenting of the software in accordance with national law. Although it is believed that the rules of SCA (software-controlled data transmission systems) are quite complex to implement, and this architecture is not without drawbacks, but now there aren’t anything better for the SDR platforms development. According to foreign experts, the significant operational benefits can’t be achieved if you use SDR technology only for one device to support many old standards and protocols. SDRs should also have additional capabilities in terms of bandwidth, immunity, cryptological stability and others. Therefore, the SDR technology success requires the searching for new signal-code structures and algorithms for their processing. SDR and SCA architecture will allow new signal processing methods to be implemented without replacing and re-equipmenting of radio equipment, and open source libraries application saves time and cost of development (usually up to 70% of program code remains unchanged).

One of the largest European projects in the field of SDR – European Secure Software Radio (ESSOR). It is attended by six countries: Finland, France, Italy, Spain, Sweden and Poland. The project budget is set at four years by the European Defense Agency (EDA) of EUR 100 million.

A distinctive feature of the project is application of Mems technologies and Smart antennas (digital antenna arrays), which are tasked with suppressing active interference. The use of MIMO (antenna technique that uses multiple inputs and multiple outputs) in tactical communication has considerable potential to increase spectral efficiency in the scattering of signals in the environment, which corresponds to urban tactical scenarios. Although the gain is not as great as the early, optimistic spatial-correlation models of transmission channels predicted, the spectral efficiency increases almost linearly with the increasing number of antenna elements. Because with some arrangement of the transmitting and receiving segments, both the STBC method and the V-BLAST may be more advantageous. Adaptive signal processing is used to take into account the actual status of the communication channels.

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TRENDS OF DEVELOPMENT OF THE COMMAND AND CONTROL SYSTEM OF FORCES AND WEAPONS IN THE USA

The US command and control system of forces and weapons is developed in accordance with the concept of "Combining and Functional Integration of Control, Communication, Computing and Intelligence Systems for combatants" – FTW C4I (Command, Control, Communications, Computers and Intelligence For the Warrior). In this case, C4I systems are systems necessary for the technical support of the control process.

The US command and control system of forces and weapons is being developed in accordance with the requirements of the US Army concept, under which the US Army will receive a new AF command and control system by 2020 that will provide communications at all levels of control and interaction, automatic updating of all users' databases; will open the possibility to obtain the necessary data from anywhere in the globe (at any time); will provide automation of the decision-making process to commanders of all levels.

The current Global Operational Management System (GOMS) will be one of the components of the US military breakthrough concept, known as the "Revolution in Military Sphere". Created in the course of implementation of this concept, the so-called "system of systems" includes three components: a unified surveillance and intelligence system, an automated combat control system (ACCS) forces and the exchange of information C4I2 (Command, Control, Computers, Communications and Information/Intelligence); a system that provides precision weapons.

The first system provides primary information management, which coming from sources that operate throughout the entire field of battlefields. It generalizes these data in order to present to the command of all levels a single information picture of the state of forces (both their own and that of the enemy) and of the environment (including meteorological conditions, the state of the soil surface and hydrological conditions of the sea, as well as the conditions of propagation of electromagnetic waves different ranges in the area).

The second system is intended for collecting, processing, combining and analyzing primary data, as well as for storing and transmitting it on demand of consumers. In contrast to the primary information, this information is obtained through the classification of targets, the distribution of weapons and the development of guidance data. Thus, this system saturates the three-dimensional information space of the battlefield with battle planning, control, and firing data to gain dominance over the enemy.

The third system is a means of facilities, which provide weapons and defeat objects with precision munitions, which allows you to achieve this domination. With precision weapons, a series of precise strikes is applied, complemented by the use of conventional means of destruction.

Thus, the ultimate goal of a “system of systems” of control is to collect, process, analyze and distribute information that provides guidance and use of weapons with such a degree of reliability and speed that will not allow the enemy to take adequate appropriate measures. Due to its application, the degree of human participation is reduced to the maximum due to the complete automation of all the above processes.

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TENDENCIES FOR THE DEVELOPMENT OF TELECOMMUNICATION NETWORKS OF THE SPECIAL PURPOSE OF LEADING COUNTRIES OF THE WORLD

If you look closely at the world's large-scale telecommunications networks, you can see that almost all of them are the result of the commercialization and further improvement of the military agencies of developed countries abroad (for example, the Internet and its development in NGI and Internet-2 programs). On the other hand, a great deal of promising research in the field of information and network technologies has been conducted and is being conducted in the interests of the military or with their personal involvement. Yes, most of the large orders from companies such as AT&T, Hewlett-Packard, Digital come from the US MoD. Therefore, an overview of the status and trends of the US and NATO specialty telecommunications networks is the most significant in this area of research.

In the development of special purpose telecommunication networks of the leading countries of the world, the following stages can be distinguished:

Stage one – since the active introduction of data processing automation systems from the 60's to the early 90's of the last century. It is characterized by the focus on creating many poorly integrated systems that automate individual processes, functions, types of supply.

Stage 2 – from the 90s to the 2000s. Integration of Disconnected Automated Command and Control Systems (ACCS) and Automated Information Systems (AIS) based on the principles of open and service-oriented architecture. Integrating components are created on the basis of web technologies and standardization of data exchange.

Stage 3 – from the beginning of the new century to the present. The peculiarity is the refusal to integrate specialized AIS and the transition to commercial systems. Aiming at creation of a unified virtual environment of different types of combat support.

For example, the Concept of Development of the Russian Armed Forces Command and Control System by 2025 defines the guaranteed management of troops and weapons in a unified virtual environment by one of its main goals.

To a large extent, special purpose telecommunications systems, if not the future of telecommunications, are at least one of the models for the future development of this area, which is important for all those working in the field.

The development and refinement of communications systems and their management have been given the highest priority by the US and NATO military leaderships. According to US military experts, carrying out work in this area for two to three years is equivalent to the inclusion in the groups of the US Armed Forces from 15 to 20 divisions. The main goals of this work (in the US and NATO ground forces) are to equip staffs and control points for automation and communication systems to transmit more information to the ATSS, as well as to increase the stability, secrecy and continuity of management.

Although hundreds of independent telecommunication systems and networks used by various military agencies and based on military and commercial communications systems are still in use in the US and NATO troops, the DCTN (Defense Commercial Telecommunications) is being built and refined. Network) – networks for the transmission of voice information, video conferencing, data transmission by switched and dedicated communication channels leased from AT&T.

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RECOMMENDATIONS INCREASE THE EFFICIENCY OF THE USE OF UNMANNED AVIATION COMPLEXES FOR SURVEYING FOR SUPPORT TROOPS

One of the tasks of topo-geodetic support of troops is the early creation and updating of topographic maps and plans for providing troops during military exercises and special operations. In the course of combat operations, the task is to create special maps, photodocuments and terrain models, to determine the coordinates of targets, to bind the combat orders of missile troops and artillery, and so on. Such materials can be quickly obtained by aerial photography of unmanned aviation complexes (UAC). Prerequisites for the use of UAC as a new means of aerial photography are the disadvantages of two traditional ways of obtaining data using spacecraft and airborne manned vehicles.

To solve this problem the mapping complex should have as a payload the following equipment: a digital aerial camera; stabilization equipment; Have an adaptation plate (adapter) to combine with a specific aerocamera model of 180; to provide a range of stabilization angles at the roll and pitch not less than 5-6 degrees. In any case, the availability of such data greatly simplifies the processing and allows you to perform some of the processing stages completely in automatic mode. The system of direct geo-positioning, which is a navigation system, is designed to determine the spatial position and determine the speed and direction of movement of the UAC.

The system of direct positioning of the mapping complex based on UAC should include: a block of inertial measurements, comprising three gyroscopes to determine the angles of deviation of the axes of sensitivity from the initial position; GPS / GLONASS satellite measurement unit, including a dual-frequency satellite receiver of the geodesic class; on-board calculator that coordinates real-time inertial and satellite measurements.

In the mapping mode, the average square error of the determination of the parameters of the linear and angular position of the UAC will depend on the characteristics of the shooting equipment and flight altitude. At the same time, the condition of ensuring the accuracy of determining the planned coordinates of the objects of the area is not worse than 5 m without ground preparation must be fulfilled. If the dual-range GPS / GLONASS receiver was used in differential mode (or GPS / GLONASS data tuning) for shooting, then the minimum number of reference points (usually enough few points per unit of 100 pictures) is required to obtain the most accurate processing results, and in some cases the processing can be carried out at all without reference points.

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METHOD OF MANAGEMENT OF RADIO FREQUENCY RESOURCES OF SAFETY AVIATION COMPLEXES

Continuous improvement of the devices of radio-electronic intelligence and radio-electronic suppression (RES) has led in recent years to increase the likelihood of suppression of channels of control and data transmission unmanned aerial systems (UAS). The analysis of the tactical and technical complexes of the RES of the technically developed countries shows that the most effective channels for control and transmission of data UAS are intentional frequency-manipulated noise disturbances in the part of the band, polyharmonic and imitation. In this case, the strategies for setting deliberate interruptions are dynamic or static. The existing scientific-methodical apparatus for managing the radio frequency resource does not sufficiently take into account the strategies of the RES complexes. It is proposed to develop a method for managing the radio frequency resource of the UAS.

The main stages of the implementation of the methodology:

1. Entering the initial data. The parameters of transceivers UAS are entered, as well as the values of the minimum required transmission speed and the probability of a bit error.

2. Assessment of the radio electronic environment (REE). With the help of estimation methods, the type of deliberate noise, the zone of continuous electronic suppression and the parameters of interference complexes are estimated.

3. Determination of the strategy of the RES complexes. At this stage the strategy of the RES complexes is determined. The strategies of the REP complexes used in the developed methodology are dynamic and unchanged during the transmission of the message in the channels of the UAS.

4. Formation of the working frequency network of the UAS transceiver. After analyzing and calculating the strategies of the RES complexes, determining the areas of continuous electronic wave suppression, determining the type and capacity of the deliberate disturbance of the formed network of workers for the transmission of messages.

The novelty of the developed technique from the known is that the developed method implements the management of the radio frequency resource taking into account the strategy of the RES complexes, the type and duration of intentional noise of the chosen optimization criterion, as well as the choice of weight coefficients taking into account the degree of suppression of frequencies.

The use of game theory methods allows us to formulate the optimal control of the radio frequency resource of control channels and transmission of UAS data under various strategies for interference with the RES complexes. The use of the developed method allows to increase the noise immunity of UAS channels in the conditions of active RES by 15-25% in comparison with the existing scientific-methodical apparatus.

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ANTICORROSIVE MASKING AND ARMORED COATINGS

New anti-corrosive masking coatings with a high absorption (85,0–99.5 %) of radio waves abilities in the range of 10–70 GHz and close to zero reflection level -(10–23) Db – (0.5–8.0) % on the basis of polyurethane varnish of the Ukrainian manufacturer with the addition of nanopowders of polyvalent iron oxides (the technology of which was created in the Institute of Superhard Materials of the NAS of Ukraine), basalt fibers, etc. have been developed. The used polyurethane base is UV-resistant, stable against aggressive media, demonstrates high mechanical performance (high dampening ability) and long service life and was developed for using as painting for ships, containers, construction structures, auto and rail transport, parts and mechanisms, which are exploited in difficult climatic conditions, including the aggressive substances.

Ceramic coatings based on aluminum nitride with high-absorption abilities with L = 20–36 dB/cm, dielectric permeability ε = 16–20 and tensile dielectric losses $tg\delta$ = 0.5–0.6 at 3.0-3.3 GHz, with Vickers microhardness H_V = 13.6–14.2 GPa (at 150 N-load), the fracture toughness K_{1C} = 3.0–4.2 MPa·$m^{0.5}$, the bending strength σ_b = 132–209 MPa, the thermal conductivity λ = 40–60 W/(m·K), costing about 10 $/kg have been developed.

Ceramic elements made of silicon carbide (sintered at atmospheric pressure) of cylindrical shape with a spherical base and top were made as discrete armored elements. This form of elements contributed to the effect of the «turning» of the bullet when it struck into an obstacle. The diameter of such elements was adopted as 30 mm, which ensured the non-penetration of the bullet B-32 of 7.62 mm caliber (diameter of the core of this bullet is 6.12 mm) in the void between the cylindrical elements. This was necessary, because the bullet B-32 caliber 7.62 mm is capable of striking armor sheet thickness up to 14 mm. Ball 7H10 (ПП) with a caliber of 5.45 mm can not break through the base armor of LBT, therefore the possibility of its penetration into the void between the cylinders is not important.

This was necessary, because the bullet B-32 with a caliber 7.62 mm is capable to strike armor sheet having thickness up to 14 mm. Bullet 7H10 (ПП) with a caliber of 5.45 mm cannot break through the base armor of light armored tank (LAT), therefore the possibility of its penetration into the voids between the cylinders is not important. Surface thickness of the coating of elements made of silicon carbide for protection against armored-sphere bullets B-32 caliber 12,7 mm and 14,5 mm was – 59–61 kg/m^2 and 91–96 kg/m^2, respectively. It in average reduce the mass for 8 %.

Since silicon carbide based ceramic reflects radar radiation, it is obvious that the shape of the top of the armored element will contribute to scattering (about 30 %) of the ejected radar radiation and to reduce the visibility of the object.

On the basis of experiments, a textile absorber of electromagnetic waves was developed, in which, through the formation of an organized volume structure with the corresponding interweaving of threads, at least one of which is textured, that is, it is volumetric, an opportunity is reached to obtain a fabric with a developed absorbent surface. In the volume of such an absorber there is a multiple reflection of electromagnetic waves, which causes a decrease in the reflection coefficient, especially in the frequency ranges from 100 MHz to 30 GHz. From the developed textile composite absorbers is recommended material with rubber coating.

Ballistic tests were conducted at the Scientific and Testing Laboratory of Weapons and Special Protective Materials of the National Defense University of Ukraine named after I. Chernyakhovsky

According to the preliminary results of ballistic tests of ballistic barriers were made (1) samples of discrete armor of 20 mm in diameter and 10 and 12 mm in height were made, and (2) samples of discrete ceramic elements with a diameter of 30 mm and a height of 22 and 32 mm.

It was established that composite armor made of discrete ceramic elements and glass fiber fabric with a specific weight of 52 kg/m^2 on a support from a duralumin alloy of 1 mm thickness was resistant to the action of the bullet B-32 of 7.62 mm caliber at a distance of 400 m (bullet speed 542 m/s); while when using composite armor with a specific weight of 55.5 kg/m^2, the distance of the bullet holding is reduced to 300 m (bullet speed 542 m/s).

Sample of composite armor made of discrete ceramic elements and fiberglass with a specific weight of 89.3 kg/m^2 on the support of an aluminum alloy 4 mm thick was resistant to the action of the B-32 bullet of 12.7 mm caliber at a distance of 400 m (bullet speed 668 m/sec). Composite armor made of discrete ceramic elements and fiberglass with a specific weight of 77.2 kg/m^2 on a support from steel of 4.5 mm thick is resistant to the B-32 bullet of 12.7 mm caliber at a distance of 100 m (speed of bullet 754 m/s).

Researches carried out in the framework of the target scientific and technical program of the National Academy of Science of Ukraine «Research and development aimed toward solution of the problems connected with increasing of the defense capability and security of the State».

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METHOD OF EVALUATION OF PROVIDING OF ELECTROMAGNETIC COMPATIBILITY OF RADIO ELECTRONIC FACILITIES

The task of evaluation of providing of electromagnetic compatibility (EC) of radio electronic facilities (REF) in practice arises up in those cases, when questions decide about the change of the frequency, spatial and sentinel modes of operations of REF, located in some territorial district, or about placing of new REF in this district. It consists in that, a priori to define or EC of totality of REF will be provided, if for some REF there will be the changed office hours (frequency, spatial, power) or within the limits of this territorial district new REF will be placed. The order of decision of task of providing of EMC is process examined on the example of placing of new REF.

The order of decision of task of providing of EC is process examined on the example of placing of new REF. Some totality of REF is considered set, id est composition, placing, spatial, frequency and sentinel modes of operations of REF and them technical descriptions in some limit district. Within the limits of this district on the chosen position, it envisaged to place new REF (for example, wireless station, radiolocation station, televisional repeater and other). Technical descriptions, frequency, the spatial and sentinel modes of new REF known, of EC earlier placed REF a posteriori tested and provided. If it will appear as a result of evaluation, that cross-coupling that mixes, between before placed and REF, that takes place, it is not envisaged, then a positive decision is accepted about possibility of exploitation of new REF in this district. In another case at REF other position or other office (if it maybe) hours targets and conducted the repeated evaluation of EC. If it will appear as a result, that EC of totality of REF in this district not provided, then drawn conclusion about impossibility of the use of new REF in this district.

Providing of EC REF safety is the constituent of radio electronic defence of REF and arrived at by the concerted use of radio frequencies; by the observance of norms of the frequency-territorial carrying of REF; by determination of priorities of the use and regulation of their work. Thus, the task of evaluation of EC can be erected to successive consideration of duel variants of cooperation of every REF. Electromagnetic compatibility REF it can solve problem by means of corresponding complex of technical and organizational events. Technical events have for an object of intentional electromagnetic obstacles in the sources of their origin. Organizational events include for itself distribution of radio frequencies, establishment of the frequency-spatial carrying between REF, determination of location of REF and other events, related to the correct taking into account of technical parameters of different facilities that have an influence on providing of EC.

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TEXTILE NANOTREATMENT FOR PROTECTION FROM ELECTROMAGNETIC RADIATION

One of the possible new types of weapons based on the latest technology, according to experts, in the near future can be ultrahigh-frequency, infrasonic and radio frequency. It is known, that even a weak energy influence of electromagnetic radiation on human body affects resonance processes on molecular and cellular level in various organs and systems of a living organism that leads to acute and chronic diseases. Therefore, protecting a person from the influence of electromagnetic radiation of any nature is an actual task. For producing textile which can reflect or absorb electromagnetic radiation four main approaches are traditionally used: introduction of electrically conductive threads, coating of metals or electrically conductive metal compounds, coating of metal nanoparticles or their electrically conductive compounds, the introduction of micro- or nanoscale carbon particles. Developments of materials that contain magnetic nanoparticles provide the new properties of textile.

The purpose of our work is elaboration of simple technology of obtaining of nanocomposite textile materials with conductive and magnetic properties and investigation of their morphological and structural characteristics. For investigation were used different raw textile materials containing nanoparticles of magnetite powder, which was synthesized by the most simple and affordable method of chemical co-precipitation.

Iron oxide particles were synthesized in the bath in the presence of polyamide fiber material, that contains reagents $FeCl_3$, $FeSO_4 * 7H_2O$. The process was carried out at 100 °C for 1 h, resulting in the preparation of magnetite particles. Finally, the treated samples were washed with distilled water for 10 min and dried at room temperature. The surface morphology of the treated materials were characterized by scanning electron microscopy. The deposition of nanomagnetite particles in the volume of textile materials and particle size determination were studied by X-ray diffraction analysis. The magnetization curves of the synthesized magnetite nanoparticles and their corresponding treated textile materials were measured using a vibrating-sample magnetometer.

Was elaborated eco-friendly accessible technological process of obtaining textile materials with magnetic properties on the basis of iron-oxide compounds according to a two-stage treatment scheme: 1 stage - sorption by material of iron salts from the original bath; Stage 2 - co-precipitation of sorbed salts of iron with aqueous ammonia solution. The process can be implemented on the existing equipment of the finishing industry of the textile industry.

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SUBMISSION OF PRINCIPLES OF CONSTRUCTION OF MODERN AUTOMATED MILITARY MANAGEMENT SYSTEMS

The intensive complication and increase of the scale of hostilities, the introduction of electronic computing in all areas of troop control, became the basis for the development of automated command systems (ACS), which qualitatively changed the formula of troop control and significantly increased its effectiveness. Nowadays, there is a large number of different types of automated control systems of troops, but in existing sources there is no generalization and systematization of the principles of constructing modern ACS.

The main operational and tactical principles of the ACS creation (construction):

1. Correspondence of the capabilities of the ACS with the organizational structure and combat capabilities of troops, armaments and military equipment, as well as the composition and structure of the command system of troops.
2. Preservation of the leading role of the commander (chief) in the process of command of troops, the correct combination of creative activity of man and work on technical devices of automation, creating the convenience for officials of bodies and control points.
3. Maintaining the main algorithms of the commanders and headquarters in the implementation of the devices of automated command of troops
4. A rational combination of centralized and decentralized management, the ability to quickly move from automated management to non-automated and vice versa.
5. Automatization of the most labor-intensive and fast-moving processes of management, the conformity of quantity and quality of applied complexes and devices of automation by the volume and significance of management tasks.
6. Creation and integrated, coherent application of the main, duplicate and backup systems of automated command of troops.
7. Ensuring the possibility of management through an authority, and in some cases through two instances.
8. Ability to transfer control functions between the control points in one control and in some cases to the control points of the subordinate troops.
9. Technical, informational and linguistic compatibility of all subsystems, included in the ACS.
10. Technical, informational and linguistic compatibility of the ACS with the higher-level ACS and ACS of other types of the Armed Forces.

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METHOD OF ASSESSMENT OF INFORMATION AVAILABILITY OF SOURCES OF RADIO INFLAMMATION BY DEVICES OF RADIOELECTRONIC RECOGNITION

Ensuring the information superiority over the enemy today is becoming a prerequisite for conducting military operations (combat operations).

The main kind of information support is military intelligence, and its basis is radio-electronic intelligence.

In the course of the analysis of the known scientific achievements in the chosen direction of research, it was established that there is no general methodology for assessing the capabilities of the forces and devices of radio-electronic intelligence to assess the information (intelligence) availability of radio-electronic intelligence sources that is suitable for the use in automation devices of various control units, which connects separate indicators of information accessibility in generalized on the basis of the use of modern intelligence-information models.

In the mentioned report the method of estimation of information accessibility of radio emission sources by devices of radio-electronic intelligence was developed.

The developed technique allows:

to evaluate sources of electronic intelligence in terms of the expediency of including in the original plan distribution of forces and facilities for different conditions of the situation (stages of battle or operation);

effectively manage the forces and devices of extraction and processing in the interests of solving the problems of radio-electronic intelligence;

assess the degree of effectiveness of the management of forces and devices of extraction and processing in the interests of solving the problems of radio-electronic intelligence.

This technique, which is an integral part of the general methodology for the distribution of forces and intelligence, can be applied at command posts (grouping of troops (forces), military units and units) of electronic intelligence and will increase the efficiency of conducting searches of sources and objects of electronic intelligence, as well as distribution of forces and devices according to tasks, objects and sources.

In addition, it can be used to assess the effectiveness of existing and promising devices and complexes of electronic intelligence and electronic warfare.

Taking into account the above, the direction of further research should be considered development of scientific and methodical apparatus for improving the efficiency of conducting radio-electronic intelligence.

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APPROACHES TO FINDING PERIODICITY OF DIGITAL SEQUENCES WITH BLOCK CODING FOR THEIR CORRELATION PROPERTIES

The widely used communication and data transmission systems (CDTS) use a variety of methods, protocols, and standards for data transmission. To increase the likelihood of receiving signals using noise immunity coding (NIC). The most common types of NICs in modern CDTS, due to their efficiency are convolutional coding, Reed-Solomon coding, composite codes, TPC and LDPC codes. Most practically used NICs are block codes.

To decode received data by existing methods, algorithms, standards must be known the type and parameters of the code. In the case of partial a priori uncertainty of the type and parameters of the encoding, it is necessary to analyze the digital data flow (DDF) of the data beforehand to determine them. The development of a methodological apparatus for the analysis of the DDF, which is performed before decoding, pay less attention.

To synchronize the decoder of block code, a synchronization sequence (SS) is inserted before the encoded data block, which determines the periodicity of the DDF. This is based on the principle of the methods of determining the type and parameters of the NIC. The disadvantages inherent in the practical implementation of the latter, limit their application. Therefore, it is relevant to study algorithms for determining the type and parameters of block NIC, in particular, periodic search algorithms.

Among the well-known algorithms that can be used to find the periodicity of a digital stream are algorithms to search using autocorrelation (ACF) and cross-correlation function (CCF).

The method for searching the periodicity of ACF is to find local highs discrete input sequence $s(n)$. In this case, at each iteration of the loop there is a logical shift of the discrete sequence to the left (right). ACF highs will correspond to multiple values T of the DDF period. The number of iterations of the shift cycle is equal to the length of the discrete sequence L.

To find periodicity in the DDF $s(n)$ length L by means of CCF, the input sequence is divided into two DDFs.

First DDF $s_1(n)$, length $l = T_{min}$, – from the beginning $s(n)$, to the minimum possible T_{min}. Second DDF $s_2(n)$ – from $T_{min}+1$ DDF $s(n)$, with the same length l.

Between sequences $s_1(n)$ and $s_2(n)$, a logical operation of a bitwise comparison is performed. The resulting number of units due to this operation is calculated using the operation of adding, and is normalized to the total number of bits in the DDF. The value of *l* at each iteration of the loop increases by one. Upon reaching the length of the formed DDF *l* values of the true period T, the shift of the SS in the formed sequences from their beginning will be the same, which will cause a sharp increase in the number of coincident bits and the local highs CCF.

To determine the effectiveness of the proposed algorithms in Visual Studio 2017 in C # programming language was developed special program with support for multi-core CPU. The operating system is Windows 7. The experimented computer is based on a 4GHz quad-core Intel Core i7-4790K CPU with 8GB of memory.

This program made it possible to estimate the search time of the periodicity in the DDF for the block NIC with priori uncertainty of the type and parameters using the considered algorithms. The ratio of the peak values of the correlation functions of the DDF to the body of the functions is also estimated.

The gain on the search time by the implemented CCF method compared to the developed module and the module of program which widely used in technical signal analysis system is given in Table. 1.

Table 1

Maximum cycle length	Average computation time, c					
	T=1000	T=10000	T=20000	T=30000	T=40000	T=40000
The existing module	0,038	2,06	6,57	14,31	28,04	48,57
Test module developed (CCF)	0,029	0,776	3,023	6,724	11,884	18,564

The practical significance of the obtained results is the ability to determine, with the help of developed algorithms, period of DDF in real time for further establishment (definition, identification, classification, recognition) based on its type and parameters of the NIC in the DDF.

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PROSPECTIVE WAYS OF DEVELOPMENT OF MANAGEMENT AUTOMATION FACILITIES AND COMPLEXES

As prospective ways of development of automation management of troops (weapons) facilities and complexes can be considered:

implementation of a network-centric principle of troops commanding by integrating of systems (subsystems) of different functional purpose, namely the creation of a set of software and hardware that interact with each other and designed to provide operational information to units, crews, armored vehicles, machines, soldiers and robotic complexes about real-time (near real-time) combat situation;

development of domestic operating system and software;

development of special software for solving functional problems, database management systems, methods of providing multiple distributed access to them;

introduction into the mathematical, algorithmic and software of the newest ways of warfare into account the capabilities of modern combat and other technical means, including functioning in the virtual information space;

development of methods and means of subjects and objects identification, as well as automatic determination of their status;

implementation of modern methods of data processing and storage with cloud technologies, distributed facilities and parallel distributed processing methods;

development and creation of self-organized networks with multiple asynchronous access, solving the problems of relaying and distribution by priority;

application of modern algorithms and standards of cryptographic information security;

providing of uniformity and modularity that will allow to develop standard equipment kits and model samples and kits of various uses based on basic elements.

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PROSPECTIVE WAYS OF COMMUNICATION FACILITIES AND COMPLEXES DEVELOPMENT

As prospective ways of communication facilities and complexes development can be considered:

creation and application of broadband high-speed radio access;

implementation of the software-reconfigured radio;

increasing of the information transfer speed;

application of hybrid modes of channel distribution (frequency, code, time and spatial);

increasing of noise and intelligence immunity by increasing the number of hops in the frequency hopping mode, the frequency spectrum expanding, noise immunity coding, applying of segment antennas;

automatic control of all types and modes of operation with the help of “intelligent” control system;

application of modern technologies of channels (streams) merging (separation);

providing the possibility of adaptation of the radio signal modulation method depending on the radio channel quality (applying of multiposition types of modulation);

implementation of a software complex, which provides the implementation of management, remote control and control of equipment and intervals (lines) functions;

providing service information and network management without the organization of dedicated channels;

replacement of the existing element base of stations on solid state basis;

efficient use of the allocated frequency resource;

application of DVB-S, DVB-S2 transport protocols;

application of frequency and energy adaptation methods by automatically changing modes, types and parameters of operation;

supporting of protocols and algorithms for automatic communication, routing, remote and operational network management, and recovery of configuration and software;

providing of automatic pointing of antenna devices to the satellite;

quality assurance of communication with the built-in control system.

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PROBLEM QUESTIONS OF CREATION OF DOMESTIC REACTIVE INFANTRY FLAME-THROWER AND WAYS OF THEIR DECISION ARE IN MILITARY POWERS OF UKRAINE

It is well-known that rocket-propelled anti-personnel flame thrower (hereafter RPAFT) are designed to destroy the enemy's covered fire positions, lightly armoured and automotive equipment, engage enemy personnel behind shelters and barriers, provoke fires spots. The greatest effectiveness of the application of this type of weapon is achieved in the fight against fortifications and in conducting military operations in mountainous, highly crossed and urbanized areas.

The temperature field and the excess pressure field are the most impressive factors of the flame thrower. The temperature field depends significantly on the composition of the flame mixture and the excess pressure field depends on the design of the projectile and the composition of the flame mixture. Thus, the design of projectile and the composition of the flame mixture are very important in terms of assessing the combat effectiveness of the flame thrower.

At present time following types of projectiles (assault rocket grenades) for hand-held grenade launcher are in operational service: projectiles with shaped-charge and tandem shaped-charge warheads (optimized for the tank destruction), thermobaric, fragmentation, high explosive, smoke, inflammatory, etc. Among them, thermobaric, inflammatory and smoke projectiles are in operation service with both units of the chemical defence troops and the Ground Forces, the other projectiles are only in the inventory of the units of the Ground Forces. According to their purpose, which is destruction of the personnel and lightly armoured vehicles, fragmentation projectiles compete with thermobaric and inflammatory projectiles, according to destruction of nonconcrete constructions (trenches, observation posts, wooden and stone fire positions) high explosive projectiles compete with them andhigh-explosive fragmentation projectiles compete with all mentioned types of projectilesin terms of destruction of all abovementioned and well fortified constructions.

Following combat characteristics of a rocket-propelled anti-personnel flame thrower model are distinguished: accuracy, power, limited application, survivability, reliability, combat flexibility, autonomy, maintainability, ergonomics, safety, etc. As a rule, each of the combat properties is formed under the influence of many factors. In general, the RPAFT model simultaneously has a set of factors in a certain optimal ratio between them, and it allows to show its combat characteristics to the full extent and to ensure maximum efficiency of its application. Neglect of any its property at the expense of others does not allow the combat capabilities of the RPAFT model to be fully implemented. On the other hand, if an optimal balance between combat characteristics is achieved, the attempts to improve one of its properties may lead to an imbalance of the entire system and a decrease of its effectiveness. Thus, combat capabilities are generalized factors of the effectiveness of RPAFT model and they occupy an intermediate place in the hierarchy of the system of factors. At a higher level, they are transformed into integral properties, such as combat potentials, for example, and at the lower level they represent a convolution of partial factors, which values directly depend on the tactical and technical characteristics of the RPAFT models.

Introduction of an intermediate link of the generalized factors of RPAFT effectiveness (combat properties) allows improving the quality of comparative assessment of the effectiveness of RPAFT model, to substantiate the ways of their modernization and the development of new, promising fire thrower models.

Analysis of application of flame throwers allows distinguishing four main groups of combat properties that affect the effectiveness of application: mobility, operational efficiency, accuracy, lethality effect.

Lethality effect is expressed through the probability of destruction (kill ratio) of various military objects (both point and plane).It depends on the characteristics of the projectile and the properties of the applied flame mixture. Thus, we can distinguish the following characteristics that affect the lethality effect of the rocket-propelled anti-personnel flame throwers: the type of projectile (thermobaric, thermobaric with a shaped high explosive charge, inflammatory, etc.), the mass of the flame mixture, the type of the flame mixture and the type of target. Such values as guaranteedly affected volume and area of damage that directly determine lethality effect of the flame thrower depend on these characteristics.

Mathematical modelling, in particular, the mathematical technique of probability theory, game theory, etc., is used as the main tool for assessing the probabilistic factors of combat effectiveness of RPAFT model. In the course of its application, predictive assessments of the effectiveness of the use of flame thrower samples in various combat and natural climatic conditions are made, their weak sides are discovered and the optimization problems for determining the inventory count of promising RPAFT models are being solved. In general, probabilistic factors characterize effectiveness of the impact of weapon on the target.

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GEL OF FUEL TO PROVIDE SPECIAL WAREHOUSE AND UNITS IN THE FIELD

Today, the use gel of fuels in individual diets (IPX) to heat food in the field is being extended to NATO armies as a substitute for flaming warming or dry fuel based on urotropine. Gel of fuels are promising due to their safety and advantages compared to conventional liquid and solid fuels. The performance characteristics and capabilities inherent in liquid fuels, as well as the high density, increased combustion energy and long-term storage capabilities, make gel of fuels attractive for many applications, namely; heating food, carrying out individual heating in the field, as well as drying the elements of real property.

Specialists of the Institute of Chemistry several variants for combustible basis gel of fuels have been investigated by the Pizarzhevskogo L.V. National Academy of Sciences of Ukraine, considering the parameters of calorific value and environmental friendliness: methanol, ethanol, diethylene glycol, isopropyl alcohol. Given the fact that methanol and diethylene glycol vapors are harmful, their use for gel of fuel production is inappropriate, although it is known that the US Armed Forces uses diethylene glycol-based gels. The ability of isopropanol to gel with most agents is the lowest that can be seen in the lowest viscosity. Thus, ethanol, the vapor and combustion products of which are safe for health, was chosen as the fuel base for the gel of fuel.

The author shows that the estimated calorific value of the selected samples is about 22 MJ / kg, which is twice the average calorific value of the most common solid fuel in Ukraine - pine firewood.

Fuel of gel is easily ignited, due to its strong adhesion to various solid materials, it can burn on an inclined plane without slipping, does not form soot when combusted, is not blown by gusts of wind. It was found that 25 g fuel of gel is capable of burning for 15 minutes. It has been proven that 25 g of a sample fuel of gel can bring to a boil 200 ml of water in 10 minutes.

The most technologically expedient composition gel of fuel was determined, its viscosity optimized with respect to manufacturability and operational parameters, a one-time technological regulation was developed for the production of a pilot batch gel of fuel.

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PERSPECTIVE AUTOMATED CONTROL SYSTEM FOR RADIATION, CHEMICAL, BIOLOGICAL TROOPS PROTECTION

The development and equipping of CBRN troops with automated control systems (ACS) is one of the key tasks to enhance their ability to perform their assigned tasks.

The beginning of development of the respective systems should be considered as the soviet combined arms automated control systems "Maneuver". It included a chemical protection subsystem. Part of this subsystem was aviation radiation and chemical reconnaissance as well as nuclear explosion detection stations.

The next step in the development of automated control systems for CBRN troop’s protection was the creation of the JWARN system (USA). It is designed to automate the process of collecting, processing, transmitting information on the CBRN situation and alerting their troops in the event of the use of weapons of mass destruction.

The JWARN system is part of a broader system, which also includes the JEM (CBRN Forecasting) modules and the JOEF (Mass Weapons Impact Assessment). The JWARN - JEM - JOEF chain of systems is the basis for any ACS CBRN troop’s protection. The US is the only country in which such a chain is currently operating.

The Russian automated control system “Constellation – XM” is the analogue of the American automated control system of the CBRN protection of troops. This system has comparatively developed special software for forecasting of CBRN situation. However, it lags behind the US in the level of automation of the process of gathering information about the CBRN situation, which negatively affects the duration of the combat cycle.

Automated control systems based on the principle of minimizing the time for the control cycle gradually exhaust their development opportunities. In our opinion, trying to copy them when creating a domestic CBRN protection system is inappropriate.

An analysis of the concepts and principles of building an ACS CBRN troop’s protection points to a number of inherent shortcomings, namely: the excessive centralization of management and the concentration of efforts to minimize the effects of the use of weapons of mass destruction.

As an alternative to overseas samples of ACS CBRN troop’s protection, an "intelligent" control system CBRN of troop’s protection, based on the following principles is proposed:

- decentralization of management with the transition from hierarchical to flexible, distributed management systems capable of changing their structure and functions depending on the situation;
- the transition from the tasks of minimizing the effects of the use of weapons of mass destruction (WMD) to the tasks of predicting the risks of using WMD in order to avoid contamination;
- the transition from full information ACS to an ACS capable of operating under partial or complete uncertainty.

In order to meet these principles, a mixed network-hierarchical structure of ACS functioning is being developed. In such an ACS, clusters are created under tasks by self-organization, which breaks down after the tasks are completed. That is, the basis of such a system is temporary network-hierarchical structures. Links between elements of such structures are network centric at each layer (control levels) and hierarchical between layers (control levels). Thus, the control system is not permanent, it is constantly transformed, adapting to the conditions of combat environment.

The author shows that most of the tasks of control of CBRN protection of troops can be formulated in the form of continuous dynamic problems of optimal partitioning of sets, which arise in the management of distributed systems. This class of problems is studied in the scientific school of Professor E.M. Kiselyova. Methods of non-differentiable optimization are used for numerical solution of such problems, in particular different variants of the r-algorithm developed by Professor N.Z. Shor.

It should be noted that the development of modern ACS CBRN protection of troops goes in two directions - improving operational management by automating decision support processes and improving situational awareness by automating information exchange processes. Thus the first direction is based on hierarchical structures, the second - on network-centric ones. However, our analysis shows that the basis for promising "intelligent" control systems should be the opposite - decentralization of operational management, and the transition to mixed hierarchical - network structures when creating a single information battle field.

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STRUCTURAL AND PARAMETRIC SYNTHESIS OF THE SYSTEM OF TECHNICAL MEANS OF RADIATION, CHEMICAL, BIOLOGICAL RECONNAISSANCE

The system of technical means of radiation, chemical, biological (hereinafter CBRN) reconnaissance is a set of technical means distributed by the organizational structure of the troops, intended for solving the tasks of reconnaissance, control and notification. The principle of distribution of these means is a complex task, which should guarantee the possibility of early detection and notification of their troops about the fact of the use of weapons of mass destruction. In [O.V.Babenko and others] it is stated that the distribution of CBRN reconnaissance means should be optimal, but no criterion of this optimality is given.

Article [S.V.Gorbunov, A.S.Starostin, G.S.Chernuh] examines the state of the Russian Intelligence and Control technical means Ministry of Emergency Situations (MOE). Comparison of the system of technical means of chemical reconnaissance and chemical control of the US and Russian armies was carried out by O.V.Babenko. It is stated that their construction is of the same nature, and the differences are dictated by the requirements of national standards, views on the content of chemical reconnaissance tasks and the possible nature of military operations using chemical weapons. The main tendencies are: supply of chemical intelligence devices to the lowest possible levels of military structures, up to the status of individual ones; building promising systems based on a reasonable balance of local and remote chemical reconnaissance; introduction of mobile analytical tools into mobile devices that combine chemical reconnaissance and chemical control capabilities.

In O.V.Babenko the following initial data for the construction of a system of chemical reconnaissance and chemical control equipment are specified:

- the military doctrine of the state, as well as the military doctrines of potential adversaries;
- views on the role of chemical weapons and tactics of their use;
- the composition of the formulations and the validity of the toxic substances that can be used;
- features of the organizational structure of the army.

The analysis of the available literature shows that at present there is no single formalized approach to support managerial decision-making on the construction of a system of technical means of CBRN reconnaissance. Such systems are generally built with the involvement of a narrow range of experts based on their knowledge and experience.

Thus, the construction of a state-of-the-art methodology to substantiate the structure and composition of the system of technical means of CBRN reconnaissance is an urgent scientific task.

The author proposes the following algorithm of structural-parametric synthesis of the system of CBRN reconnaissance means:

- set the levels of hierarchies of the organizational structure of the troops;
- for each level of the hierarchy to determine the set of allowable (by purpose and technical characteristics) technical means of CBRN reconnaissance and monitoring;
- to create from each level of the hierarchy a sets of possible combinations technical means, which represents different variants of construction of the system of technical means of CBRN reconnaissance;

- to determine the integral indicator of the effectiveness of the system of technical means of CBRN reconnaissance;
- to determine the objective function of the structural synthesis of the system of technical means of CBRN reconnaissance based on the criterion of integral efficiency-cost;
- to create a set of inequalities, that put a restriction on the synthesized variants of the system of technical means of CBRN reconnaissance;
- to use the evolutionary algorithms to search for an approximate solution of the structural synthesis optimization problem;
- to determine the basic parameters of the structural elements of the system of technical means of CBRN reconnaissance using the method proposed by the author (fuzzy expert assessments).

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ANALYSIS OF OPTIONS FOR CONSTRUCTION OF MOVING COMPONENT OF RADIATION, CHEMICAL, BIOLOGICAL RECONNAISSANCE SYSTEM

Technical means of reconnaissance may be stationary or mobile, point or plane, non-specific or specific, specialized or combined. Among the moving means of CBRN reconnaissance are the following: special CBRN reconnaissance vehicles, field chemical laboratories, nuclear explosion detection stations and ets. Special CBRN reconnaissance machines are generally combined point or plane means. That is, they can control the CBRN environment at its location or within a certain radius (with the presence of remote reconnaissance devices or unmanned aerial vehicles).

Currently, there are various variants of building a moving component of the reconnaissance CBRN system. However, there are two main trends. The first of these is to separate the functions of non-specific and specific CBRN reconnaissance. The first function, which is to identify a possible CBRN threat, troop alert and sampling for further analysis is performed by special CBRN reconnaissance machines. The second function is the identification of the CBRN threat, confirmation or cancellation of previously sent to the troops warning and correction of measures for the treatment of victims performed by field chemical laboratories.

In the second variant, the functions of non-specific and specific CBRN reconnaissance are combined in one machine at the level of combining the capabilities of special CBRN reconnaissance machines and field chemical laboratories. Such CBRN reconnaissance machines, along with radiometers, gas analyzers, non-specific biological intelligence devices, also contained equipment from field chemical laboratories. Specifically, spectrometers, gas chromatographs, chromate-mass-spectrometers, specific biological intelligence devices, other sophisticated equipment that works with air, water and soil samples.

All other options for constructing a moving component of the CBRN reconnaissance system are intermediate options between the above two main ones.

The option of constructing a moving component of CBRN reconnaissance system that combines the functions of non-specific and specific CBRN reconnaissance is now prevalent. In fact, all NATO member states, as well as other wealthy countries, are focused on it. This option has both advantages and disadvantages. A key advantage is the ability to identify high-risk, high-reliability, CBRN threats in near real time. This increases the speed of the response of the reconnaissance system to the threats of the recurrent character. However, there are a number of significant drawbacks, most notably the high cost of special CBRN reconnaissance machines. While most of the CBRN scenarios for military conflict are local and unlikely, the combination of non-specific and specific reconnaissance will lead to the need for transportation and maintenance of complex and expensive equipment that is never likely to be used.

As a result, even in such financially viable countries as the United States and Germany, the CBRN special machine fleet does not exceed 300 units. The neighboring Republic of Turkey intends to purchase 60 vehicles in the second version under the SPV program. If we compare this number of machines with the area of the territory occupied by these countries, we get a very rare coverage network. That is to say, with the availability of special CBRN reconnaissance machines, it is very difficult to ensure prompt response to CBRN threats. An addition, for many countries, the cost of one machine, which starts at $ 3-4 million, is "not liftable." Therefore, in our opinion, it is advisable to consider the first variant of construction of the moving component of the radiation, chemical and biological reconnaissance system on the basis of relatively not expensive machines of non-specific CBRN reconnaissance, emphasizing the sensitivity and reliability of the data obtained by them. The performance of these machines can be greatly enhanced by installing modern communications and connecting them into a single network.

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CLASSIFICATION OF TECHNICAL MEANS OF RADIATION, CHEMICAL, BIOLOGICAL RECONNAISSANCE

Classification of technical means of CBRN reconnaissance is possible according to the principle of operation, purpose, method of detection (point or remote), etc. From the work of Babenko O.V. with colleagues, it follows that the distribution of technical means of CBRN reconnaissance by organizational structure of Russian and US troops is based primarily on their purpose. In according to work of Radeutsky V.Yu., Shulzhenko V.N., Rubanova Yu.K. and others, the appropriate classification is made by type of contamination and is based on formal logic approaches. The authors distinguish three levels. The upper (first) level contains four classes: radiation intelligence detection devices, chemical and biological detection tools, CBRN detection complexes, tools and complexes of CBRN data gathering, collection and processing. At the second level, each class is divided into types of means, and at the third level, the corresponding types of means are divided into specific samples.

Such a classification allows covering the whole spectrum of technical means of CBRN reconnaissance, but it has some disadvantages. In particular, it is redundant, since the class of tools and complexes for the collection and processing of data on CBRN environment does not actually contain the technical means of CBRN reconnaissance and belongs to a higher level system - "system of CBRN reconnaissance ". In addition, such a grading does not allow the combination of radiation, chemical and biological reconnaissance devices to be attributed to any of the classes.

Therefore, in our opinion, the classification of the four levels will be more complete: Class (Level I) → Type (Level II) → Means (Level III) → Tools (Level IV). This classification is based on the following definition system.

We will consider as means of one type the means of CBRN reconnaissance, which are identical in their functional purpose, but may differ in their tactical and technical characteristics, principle of operation and cost. For example, gas analyzers can identify different amounts of warfare and especially dangerous chemicals, and do so with different physicochemical methods, but they are of the same type. However, gas analyzers that can identify a group of chemicals (for example, nerve activity) but do not identify the substances themselves, and analyzers that can identify a chemical are not the same. Similarly, non-specific and specific CBRN recon machines, CN and NBC reconnaissance machines, machines with and without remote reconnaissance capabilities, etc. - are not the same.

A more general concept will be the class of CBRN reconnaissance assets, which may include several types of CBRN reconnaissance assets that are combined by certain common functionalities. For example, different types of special CBRN reconnaissance machines belong to the same class - CBRN reconnaissance machines, all gas analyzers belong to the same class - chemical reconnaissance, and gas chromatographs, mass spectrometers, chromatographic mass-spectrometers - to the class of chemical control means.

We will assume that the gradation of means is conducting by the method of their transportation. So CBRN reconnaissance devices can be stationary, portable and onboard. CBRN reconnaissance machines can be ground, air, or marine, crew-operated, remotely, or autonomous. Special labs can be stationary and mobile, etc.

At the first level, there are three main classes: indicators (natural or artificial), devices, complexes of technical means of CBRN reconnaissance and monitoring. Each of them can, in turn, have its own subclasses. For example, the class of complexes of CBRN reconnaissance and monitoring equipment includes the following subclasses: special CBRN reconnaissance machines, object-specific CBRN monitoring systems, nuclear strike stations, special CBRN control laboratories. Under the complex of technical reconnaissance and monitoring equipment, we will understand the target set of devices and tools integrated into a single system for simultaneous measurement of multiple parameters for the purpose of comprehensive assessment of the current CBRN situation. The components of such systems may be (in addition to the actual intelligence and control indicators and devices): meteorological kits, controls, communications and information processing, decision support systems, sampling and storage tools, etc.

The class of CBRN reconnaissance devices includes the following subclasses: radiation, chemical, biological intelligence tools, combined radiation-chemical, chemical-biological, radiation-chemical-biological reconnaissance tools, remote chemical, biological, chemical-biological reconnaissance devices. Each of these subclasses contains one or more types of CBRN reconnaissance devices. For example, a subclass of radiation intelligence devices contains two types of instruments of this class: the detection and control of radiation conditions. Each of these types can in turn be subdivided into subtypes.

The classification given to a certain extent takes into account all possible criteria: the principle of operation, the type of contamination, the purpose, the mode of transportation and detection. In our opinion, it can be the basis for further work on the formation of principles for systematization of technical means of CBRN intelligence and control, which do not contain contradictions.

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EXPERIENCE IN DEVELOPMENT AND USING NON-LETHAL WEAPONS IN NATO

Interest NATO to non-lethal weapons (NLW) begins with the mid 1990s, after briefing the general Anthony Zinni about the results of using non-lethal weapons during the UN mission in Somalia. In 1999 North Atlantic Council (NAC) published NATO policy in the field NLW (NATO NLW Policy), which was based on the initiative of Defence Capabilities (Defence Capabilities Initiative, DCI) and considered NLW as a critical additional capability, which is necessary to meet the needs of future operations.

Later, the need to combat terrorism put the operational NATO community in front of the problem of minimizing land losses, which accompany force actions and lead to escalation of violence and danger against both civilians and military, leading to unwanted injuries, mission failures and political resonances. So in 2007 Conference of National Armaments Directors (CNAD) decided to expand the Defence Against Terrorism Programme of Work (DAT POW) due to using Non-Lethal Capabilities (NLC). Development these capabilities has become 11s direction of realization for DAT POW and since then remains relevant.

Non-lethal weapons development, as and traditional weapons and military equipment in NATO countries started from related research. For this purpose, a separate system of state and non-state ownership subjects has been created and is effectively functioning.

Basic research execution mechanisms are:

attraction of the scientific potential of NATO member states and partners withing Science & Technology Organization (STO), former Researh & Technology Organization (RTO);

using industrial research capabilities with help NATO Industrial Advisory Group (NIAG);

multinational projects of "Smart defence";

Defence Against Terrorism Programme of Work (DAT POW).

Besides, should be indicated researches within European Defence Agency (EDA) or without attraction non-state organization structure of national level on bilateral or multilateral basis.

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THE USE OF ALGORITHM OF ANT COLUMNS FOR SOLUTION OF ROUTING TASKS IN NETWORKS OF COMMUNICATION WITH THE POSSIBILITY TO SELF-ORGANIZATION

Routing in communication networks with the possibility of self-organization is a complex scientific and practical task. The authors of this report suggest the use of multi-agent systems for solving routing problems, one of which is the ant colony algorithm.

Simulating the self-organization of an ant colony forms the basis of ant optimization algorithms. The colony of ants can be considered as a multi-agent system in which each agent (ant) operates autonomously under very simple rules. The basis of the behavior of the ants is self-organization, the mechanisms of which provide theoretically optimal behavior. Its principles consist in achieving a system of some global goal as a result of the low-level interaction of its elements.

An ant algorithm for solving routing problems in communication networks with the possibility of self-organization is applied in the following way. At the initial time of each function of the knowledge base is the number of ants, which is equal to the number of clusters, which includes this function. At the same time, each ant has a strict affiliation with the cluster from which he began his movement. The affiliation of the cluster is manifested in the fact that the ant is more susceptible to the pheromone left by the ants from its "own" cluster. Moving from function to function for an ant depends on the following indicators: visibility; magnitude, return distance between functions; virtual pheromone trail; the amount of pheromone left for communication before the other ants and stored prior to the iteration of the algorithm. The algorithm is used in two stages of the analysis of knowledge of the system. In the beginning, it starts on the spatial (multidimensional) base model, after which the initial conclusions are drawn based on its work. Then the model is simplified: some links between functions are removed, separate functions are combined into larger structural units, the knowledge structure is displayed on two-dimensional space.

After this, the algorithm runs on a simplified, flat model of knowledge. According to the results of this research, it can be concluded that the ant algorithm, in all its complexity, is the most productive for solving routing problems in communication networks with the possibility of self-organization.

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ANALYSIS OF THE ASELSAN MANUFACTURING OPPORTUNITIES OF THE C4I TACTICAL SYSTEM

The C4I tactical systems manufactured by Aselsan provide decision support to the commander by processing information on the individual functional capabilities of individual combat units at the tactical and operational level, air defense and logistics. C4I systems analyze the effectiveness of the units' combat use and automate the process of controlling the commander over the battlefield, providing the ability to operate in changing operational conditions.

An administrative battlefield management system provides:

analysis of its troops (forces, units), provides units with automated distribution of information on the battlefield;

complete control and management tasks for all units;

planning and preparation of combat employment of units using digital maps and geographical information system (GIS);

digital messaging and data exchange;

control of operational and logistical condition;

planning the movement of units.

The fire support system (fire control) provides:

integrating all fire units and targeting systems with one another to ensure the most efficient and timely fire;

maintaining subsystem integration for tactical and technical fire;

automation of commands to support the decision to open fire;

planning and executing enemy fire damage, at the right time, with an optimal weapon system defined by ammunition;

support the decision to replenish the ammunition.

The Air Defense system provides:

air defense command and control systems and fixed assets for combat use at the theater of operations;

processing of information about the air situation;

creating a unified air environment that is distributed to all users and weapons systems in real time;

automatic or manual targeting with appropriate algorithms.

Intelligence and electronic counteraction is based on the use of radar detecting air and ground targets, electron-optical sensors and specialized sensors (so-called EW (electronic warfare) sensors of our own production. Due to the open architecture, ASELSAN's C4I system can integrate all facilities through the use of common standards for the exchange of information.

The communication system is designed to ensure reliable and timely communication of high-speed digital data from sensors, weapons, as well as between the automated workplaces of officers of units (units), both while driving and in the parking lot.

Such a system is based on the flexibility and ability to quickly change the topology, which significantly increases the time of processing information with further support for decision-making by commanders of all management units.

Thus, it should be concluded that ASELSAN's experience in developing a C4I domestic system is needed to provide decision support to commanders during combat and unit management in all circumstances.

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TRENDS OF THE TACTICAL INFORMATION EXCHANGE NETWORKS DEVELOPMENT

Trends in the development of tactical information exchange networks indicate the need for the widespread use of cloud technology to effectively transfer data between control points and combat units to a single soldier, inclusive.

Modern systems consisting of computers, UAVs, vehicles, navigation, surveillance and reconnaissance, sensors used by individual soldiers, etc., use the principle of transferring information for processing to large data centers. This process is time-consuming and uses considerable bandwidth.

Creating a modern interconnected tactical information exchange network must be based on gaining access to data through software, even when there is no access to powerful network

This data can take several possible forms:

1 Operations. For example, UAV snapshots of a potential danger zone can be enhanced by reconnaissance and operational data through local real-time image processing.

2 The constant tracking of their troops will allow the management of large amounts of data at the level of small units and individual soldiers regarding their location.

3 The health of a soldier can be monitored by using sensors that can track the heart rate of soldiers and other vital signs to control the safety of soldiers as they perform tasks.

Such various functions depend on quick and reliable access for tactical data exchange and processing. This is an inherent advantage of tactical information exchange networks.

Application of tactical information exchange networks will enable you to perform functions on any available resource. They can be mobile and heterogeneous through the use of applications that are installed on mobile platforms, managed devices, or sensors that are not constantly monitored. This approach will allow you to collect information on the ground without having to send it for processing, which will greatly help you respond more effectively to changing circumstances on the battlefield.

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THE MULTILEVEL SYSTEM OF HYPERSPECTRAL MONITORING OF THE EARTH

The multilevel system of hyperspectral monitoring of the Earth is aimed at creating a unique system of hyperspectral monitoring of the physicochemical composition of objects based on the use of complex data obtained from hyperspectral sensors of space, aviation and ground based in the interests of the Armed Forces of Ukraine.

The proposed system implements three levels of hyperspectral monitoring: space, aviation and ground.

The space segment of the operational hyperspectral monitoring system is represented by spacecraft, which will allow global monitoring of most of the territory in one route.

The aviation segment is a laboratory laboratory based on a light multi-purpose aircraft or an unmanned aerial vehicle and is designed to calibrate and validate hyperspectral data received from a spacecraft, and in stand-alone mode to obtain operational hyperspectral information of high spatial expansion.

The ground segment is a mobile and stationary physical and chemical laboratories.

This allows you to get information about the composition of natural and man-made objects, given the following indicators:

- determination of a number of characteristics of the object in a large number of narrow spectral ranges;
- obtaining the surface distribution of spectral characteristics over the area of the object;
- integration of video information of traditional monitoring equipment with an information-measuring component, the role of which is played by hyperspectral equipment.
- the formation of a portrait of an object based on the integration of spatial data and spectral characteristics, in the future allows accurate identification of objects, determine their characteristics and current status;
- solving the problem of classification of hyperspectral survey data.

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GEOSPATIAL INTELLIGENCE AS A NEW TYPE OF INTELLIGENCE

In the era of maneuverable military operations with the widespread use of high-precision weapons, topographic and geodetic support (TGZ) of operations (combat operations) of troops (forces), importance is attached, which in turn consists of a set of tasks of a scientific, technical, industrial and organizational nature, aimed at creating restoration and timely communication of topographic and geodetic information (TGI) to command and control bodies in order to study and assess the terrain when making decisions, planning and conducting operations (military operations) , the organization of interaction and tricks, as well as the effective use of weapons and military equipment.

Topographic and geodetic support of the advanced countries of the world is a set of measures for the creation, accumulation and bringing to the topographic and geodetic information of troops,

At present, topographic and geodetic support has developed into a scientific and industrial sector, determining the directions of success in solving military tasks at the level of their analysis, forecasting, planning and evaluation. This industry is a combination of information-guiding, scientific-technical and industrial-technological processes, attracting natural and applied sciences into its sphere of interests and using modern achievements of high technologies.

The basis of topographic and geodetic support of the armed forces of the advanced countries of the world is geospatial information.

Geospatial information is a type of information about spatially distributed objects, processes and phenomena on the surface of the Earth, in subsoil and near-Earth space, allows you to establish a relationship between them, and patterns of their development. Geospatial information consists of topographic and geodetic information (TGI) and navigation-time data (LPR).

One way to obtain geospatial information is geospatial exploration.

The development of ways to obtain and use geospatial information affects fundamental changes in state and military structures, ensuring national security,

For example, in the United States, the process of combining cartographic, intelligence and information technologies led to the creation of the National Geospatial Intelligence Agency (NGA), and in Germany to the creation of a unique Bundeswehr geoinformation service (Geoinformationsdienst derBundeswehr).

Geospatial intelligence in the United States is considered as shooting and image processing in order to obtain intelligence information, data for their further overlay on geospatial information. Geospatial reconnaissance is aimed at reducing the level of uncertainty of the situation by modernly providing military guidance for the data necessary for decision-making and effective measures.

Absorbed all the achievements in the field of analysis of specific information, cartography and geodesy, geospatial exploration turned into a new type of intelligence activity, different from everything that came before it.

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HYPERSPECTRAL ANALYSIS AS A PERSPECTIVE DIRECTION OF RESEARCH OF EARTH SURFACES

In recent years, in our country and abroad, technologies of hyperspectral analysis of earth surface objects in the process of remote sensing of the earth have been actively progressing. This is a promising area of research on earth's surface objects and their properties based on the ability of materials to absorb and reflect light. It is for this purpose that a whole line of hyperspectral sensors of the optical range (hyperspectrometers) for aviation, space and other purposes is being developed. Such equipment makes it possible to obtain images fixed in narrow adjacent spectral ranges from 0.3 for a given region of the terrain. . . 2.5 microns. As a result of recording, an array of data is formed in the form of a set of images of the same scene obtained in different spectral ranges, which subsequently makes it possible to identify objects.

The fundamental basis of hyperspectral acquisition is an unambiguous correspondence between the recorded reflected optical signal and the elemental composition of the reflecting surface. As the illumination of the Earth's surface in the daytime, solar radiation can be used, and at night - lunar radiation as well as star radiation.

The high sensitivity of the reflection coefficients of dissimilar objects of frequency and polarization of the illuminated radiation distinguishes the hyperspectral method from other methods for studying the Earth's surface. Hyperspectral measurements are used to solve complex problems of detecting small objects, identifying, distinguishing differences between objects that are very close in class, assessing biochemical and geophysical parameters, etc. Only hyperspectral measurements can reveal small spectral differences between individual surface elements and serve as an indicator of objects that we are interested.

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USING OF ARMORED GLASS IN LOOPHOLES FIRE STRUCTURES VS-1 AND MVD-2

An important component of the fulfillment of the tasks of the United Nations operation zone is engineering support, namely the engineering equipment of the firing structures in order to increase the effectiveness of the use of weapons and military equipment, ensure sustainable command and control of the troops, and protect personnel.

Considering the fact that in the overwhelming majority of fire installations of the VS-1 and MVD-2 type, they are mainly used as observational structures on the contact line with the enemy, the question arises of increasing their protective properties both from individual armed provocations and from sniper fire, one of the ways to increase protection personnel in these structures is the use of armored glass on the loopholes.

But at the same time, the glass that will be used on the loopholes of firing structures must meet certain requirements for reliability, namely:

- the nominal thickness, size, number of layers and composition of the glass must provide reliable protection of a given level and comply with regulatory documents for a specific glass;
- lightfast and do not change the transmission of light and color after 100 hours of exposure to ultraviolet rays;
- heat and moisture resistant, withstand temperatures of 60 ° C, humidity 95% and prevent the formation of defects in appearance;
- withstand temperatures up to minus 40 ° C and prevent the destruction of appearance;
- have camouflage properties from the glare of glass should be provided by the design features of its installation or by applying special anti-reflective coating to it;

- soundproofing of laminated armored glass, taking into account specific operating conditions;

Also, when making a reservation, it is very important to ensure high-quality booking of not only glass but also the glass fixing profile. The profile must be strengthened in a special way, for a certain class of protection, it is tested by firearms for resistance to shelling.

For bulletproof glazing of class SP-3 (protection against a bullet of caliber 5.45 and 7.62 / Kalashnikov AK-74, AKM), SP-4 (protection from a bullet of caliber 7.62 / SVD sniper rifle) and SP-5. Special metal armored profiles are used. Given the large weight of the glazing and the metal structure, it is necessary to pre-calculate the load and predict the possibility of delivery of the installation of the structure in the holes.

For outdoor use, profiles with heat-insulating inserts are used, and protective glazing as part of a heat-resistant double-glazed window.

Such double-glazed windows can be used not only on the firing structures of the VS-1 and MVD-2, but also in the construction of roadblocks and other fortifications.

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NON-TRADITIONAL NON-LETHAL WEAPON IN THE ARMED FORCES OF UKRAINE

Nowadays armed forces at greater scale have to carry out very specific military missions such as peacekeeping operations, guard and defense of important objects and communications, release of hostages, anti-terrorist operations and so on. In such missions, military units are forced to operate in the conditions of durable and close environment and contact with civilian population that very often is hostilely disposed.

To prevent excessive and worthless violence escalation, unnecessary fatalities and destructions and to make such military missions more successful it is very important that relative military units would be armed not only by standard lethal weapon but the special means (weapon) of non-lethal action as well. Moreover, military units must be trained to use non-lethal weapon effectively. Non-lethal weapon (NLW), in contradistinction to conventional weapon or weapon of mass destruction, not cause excessive sufferings and destructions. It is designed primarily to temporary incapacitate and neutralize adversary personnel and materiel. After using of NLW adversary personnel remain alive while adversary equipment and property are mainly suitable for further application.

In NATO states NLW have been designed, supplied to armed forces, trained to use and used in field conditions for more than 20 years. There are many regulatory acts – directives, manuals, orders, that regulate various aspects of using of such weapon. Nevertheless, for the Armed Forces of Ukraine such range of problems besides of its undoubted urgency is practically unknown.

Largely because of absence of non-lethal weapon in the Armed Forces of Ukraine' weaponry, we have a sorrowful experience of the first months of anti-terrorist operation in Donbas region, when Ukrainian marching combat columns had been blocked and even disarmed by unarmed hostile groups so far as it was no possibility to use a lethal weapon against it.

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WAYS OF COMPREHENSIVE SOLUTION OF THE QUESTION OF SECURING THE ARMED FORCES OF UKRAINE BY MEANS OF DELIVERY OF MILITARY PROPERTY

The history of mankind is replete with wars and conflicts that have accompanied it for millennia. Even a superficial analysis of them confirms the commonplace truth – the lack of proper rear support dooms any military company to inevitable defeat. A significant role in this is played by the presence or absence of a sufficient number of means of delivery of military equipment (including ammunition).

The experience of building the armies of the most developed countries of the world (for example the armies of NATO member countries) indicates the desire to standardize elements of both rear support and weapons, taking into account the vehicles used for their delivery. This allows you to: reduce the time of cargo delivery and deployment of units; minimize the number and nomenclature of vehicles used for delivery; unify carriers of weapons and property samples at the interstate level. One of the biggest breakthroughs in this direction can be called the widespread introduction of intermodal container transportation, as well as the use for these purposes of vehicles equipped with HOOK LIFT systems. Their main unit was a standard 20” container type 1C. The time of loading and unloading containers was reduced to 60 seconds. Based on the foregoing, the immediate prospect of using modular systems in the Armed Forces of Ukraine in the dimensions of standard containers can be inhabited modules, rear support modules and Flatrack .

Over the past 50 years the world has accumulated vast experience in this direction. Analyzing the available information we can use its results. The goal is not only to reduce the time for introducing advanced technologies in our army but also to save considerable money. In the USA for example intermodal transportation in the interests of the armed forces is handled by a specially created structure – USTRANSCOM (UNITED STATES TRANSPORTATION COMMAND) of about 140 thousand people. At its disposal it has not only a fleet of containers but also various vehicles. If necessary, civil carriers may be involved in the transportation of goods. At the same time the weight of the most massive containers of type 1C used to transport ammunition can reach 21 tons. Therefore for their movement by road both single cars and road trains as part of multi-axle vehicles (four or five axles) with trailers are used. At the same time the current situation in Ukraine with providing power structures with vehicles allows us to rely only on single containers to transport containers weighing no more than 11 ... 13 tons. Reason - the only domestic manufacturer has mastered mass production of cars with only three drive axles. And to bring to the serial production of new models of cars with four bridges will require additional time and significant financial resources which today are in short supply.

Given the above at “KVZZ” PJSC in the interests of the Armed Forces of Ukraine a concept was developed for constructing a promising type of semi-trailers which was formed in the form of a table. The fundamental principle of its formation was the wheel formula for the transmission of semi-trailers. The number of axles varies from one to four. The use of passive, active, steered and lift axles is permitted. The type of drive of the wheels of the semi-trailers (mechanical or hydrostatic) is not considered by the concept and can be any. The proposed approach can also be applied to the formation of civilian versions of semitrailers.

At the same time the structure of the Armed Forces of Ukraine is currently undergoing reform with the formation of a new structural unit such as the Logistics Force Command. Given the above it can be assumed that the proposal from “KVSZ” PJSC will not go unnoticed and can be not only appreciated but also in demand by our army in the near future.

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PECULIARITIES OF FORTIFICATION EQUIPMENT OF BLOCK POINTS IN THE UNITED STATES OF UKRAINE

The nature and scope of fortification equipment, organization and methods of performing tasks are largely determined by the tactics of joints and units of the CAB (ATO) and the tactics of actions of illegal armed groups.

The main purpose of the fortification equipment of positions and areas is to ensure the effective use of firearms and the protection of personnel, equipment from the means of defeat of illegal armed formations.

The main tasks of fortification equipment are the equipment of checkpoints to control the movement of human and material resources to the locked areas, positions of guard, positions of subdivisions and areas of deployment of control points.

The fortification of checkpoints should protect the next change from an unexpected attack by terrorist groups. Therefore, the basis of the fortification equipment of checkpoints are trenches for military equipment in the main and spare positions, trenches for offices, firing structures, covered cracks, armor.

In order to limit the speed of traffic on the section of the checkpoint on the carriageway, the barriers are staggered after 10-15 m. Within the checkpoint on both sides set a barrier with a warning sign. At the barrier, there is a fire enclosed structure, shelters for regular controllers. For fire cover on both sides of the road arrange machine guns closed or trenches for regular firearms (APC, BMP).

To protect and rest the personnel of the checkpoint, there are well-equipped area armor for the placement of household equipment and rest places for the entire staff. The perimeter of the checkpoint arranges for restricted zone enclosures, sets signal mines, directional mines in controlled mode, double-row wire fencing.

SECTION 4
DEVELOPMENT PROSPECTS OF THE NAVY ARMAMENT AND MILITARY EQUIPMENT

SECTION 4

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DEVELOPMENT OF MARINE ARMAMENTS AND TECHNIQUE OF NAVAL FORCES, AS INALIENABLE PART OF RENEWAL OF NATIONAL NAVAL FORCES

To adequately respond to existing threats to national interests and to ensure Ukraine's defense capabilities from the sea, a joint concentration of efforts of the military-political leadership of the country, enterprises of the military-industrial complex and scientific institutions on the development of Marine Naval Forces of the Naval Force is necessary, as well as a single vision and common understanding of the directions of this development.

During 2018-2019, comprehensive strategic program documents have been developed, discussed and adopted, which define the main vectors and priorities for the development of the Navy as a Service of the Armed Forces of Ukraine.

The Government has approved the changes to the Maritime Doctrine of Ukraine (approved by the Resolution of the Cabinet of Ministers of Ukraine dated December 18, 2018, No. 1108), which identified the actual threats to national security in the field of maritime activity and defined the priorities of a consistent maritime policy of Ukraine for the long-term (until 2035) perspective.

The Strategy of the Naval Forces of the Armed Forces of Ukraine until 2035, developed by the Command of the Navy of the Armed Forces of Ukraine together with Ukrainian and foreign experts, identifies concrete ways for gradually increasing the capabilities of the Navy, including the generation of forces, their education and preparation for maritime and joint operations, provision of weapons, other material and technical means.

Today, the list of tasks actually carried out by the Navy of the Armed Forces of Ukraine is extremely limited due to the lack of means for detecting the enemy, targeting and defeating, as well as the corresponding plans from which these means can be applied. Thus, the immediate task is to quickly replenish the ship's composition to the minimum necessary needs and solve the problem of equipping ships and boats with modern weapons and equipment. The existing ship and boat structure, due to its combat capabilities and technical condition, does not fully meet the intended tasks.

In order to carry out the task of replenishing the ship's structure, armaments and equipment of the Navy of the Armed Forces of Ukraine to the minimum necessary requirements in the State Target Defense Program for the development of weapons of mass destruction for the period up to 2022, a number of appropriate measures are envisaged. The timely implementation of these measures and their full financing will allow the restoration of the combat capabilities of the domestic Naval Forces.

On November 22, 2017, the Cabinet of Ministers of Ukraine approved by its resolution No. 879 a new version of the State Target Defense Program "Corvet". Its implementation was postponed until 2028, and nearly doubled the overall program estimate. Nevertheless, in 2018 and 2019, the measures of the program were not funded according to its targets, which increases the risk of non-fulfillment or non-timely implementation of this extremely important program for the further development of the Navy.

In addition, the vital importance for the development of the Navy is the support and assistance of the international community, primarily the United States, in which the Navy of the Armed Forces of Ukraine creates modern bases, equipped with communications and systems, receives boats, means of illumination of the marine environment and other weapons and equipment. Extremely important is the expansion of the volumes, forms and content of this assistance, including the lethal means, the development of joint development and the production of weapons in Ukraine.

Thus, full implementation of all measures defined by the above-mentioned strategic and program documents will enable Ukraine's national interests in the Azov and Black Seas, the Kerch Strait and other regions of the territorial sea of Ukraine to be realized, taking into account the actions of the Russian Federation as an aggressor country, as well as intensify the development of the marine industry on the basis of modern technology and turn it into a modern sector of the economy, strengthen integration with the world maritime community ensure sustainable development of marine industry and coastal regions, fulfill social and cultural challenges associated with maritime activities.

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OVER-THE-HORIZON COASTAL TARGET DETECTION AND DESIGNATION SYSTEM FOR MISSILE STRIKE COMPLEXES

Over-the-horizon coastal target detection and designation system is intended for long-range (over-the-horizon) detection of surface targets, generation, and issuance of target designation data for strike missile weapon (for the full range of firing).

The system provides:

- illumination of the surface environment;

- identification, classification, determination of coordinates and tracking of surface targets;
- generation and issuance of target designation data for users.

The system includes passive radar station (PRS), active radar station (ARS), and relative orientation and management of joint combat operations station (MEI-MOR), which together ensures coverage of the surface environment over-the-horizon at the distance of up to 450 km.

The main feature of the system: equipment of all three stations is complexed; it allows placing all the equipment on two carriers: antenna platform and container/shelter, which ensures operative delivery of these two carriers to the preset coastal positions.

The antenna platform fits combined antenna post of ARS and PRS, an antenna post station MEI-MOR; the container/shelter fits receiving and transmitting devices and operators’ workstations/workplaces.

The area of responsibility of the system, which is to be located on the seashores, is up to 1000 km, with the radius of 450 up to 500 km.

The main mode of operation of such a system is to operate in a passive mode, the main advantage of which is the radio-silence and, consequently, the system covert.

To solve the triangulation problem for measuring the distance to the targets by the radar system, two PRS are to be located at a distance of approximately 30 km between them, which gives the possibility of obtaining the specified technical characteristics, as well as measuring of target coordinate errors in passive mode.

This system provides separate operation of ARS or PRS, as well as the combined operation of active and passive stations, with the operation of the MEI-MOR station at all possible modes of the system operation.

Basic technical characteristics of the PRS station:

- coverage area is up to 450 km in circular and sectorial modes, with the mean-root-square error in the bearing (0,4 - 0,8) in degrees, in range (4-8) in the percentage ratio of the measured range. The number of simultaneously processed targets is up to 100.

Basic technical characteristics of the ARS station:

- the range of detection for surface targets - 0,9 of radio horizon, and in the mode of super-refraction it is up to 250 km, the accuracy of coordinates determination equals 50 m, in the bearing - it is 0.25 degrees. The number of simultaneously processed targets is up to 50.

Basic technical characteristics of the MEI-MOR station :

- the range of interactions is up to 30 km, with the accuracy of coordinates determination of up to 40 m in range, 0,3 deg. in bearing, with the processing of up to 200 targets datum.

The system operates in the ultra-high frequency range (UHF), in particular, ARS and MEI-MOR in the range I, PRS in the ranges I, E/F, G, D, D/C, covering the entire frequency range from 1 to 10 GHz.

The system is completely solid-state, it uses modern UHF elements and modern high-performance PLG (programmable logic device), the advanced algorithms and digital information processing programs based on the use of high-speed Fourier transformations are developed, digital analyzers that provide real-time measurement of the frequency and time parameters of radar signals, which provide efficient digital signal processing are also developed.

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PROSPECTS OF DEVELOPMENT OF THE SYSTEM OF LIGHTING OF UNDERWATER SITUATION IN COMPOSITION STATE INTEGRATED INFORMATIVE SYSTEM OF LIGHTING OF SURFACE AND UNDERWATER SITUATION

According to Conception of the Government program of alteration having a special purpose and reconstruction of state boundary on a period by 2020» in relation by implementation of tasks from alteration of the state integrated informative system of illumination of surface and underwater situation in the aquatorium of the Black and Azov seas and pools of rivers Dnepr and Danube, which is approved by the order of Cabinet of Ministers of Ukraine from 11.11.2015 №1179-р, one of directions is the System of Lighting of Underwater Situation (SLUS).

SLUS is intended for the exposure and classification within the limits of the proper operation zones of different underwater object: submarine boats of all classes, facilities of delivery of underwater diversionary forces, underwater saboteurs, naval mines and others.

In accordance with the operation zones of lighting of underwater situation (fellow creature, middle that distant) the proper hydroacoustic facilities are used:

fellow creature – the anti-underwater-diversionary defensive answers the zone of self-defense of ships;

middle – 20-35 miles from the entrance in harbors, bays, points of basing and others;

distant – to 50-75 miles.

For the exposure of underwater object in a fellow creature zone the mobile anti-diversionary hydroacoustic station is used (HAS) «Tronca-MK», by which it is planned to replace out-of-date HAS of soviet production MG-7 «Braslet».

The position hydroacoustic station «Olipm-3К» is fully able to provide the exposure of underwater objects in a middle zone.

For the exposure of objects in a distant zone it follows to apply ship hydroacoustic complexes and systems of exposure of underwater mobile objects on the base of the passive undirected buoys RGB-16 В.

Thus realization of the operative providing of anti-submarine and anti-underwater-diversionary defensive of points of basing of Naval of Ukraine, places of stand of ships, regions of mining, routes of motion of ships will give possibility in advance to expose that or other threat.

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TRANSFORM OF THE REAL PROCESS OF EXPLOITATION OF SHIP AND SHIPS ARMAMENT HAVING AFTER ACTION TO THE MODEL OF MARCOV

In practice the changes of the state of the system of exploitation of armament and military technique (AMT) take place not in the fixed moments of time, and in accidental. In engineering practice for description and estimation of such processes is used accidental process of Marcov with the discrete states and continuous time – by a continuous model of Marcov, with development and decision of the system of the differential equalization of Colmogorov, that is without consideration of after action.

The real process of exploitation of ship and ships armament differs from process of Marcov, because he always has after action. There is a question – how the real process is that has of after action, to take to the model of Marcov, and what errors replacement can lead to? Or it is necessary to apply the system of the differential equalization of higher orders, which are very difficultly.

On occasion it is possible without the losses: namely, if the number of the states of the system is not very large, and the streams of events present the streams of the Erlang data k order. At $k=1$ we will get the ordinary exponential distributing.

Distributing of Erlang is the partial case of gamma-distributing at the whole parameter of its form α. Indeed, at α – positive integer, gamma-distributing by the transforms distributing of Erlang $f(n,\beta;t)$ with parameters: $n=k$ – number of the pseudo of states, $\beta=\lambda$ – transition intensity on to the pseudo of states of the system.

Therefore, entering the fictitious pseudo of states in the chart of the possible states, is succeeded to take a not Marcov process to Marcov one and describe him by means ordinary differential equalization, and for estimation of processes of exploitation armaments taking into account after of action, it is possible to substitute the models of their states by new with gamma-distributing. Thus it is needed to provide the minimum of losses of information, which is store the maximum of information about the initial model of process.

As from initial it is needed to take measures of difference of new states integral measure of difference of laws of distributing of accidental values. The known following most widespread measures of difference: mutual information of Shennon; variation measure of Colmogorov; divergence of Coulbac; distance of Matousiti; distance of Chebishev; measure of divergence of Baba.

Measure of Coulbac, what protuberant and has a smoothness, deserves attention, that allows to get the ordinary methods of differential calculation and decide the proper systems of equalization.

Divergence of Coulbac has physical maintenance, which answers essence of ehe decided task – to estimate the losses of information. To property of smoothness, bulge and positiveness guarantee the presence of single decision at definite parameters of gamma-distributing of time. Thus, the values of these parameters can be found the usual methods of differential calculation.

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INFLUENCE OF ACOUSTIC FEATURES OF A SURFACE SHIP ON RECEIVING HYDROACOUSTIC INFORMATION

An important role in radiation and receiving hydroacoustic signals hydroacoustic armament (HA) of surface vessel (SV) play acoustic features associated with its complex geometric form surfaces and complex physical and mechanical properties of different parts of the surface of the underwater. The influence of geometry, physical and mechanical characteristics of the material of underwater part of the SV on hydroacoustic signals information system depends on the location of hydroacoustic antenna HA and determined forms surfaces are placed close to the antenna as the amplitude and phase of the reflected waves of hydroacoustic signals depends on them.

For on board conformal hydroacoustic antennas on the hull of the SV create special niches, whose surfaces are covered with special sound absorbing hydroacoustic screens. In under keel placed hydroacoustic antenna sound waves that carry hydroacoustic signals reflected from the surface of its hull and surface fairing, which placed hydroacoustic antennas and their amplitude and phase depend on the geometry underwater part of the hull of SV and characteristics of the materials from which its is made.

SV is an active source of acoustic noise in the work of the HA. The sources of these obstacles are the vibration of the hull structures that cause the appearance of underwater noise. Types of vibrations that occur when operating machinery and ship systems and ways of transmission include vibration sound and infrasound frequency ranges – in most hulls mechanisms and systems and their supporting structures; vibrations through the foundation and hull designs of the ship; the airborne noise emitted by the mechanisms and systems of the ship – through the ship's fences (walls, lining, bulkheads, decks).

The given analysis of acoustic features of SV allows us to draw the following conclusions.

First, SV as a carrier of HA characteristic acoustic features significant impact which on the hydroacoustic signals information to consider when operation of “SV-HA”.

Second, these acoustic features are based on a different physical nature. Therefore, in order to reduce their impact on the system “SV-HA” it is necessary: develop assessment methods and, on their basis, obtain quantitative estimates of this impact; on the basis of the obtained estimates to find technical solutions for the practical implementation of reducing their impact on information hydroacoustic signals.

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GRANT OF ESTIMATION OF POSSIBILITIES OF UNMANNED BOATS TO IMPLEMENTATION OF TASKS

Searching possibilities. In interests of implementation of searching tasks unmanned boats (UB), that are related to the exposure of submarine objects, and also mines, the possible use hydroacoustic stations (HAS), HAS, that submerge for the exposure of submarine, sonar of lateral examination for the exposure of the ground diversionary-reconnaissance facilities and naval mines. It should be noted about enough high efficiency of exposure of the ground objects at impossibility of their reliable authentication with the use of sonar of lateral examination, especially at are muddy sea-bottom by the objects of natural and unnatural origin.

Shock possibilities. On UB there can be limitedly the placed facilities of defeat, however absence of target designation, from one side, that complication of management, from other side, hinder and on occasion create complications in their application. The given circumstances stipulate the necessity of the use of UB in quality of auxiliary facilities of illumination of situation.

Navigation possibilities. The navigation equipment of UB will provide swimming after computation co-ordinates and with the use of the satellite navigation systems of type GPS with sufficiently high exactness, that allows to carry out implementation of combat missions without limitations on condition of organization of automatic correction of courses of UB without participation of operator. Together with it the questions of the use of submarine anti mines vehicle with UB are considered, that needs placing on the UB of the hydroacoustic navigation system, that considerably complicates the management.

Methods of management. UB is executed by the tasks, using the off-line systems of management and (or) systems of radio management with the function of telemetry, that is with information of boat about implementation of commands of management. In semiautomatic UB the interference of operator with the process of management is foreseen. During the job processing in relation to elimination of object of enemy, confirmations of recognition of target and permission of causing of blow must be carried out by an operator. Also UB can execute the function of retranslation of commands and information transfer to other objects.

Positive qualities and lacks of the use. By one of positive qualities of UB it is necessary to count possibility of their application in the conditions of shoal, that it is enough critically in interests of anti mines defense. Application of UB in the conditions of risk is basic advantage. System of the uncontact trawling of mines, influencing on uncontact detonating fuse of mines, results in their injury, that can defeat to the ship and crew. As a rule she must be unmanned, therefore from the special ship of management the telemetry must be carried out.

Objectively unmanned gives birth of other problems, namely impossibility to react on unforeseen, the пot planned situation, to make decision in the ПОЕ standard circumstances, and others like that. To the autonomous management also peculiar other problems.

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MATHEMATICAL SUPPLY AND SOFTWARE REALIZATION OF DESIGNING OF TOWED AND TETHERED UNDERWATER SYSTEMS

By 1991 Ukraine had considerable potential to develop and build special purpose towed and tethered underwater systems. Industrial enterprises of Ukraine and institutions of the National Academy of Sciences of Ukraine worked successfully on this topic. From 1987 to 1991 the author of the report spent up to 3 months annually in duty journeys to Murmansk and Murmansk region to enterprises specializing in practical implementation of such systems. Since 1991 research has not been funded in this area.

At the same time work in this direction did not stop around the world. Towed and tethered underwater systems have been created: ARMS (UK) — designed to search, identify, classify and destroy mines, moves 1000 m ahead of supply ship; Trail Blazer (Canada) — when searching for mines, it is up to 600 m ahead of supply ship; Pinguin-AI complexes (Germany) — search 2-3 miles ahead of supply ship. Mine search system S0MSS (USA) is designed to be installed on board of the submarines of the Los Angeles type. It provides passage of the submarine through underwater minefields and maps detected mines for their further destruction. Russia has created nuclear underwater vehicles AS-12 ("Losharik"; fire occurred on July 01, 2019). AS-12 is non-armored deep-water nuclear station capable of submersion, according to some reports, up to 6,000 meters deep. The purpose of the AS-12 — "sabotage system" for installation of devices for destruction of various underwater infrastructure, primarily communication cables. It is capable of damaging deep-sea components of the US submarine tracking system SOSUS.

From 1991 to 2019 the author of the report has developed new multi-wave mathematical models of stress-strain state of distributed systems in the space of mass and surface forces. Corresponding software complexes have been created for their calculation. Mathematical models have been practically tested in experimental and theoretical studies of multi-wave processes in reinforced concrete piles over 40 meters long (analog of the cable-rope in fluid flow). The studies have been published in periodicals and peer-reviewed materials of international conferences. About 10 publications are being indexed in the SCOPUS database. In autumn of 2019 in Research Institute of Building Constructions the aspirant of the author of the report Vusatyuk A.E. is defending the dissertation "Assessment of technical condition of reinforced concrete piles in soil using non-destructive methods".

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ABOUT BASIC REQUIREMENTS TO MARINE TARGETS

In Navy of the Armed Forces of Ukraine marine targets are absent for testing marine strike weapons.

Today, creation of target’s ships is an actual question, in connection with creation of surface rocket complex within the implementation of research and development work, code “Neptune”. In addition, this research and development work foresees creation of complexes of rockets of the marine (ship) and air basing.

Minimum requirements to the ship-target is:

nautical qualities – possibility of its towage at sea state not less than 3 points;

stability – providing of not knocking over of target on speeds of wind not less than 6 m/s;

equipping of the devices of commons (by two anchor devices or two mooring devices for a tie-down to the moorings barrels);

presence of structural decisions is in relation to providing of maximal vitality of target;

variable effective surface of dispersion which is reproduced by equipping of different (or a few) angular reflectors;

presence of structural and technical devices of fixing of hit of rocket in a target.

For prototypes, it is possible to consider such projects, as a project of 436B (large ship shield), project 455 (small ship shield).

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EVALUATION OF THE PROSPECTS OF DEVELOPMENT OF SHIP CONSTRUCTION TECHNOLOGIES IN CONDITIONS OF MODERN NEEDS OF THE NAVY OF UKRAINE

The issue of updating and replenishing the Naval Forces of the Armed Forces of Ukraine is now acute. According to the results of the researches, the analysis, generalization and development of practical recommendations and approaches for substantiation of requirements for the projects of prospective ships using the practice of modular technologies were made. The scientific novelty of the proposals lies in the comprehensive coverage of the task of modular shipbuilding, which had not been specifically investigated before in the research establishments of the Armed Forces of Ukraine, and introduced into the scientific circulation of generalized materials collected by the author during the research process.

The adoption of modular technology as a basis for design methodology, in particular in the countries of the European Union, has demonstrated its ability to substantially reduce the cost of shipbuilding and operating costs, and to increase the flexibility of naval forces when properly understood and applied appropriate modular approaches or concepts.

Modular ship concepts come first and foremost from the capabilities of specific ship equipment that has the ability to be quickly and easily replaced.

The result of such a replacement is a change in the purpose of the ship and its ability to perform certain tasks. Modular concepts tend to be different:

Weapons systems, primarily artillery and missile, for striking or self-defense tasks;

by special means, first of all by unmanned vehicles for carrying out mine action or anti-human warfare tasks;

auxiliary equipment, such as crane equipment and equipment for loading (unloading) special means.

In case of realizing the advantages of modular technologies to meet the prospective needs of the Ukrainian Navy, the key are:

the ability to offer increased operational flexibility for small ship composition;

adapting the payload of ships to perform a specific task or operation;

increased overall modular redundancy of ships but with cheaper and easier maintenance and repair;

simple and inexpensive design and construction of the next generation of ships due to the long-term development and use of these technologies.

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EFFECTIVENESS OF CONTINGENT ACTION ON THE SEA

Antimicrobial actions as a military operation are aimed at reducing the damage that may be caused by mine barriers to the forces of the fleet, which force them. However, the quantitative estimate of such damage and its reduction is complex and ambiguous. At the same time, it is proved that damages from the barriers are determined by other equal conditions, the number of mines in the barriers and reduced, depending on the reduction of their number as a result of trawling. Therefore, for the quantification of the effectiveness of the purpose of the malignant operation, it is formulated as the identification and destruction of all mines located in mine barriers.

In order to conduct such an assessment and determine the effectiveness of mitigation actions, it is necessary to have quantitative characteristics of the effectiveness of anti-ship ships and helicopters with a variety of anti-aircraft weapons. As such characteristics, the expected productivity of the "minesweeper - antipersonnel weapon" systems should be used, with their inherent probability of destroying the mines entering their zone of operation, the width of the area of action of the anti-aircraft weapon and the average speed of trawling. In determining the average speed of trawling, it is necessary to take into account the time expenditures at all successive stages of the operation, that is, at the setting up and sampling of trawls, the passage of the tramp on the tracks, the stopwatch of the minesweeper for mine identification and their destruction by means of underwater vehicles.

For example, it can be obtained that the expected productivity of a mineswitch destroyer by a base miner in the range of depths of 10 ... 60 m is 0.4kv. km / h with probability destroyed min 0.8. Such a quantitative description of the effectiveness of a mistreatment weapon specimen is sufficient to evaluate the effectiveness of a minting operation with its use.

The probable probability of the destruction of all mines is achieved by increasing the number of minesweeper passes over mines, which is provided by repeated coverings of the minineless zone of the region. It is clear that this increases the time of conducting an operation, which eliminates the effectiveness of mimetic actions. It is also obvious that all possible measures should be taken to reduce the probability of a subterfuge in the minesweeper.

To sum it up, it can be said that the countermeasures will be more effective than the larger width of the trapping (trawling, search) of anti-aircraft weapons and the higher probability of destroying the mines that hit it, the greater average speed of trawling, as well as more precise coordination, which reduces losses on overlap between neighboring stripes.

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PHYSICAL FIELDS OF CIRCULAR SHELL CYLINDRICAL HYDRAACOUS ANTENES

Cylindrical antennas are installed on the ship in the nose cone, including the tuber, in the stationary accelerator and in the body of variable depth antennas that are towed or dipped. Such a wide area of practical use of such antennas has necessitated the development of methods for calculating their parameters and studying the properties of antennas. However, the main attention was paid to the study of acoustic fields, especially taking into account the interaction of elements of antennas on the acoustic field, caused by multiple scattering of sound on these elements. At the same time, the hydroacoustic antennas are characterized by the fact that they not only form the distribution of the acoustic field in the surrounding space, but also convert one type of energy into another, for example, electric energy into an acoustic in the mode of radiation.

The process of converting energy causes the need to record in the development of antennas another type of interaction, namely, the interaction of electrical, mechanical and acoustic fields. Antenna function is the only process in which the electric energy is converted into an antenna into mechanical, mechanical - into acoustic, and the latter, propagating in the surrounding space in the form of acoustic waves, undergoes multiple reflection of these waves from all elements of the antenna construction and is formed in the result of the interference of all the emitted and scattered waves in the form of a certain distribution in the surrounding space.

To determine the physical fields of a circular cylindrical antenna with a screen it is necessary to make a joint solution of differential equations:

- the Helmholtz equation describing the movement of elastic media (gas or liquid) inside and outside the antenna emitters;
- equations of motion of thin piezoceramic shells of radiators with circular polarization in displacements;
- equations of forced electrostatics for piezoceramics of the emitter.

An infinite system is the source for obtaining quantitative data about the physical fields of circular cylindrical antennas with the screen and their elements, taking into account the interaction of fields, both in the transformation of electric energy into acoustic and in the distribution of acoustic energy in the surrounding space.

In order for the calculated parameters of circular cylindrical antennas with the screen when performing design work corresponded to experimentally determined parameters on real samples of such antennas, it is necessary to take into account several types of interactions. Namely: the interaction of the emitters of the antenna with the environments, among themselves and with the screen in the formation of the acoustic field in the surrounding space and the interaction of physical fields in the radiators of the antenna in the transformation of electric energy into acoustic. For this purpose, the method of bound fields in multidirectional domains yields analytical expressions for the determination of the parameters of all types of interacting physical fields taking part in the work of real circular cylindrical antennas with acoustic screen.

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WORLD EXPERIENCE AND TENDENCIES OF APPLICATION TOOLS OF IMITATION DESIGN OF BATTLE ACTIONS

For today problems of increase of efficiency of functioning of different links of human activity - in a technique, economy and many other, in particular in military business, require development of new methods of researches. An imitation design (IM) became the only method of decision such of tasks essentially.

Application of this effective tool for preparation and studies of personnel of different links in the armies of leading countries of the world acquires more ponderable value.

Design - it the method of decision of tasks, at the use of that the investigated system is replaced by more simple object that describes the real system and called a model. A design is used in the cases when realization of experiments above the real system is impossible or inadvisable: for example, as a result of fragility or costliness of creation of prototype or through long duration of realization of experiment real-time.

An imitation design is used to the processes human will can from time to time interfere in motion of that. A man that manages an operation can depending on a situation that was folded, to accept those or other decisions, like that, how a chess-player, looking on a board, chooses his duty motion. The change of situation is then expected in reply to this decision and to what consequences it will lead for some time. A next current decision is accepted already taking into account the real new situation and others like that.

As a result of frequent reiteration of such procedure a man gains experience, studies on it stranger errors and gradually begins to acquire skill in making decision.

The aim of imitation design consists in the recreation of behavior of the investigated system on the basis of results of analysis of the most substantial intercommunications between her elements or, otherwise speaking, - to development of simulator of investigated evident to the sphere for realization of different experiments. An imitation design allows to recreate behavior of the system in time. Advantage is that it is sometimes possible to lead in a model: to slow in case of fleeting processes for the design of the systems with a slow dynamics.

A machine imitation in the whole world got considerable distribution at research of the difficult systems due to important advantages, that the users of this method have them.

The sector of imitation design in military powers of leading countries of the world occupies a prominent place in the system of preparation of troops (forces). Studies with application of tools of imitation design a battalion, teem and higher level plugged in the general system of the combat training of military powers. Development of the special programmatic and mathematical providing of imitation design goes in direction of the most complete imitation of all functions of application of armament, military equipment and soldiery forming.

The most run-time sector of imitation design is development of the programs that help the commanders of different level in a decision-making on a fight (operation). Such programmatic foods next to the grant of possibilities of editing of battle graphic and textual documents have the module of imitation design, that allows singing to put the select methods of actions of the troops and opponent and, also, counting a few variants of embay, to choose optimal. Experience of application of imitation design in the armies of leading countries of the world can to a full degree be applied in Ukraine.

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ELECTRO-OPTICAL SYSTEM FOR MANAGING TAKEOFF, APPROACH AND LANDING OF THE HELICOPTER ON THE DECK

The system is designed to provide helicopter takeoff, flight safety, approach to and landing onto the deck of the ship as well as providing objective control and analysis of flight data.

Primary tasks:

- controlling the helicopter’s far distance approach to the ship’s zone using a medium wave radio beacon;
- controlling the helicopter’s close distance approach to the helicopter deck using LED projectors, course and gliding path indicators;
- determining the coordinates of the helicopter and ship using satellite receivers, displaying the location of the helicopter and ship on a vector map, calculating mutual distances and courses;
- transmitting movement data, remaining fuel and commands between the helicopter and the ship using “helicopter-ship-helicopter” data interface hardware;
- calculating final approach trajectories and displaying the data on helicopter instruments and ship instruments when interacting with the ship’s systems;
- analysis of flight data;

- data interface with ship systems (meteorological data, navigation data, radar data);
- logging movement parameters of the helicopter and the ship with regards to maintaining given route and the helicopter's approach or takeoff;
- reading, decoding and analyzing data provided by on-board "Tester"-type systems;
- logical analysis of received data, analysis of registered flight data;
- constant monitoring of peripheral equipment and data interface with computer system users.

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ABOUT ADVISABILITY USE PASSIVE DIRECTIONAL SONOBUOYS WITH COMPOSITION IN RADIO HYDROACOUSTIC SYSTEM "YATRAN"

Adoption by Ukrainian NAVY in June 2019 radio-hydroacoustic system that based on passive non-directional sonobuoys RGB-16B (hereinafter RHS Yatran) greatly enhances the possibilities of Ukrainian NAVY in hydroacoustic, allows to detect modern enemy low-noises submarines, and small-size delivery vehicles of underwater sabotage forces.

In particular, passive non-directional sonobuoy RGB-16B have satisfied by his parameters acoustic array, and accordantly as well use for detection submarines and even small-size surface targets, mostly in far distance form shipping routes areas. In this case, on buoy virtually no interference from outsiders noises, that allow to detect single targets on range up to 6 km, and to provide spectrum analyze of object acoustic field. At the same time, existing possibilities RGB-16B is not enough for use in areas with intense shipping routes, particularly to determine current coordinates of a few targets simultaneously and their tracks, because acoustic array do not have directional beam patters in horizontal and vertical axes in low and infrasound frequencies. Therefore, it is considered expedient of possibilities radio-hydroacoustic system by introducing in composition a passive directional sonobuoys, that will allow to decide a problem determine bearings, and accordantly, targets tracks in difficult acoustic noise conditions.

Thus, passive directional sonobuoy can determine bearings on all frequencies that transmitting by different objects (discrete components) in acoustic field with corresponding frequency band, and through radio-link RGB-16B transmit useful information to onboard equipment RHS "Yatran" for post processing and view on operator`s lap-top. Further triangulation method (crossing same frequency bearings) allow to determine the tracks of all targets, are located in covered by sonobuoys sea area.

Thereby, a field of passive directional sonobuoys, allow promptly in difficult acoustic noise conditions to detect tracks of all presence objects: surface and underwater, that increase technical possibilities and application efficiency RHS “Yatran” as intended.

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ELECTROMAGNETIC COMPATIBILITY OF PASSIVE AND ACTIVE CHANNELS IN MARINE INTERCONNECTING RADAR

At present, the possibilities of improving the parameters of radio-technology systems have been almost exhausted. Maritime surveillance radars are no exception. In world practice, interconnecting methods began to be used when, in order to improve technical capabilities and to obtain new positive qualities of radars, they work together with other radio-technology devices. Much attention is paid to radiothermal contrasts of surface objects in the mm-range and predicting the possibility of passive detection, including small and stealth. Therefore, the use of radiometric devices in conjunction with the radar (interconnecting) of the same radio band is relevant and gives a number of positive qualities.

The joint operation of marine radar and radiometric devices allows improving the visibility of surface objects against the background of reflections from the sea surface, since they have different thermal contrast. In addition, not only the ships themselves can be detected, but also their wake trails, the temperature of which is several degrees Celsius above the surrounding water. Submerged submarines also leave behind a thermal trace that exists for several hours.

Radiometers are very effective for ice exploration. So, when the radar does not detect an ice obstacle due to poor reflection of probe signals from it, the radiometric device detects it, etc.

When creating interconnecting radars, the most difficult task is to ensure the electromagnetic compatibility of the radar transceiver channels and the radiometric channel when working on the same antenna. This option to build interconnecting radar (passive-active) is most suitable for solving the tasks. However, the necessary level of separation between the passive and active channels should be at least 140 dB, which is quite a difficult task.

There are passive-active systems in which electromagnetic compatibility of receiving-transmitting and passive radio devices is realized when operating on a common antenna. These systems have some differences and operate in a pulsed mode as follows. The modulation period of the radiometer coincides with the probe pulse repetition period. During radiation of the probe pulse and reception of reflected signals, the modulation radiometer input is disconnected from the system and connected to a matched load, which serves as a reference noise generator (completely black body). In the time interval when the range reaches the limit, and until the next probe pulse, the modulator is given a signal that opens it and connects the antenna to the radiometer input. Thus, a temporary separation of the signals of the transceiver and the radiometric device is carried out.

In some passive-active radars, in order to provide additional separation, the operation of transmit-receive channel and radiometric device is provided at fairly strongly spaced frequencies. The advantages of such schemes include a high degree of separation of the radiometer and radar with a relatively simple design. However, large losses in the waveguide ducts from the antenna to the receiver input lead to a lower sensitivity of the radiometer. In addition, by reducing the pulse repetition period, the area of unambiguous determination of the range is reduced, and under certain conditions of radio waves propagation, interference from objects located outside this area may appear.

In special purpose radiometric systems, when their work time is limited, the loss of information about targets, even for very short periods of time, is generally inadmissible. Therefore, temporal channel separation in such systems is unacceptable. Hence, the problem of electromagnetic compatibility in the creation of passive-active radar still remains relevant and is waiting for its decision.

Currently O. Ya. Usikov IRE of the NAS of Ukraine has developed a method to suppress the signals reflected from sea surface objects in the radiometric channel of interconnecting radar. This is the focus of this report.

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DETECTION OF SURFACE TARGETS USING A RADIOMETRIC SENSOR

One of the most important tasks for passive detection devices is the automatic detection and direction finding radiothermal signal. The main difficulties encountered in solving this problem are the lack of a priori data on the noise power, the level of which may change with the time allocated to detect the radio thermal signal. In addition, spatial anisotropy of noise disturbances, which can reach a significant value, often takes place. Using "optimal" methods of detecting noise signals in this case is unacceptable, because they require a priori data on the power of noise.

As it is known, the algorithm of optimal processing of the received signal for the radiometer is implemented on the basis of the energy receiver, by which it is decided whether the signal is present at the receiver input, if the decision statistics exceeds the threshold, and about its absence, if such excess is not observed. The energy detector consists of a bandpass filter, a square detector, an integrator, a gating device and a threshold device. In a digital detector, after a square detector, a low-pass filter is set, the output voltage of which is converted by means of an analog-digital converter to a sequence of digital samples, and further processing is performed in digital form.

In practice, the power spectral densities of the detected and interfering signals are unknown. Therefore, the report discusses the possibility of using a contrast method of detecting a thermal signal, which consists in comparing the output signals of a digital integrator for two different resolvable elements (two positions of the antenna pattern). The automatic detection of a target in a non-stationary noise while maintaining a constant probability of false alarm represents the main task of a radiometric system. Due to the non-stationary nature of the background noise, classical detection based on an energy receiver followed by a fixed threshold is incapable to realize the goal of fixing the false alarm rate. Detection with constant false alarm rate implies local clutter parameters estimation based on which the decision threshold is setting so that a constant false alarm probability is guaranteed for all values of the unknown clutter parameters. The objective of constant false alarm rate procedure is to hold false alarm probability unchanged both locally and globally. The idea of solving this problem is that the observed area, for example, a rectangular area is covered with a grid also with rectangular cells. As a result, the site is divided into "N" cells and can be represented as a rectangular matrix. The space between two adjacent cells is equal to the width of the antenna pattern. The cells of the matrix are filled with measured temperature values for each of the N positions of the antenna beam. The tested cell is a matrix cell, which is checked for the presence or absence of a signal emitted in it by the target. The test cell is excluded from these N cells, and L cells that have the largest amplitude are additionally excluded. The remaining N–L–1 reference cells are used to estimate the background noise level. Thus, the tune-up from the powerful noise that falls into the reference cells is made. This assessment of the level of background noise is made for each cell of the matrix. These N results are stored in intermediate memory and are used to estimation the difference statistics and the fluctuation sensitivity of the radiometric system. After these estimates, the local threshold value is determined by multiplying the current fluctuation sensitivity by the scaling factor, which is a multiplier of the constant probability of false alarms. It is derived from a statistical distribution model adapted to the amplitude or power of the background noise. On the other hand, a detection method is said to be CFAR if the relation between scaling factor and false alarm probability is independent of the true background noise statistics. That is, the method is guaranteed to provide a constant rate of false alarm. Finally, a decision rule is applied to determine whether a target is present or not. The decision is made on the basis of a comparison of the difference statistics with a threshold depending on the expected temperature contrast. As a result, calculating the average, variance and fluctuation sensitivity of a radiometric system, we can formulate the following rule of contrast detection of a noise signal at the radiometer output: a decision is made on the presence of a signal at the receiver input, if the decisive statistics exceeds the threshold, and the decision on its absence, if not. Thus, the radiothermal contrast detector consists of a decisive statistics calculator, an adaptive threshold level calculator, a threshold device and an intermediate device storing the radiothermal contrast of the elements of the observed place.

Thus, the report considers the algorithm for detecting the surface target using a radiometric sensor using the contrast detection method of the radio thermal signal and ensuring a constant probability of false alarms. For the radiometric channel, an algorithm and structural scheme of contrast detection of a surface target has been developed in conditions when the spectral power density of the detected signal and interference is a priori unknown and varies with time. The algorithm is based on the comparison between the output signals of the radiometer for two different cells that are resolved. The decision on the presence of the surface target is made on the basis of a comparison of the difference statistics with a threshold depending on the temperature contrast, which is continuously evaluated.

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ELECTROPHYSICAL PROPERTIES OF SAPHYRE IN THE Ka WAVEBAND

Antenna devices that radiate and receive electromagnetic waves are widely used in radio equipment installed on various aircraft. A variety of tasks tackled by onboard radio-technical devices (navigation, aiming, etc.), as well as the constantly growing speed of aircraft, require close attention to designing and creating special nose airlocks (cones). Nose airlocks serve to protect antenna systems against external adverse factors (hydrometeors, various mechanical damage, high temperatures). Besides, when designing and making nose airlocks, special attention should be paid to the issues of radio transparency and minimizing the distortion of the directivity diagram of the antenna.

To achieve the required radio transparency in a given frequency range and at different angles of radio wave incidence, it is necessary to select appropriate materials. To simulate the possible influence of the nose airlock on the operation of the antenna system, it is necessary to know the electrophysical properties of the material it is made of, namely, the dielectric constant and the tangent of the dielectric loss angle.

To measure the dielectric constant and tangent of the dielectric loss angle of sapphire, a well-known method was used, which based on the dependence of the S-parameters of a rectangular metal waveguide on the parameters of the dielectric filling it.

The measurements were carried out with the help of a panoramic meter of the standing wave ratio and P2-65 attenuations. The sapphire sample that was manufactured had the length of l = 27.045 mm; it fully occupied the cross section of the waveguide segment 3.4x7.2 mm. The screen of the panoramic meter indicator showed the dependence of the standing wave ratio of the segment of the waveguide with the dielectric on frequency. The values of frequencies at which the standing wave ratio reached a minimum were registered. After that, the dielectric constant was calculated. In the range of 30.74 GHz-34.34 GHz, it was $\varepsilon = 8.8$.

At the frequency of the minimum of the standing wave ratio, we measured the attenuation of a hollow and dielectric-filled waveguide. Based on these measurements, the dielectric loss tangent was estimated. It constituted $tg\delta = 4x10^{-3}$

Thus, as a result of the experiment, the dielectric constant and the dielectric loss tangent of a sapphire sample in the waveguide line of 3.4 × 7.2 mm were measured.

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ON THE NEED TO SOFTWARE ADAPTATION INLAND ECDIS ON TOWING VESSELS FLEET

With the development of the river towing fleet, the need arose for precise control of the tugboat convoy relative to large tonnage vessels in the port area, where the accuracy of the position should not exceed 4% of the distance to the navigation hazard and its maximum value should be no more than 4 miles. The vessel’s position must be determined within 95% of the error figure, i.e. with a probability of 95%. The difficulty lies in calculating the rotation of the vessel hull under the influence of wind and current, because, unlike from large vessels, there are no sensors on the bow and stern of the tug on the towing vessels fleet. The intended solution is to develop software for tugboats.

This software should project the trajectory of the tug, based on the entered data into the program (vessel dimensions) and upon detection of a dangerous approach, software will produce a sound alarm. Also the attention should be payed on the synchronization of the speed of the vessel with the developed program to ensure a safe approach to the moving vessel. The purpose of this software is to exclude errors due to the human factor (fatigue, inattention) on the tugboats.

It is planned to introduce software in two modes of operation: automatic and manual. The automatic mode of operation involves bringing the tug closer to the moving ship by itself, that means that the vehicle will capture the moving target, under the control of the boat master, but without his participation. In the manual mode of operation, this software will offer safe ways of approach and display hazardous areas on the chart.

It is proposed to install additional GPS sensors on the bow, stern and sides of the towing vessel, as well as sensors for measuring angular velocity with the further development of appropriate software for synchronizing all installed equipment.

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GENERAL PRINCIPLES OF CREATING SHIPS

The Navy, as a foreign policy tool, has unique capabilities. They can ensure the "presence of the flag" of their state anywhere in the far point of the world ocean. In addition, modern naval weapons make it practically possible to reach any object in the territory of a potential enemy, regardless of its distance from the coastline. This means that Navy is the most important way of conducting contactless combat.

On Navy assigned task for ensuring security of the economic activities their countries in the ocean, seas and near maritime zones.

Conditions for building of naval forces require a considerable expansion of scope of scientific research, exploratory work on the background of weapons programs and view of perspective ships, increasing the variability of possible solutions, fuller use of cost-effectiveness optimization methodology.

Changed the principles of naval construction, that allow to formulate general requirements for perspective ships.

The most important of these are:

multifunctionality of the ship as a whole;

versatility of weapons and electronic systems;

high level of secrecy on physical parameters;

increase stability and survivability when using different types of ammunition;

maximum compatibility with Navy ships in other countries in ensuring interoperability in operations;

high degree of environmental safety;

improved living conditions;

high level of ergonomics of ship equipment.

The requirement for the multifunctionality of ships is dictated by the limited number of ships in the fleet in the future and the variety of tasks for ships. The quality of the ship is ensured, first of all, by the versatility of its weapons. The maximum versatility should be add to electronic detection and targeting systems, which will increase the efficiency of fire control and reduce the cost of these systems.

The high level of security of surface ships ensuring by equipping on ships STEALTH architecture in combination with a highly efficient complex of electronic counteracting.

Requirements to ensure the stability and survivability of the ship must guarantee that ship will safe in the case of single hits of different types of ammunition attack. The issue of returning to a new technical level to the armoring ships is not excluded.

Environmental requirements should met with increasing numbers of measures to eliminate the possible contamination of environment water and air.

The conditions of crew living should significantly improved, especially on ships with contract officers and sailors.

In aim to improve the ergonomics of the equipment are envisaged in order to eliminate the errors of the operators as much as possible. Crew training on electronic training complexes is expanding.

The high possibility of using Navy ships in peacekeeping and other operations requires the maximum compatibility of ships in speed, autonomy, communication facilities, cargo transfer systems at sea, landing facilities, means of landing and takeoff of helicopters, rescue equipment.

The tasks assigned to the naval forces of States that do not have way to the ocean determine the following types and classes of surface warships: corvettes, patrols, missiles, amphibious, landing craft and boats, submarines, unmanned and surface vehicles.

In military shipbuilding, the most important role always been given to new technologies. The main priority in the development of ships was the reduction of their physical fields (acoustic, electromagnetic, radar, thermal, radiation, etc.).

The development of world shipbuilding in the last twenty years is under the dynamic introduction of electronics. Modern ship automated control systems characterized by a high degree of reliability and survivability, a large capacity for high speed signal processing.

The multipurpose nature of warships and the complexity of naval operations preclude the possibility of their transformation even in the distant future into automatic ships. The most urgent area of automation and robotization on board ships is the survival of combat and operational damage, as well as the maintenance of potentially dangerous arms and systems.

The most important trend in the world practice of naval shipbuilding is the transfer of advances in civilian shipbuilding to the military. Leading foreign classification societies, under the rules of which are designed for civilian ships, have already begun to develop rules for the design of warships. For example, English Lloyd has already issued the first version of such rules. The Italian Register, the Norwegian Veritas, the American Bureau of Navigation have developed their own rules for certain classes of ships.

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COMPLEX OF CONTROL DEVICES MODERNIZATION AND SERVICE LIFE EXTENSION

In order to maintain Ukrainian naval forces combat effectiveness under difficult circumstances of the present the modernization and repair of equipment is proposed to provide for the further usage of complex of control devices(CCD) that has expired assigned terms of service (ATS).

Definite part of these devices can’t be operated already, and in the next 4-5 years all products will become non-serviceable. It is not possible to produce new control devices for these products according to the technical documentation, which operated in 1979-1986 years because the element base of electronic devices pulled off the market.

Schematic and technical solution of control devices, according to modern technical point of view, has several disadvantages:

– the device control at a depth of it’s movement is performed by using a rudder meter pendulum, which leads to overshoot in the products output in arriving at the set depth;

– the minimum depth of device movement does not ensure its use in shallow water;

– relay control laws on the course, roll and depth channels create excess noise during the device work, that does not contribute to its secrecy;

– relay-amplifier blocks are made on a germanium base, which has been discontinued.

Extension of service life and modernization are interrelated actions that are proposed to implement concurrently. In this case, it seems appropriate to upgrade the CCD by means of transition to a modern elemental base and expansion of technical capabilities.

Solving a list of problems is expected to be solved while modernization:

– transform the CCD into a universal unit, that is planned to be suitable while usage against underwater and surface targets;

– eliminate the submersion of the product in arriving at the set depth or depth limit "Bottom" and provide a minimum moving depth that allow to use the product in shallow water;

– extend service life of the modernized control devices in order to meet the naval forces needs during a certain period.

It is offered by modernization:

1) to retain the basic principles of establishing the control laws in course, roll and depth-rudder channels, also to keep dimensional and connecting sizes of control units and its electrical connections with the product board;

2) to conduct the research of possibility to use electrical products of the angular velocity sensor (AVS), pressure sensor (PS), selsin and others of the modernized devices;

3) transform the components of electronic equipment unit into a modern element base, which provides the necessary precision characteristics and warranty terms;

4) receive information about the rudder from the gyroblock, the angle sensor must be positioned along the inner axis of gyroblock suspension, and as a result gyroblock becomes a roll and rudder sensor. The pendulum angle sensor is removed from the depth unit because it causes additional errors;

5) to transform the scheme of the angular velocity limiter the element base must be replaced by modern analogues, to make possible the positioning of the angular velocity limiter (AVL) into the tape dimensions;

6) to enter the scheme of switching off the product control in the vertical plane using the signals from homing system (SHS) in cases of usage the product against the NC at shallow depths.

Optionally will be considered the possibility:

- of implementation a rudder signal into the control law of the depth from the AVL to improve operational conditions of SHS in the horizontal plane using damping;
- of replacement the electromechanical tracking systems at a given course, depth and rudder into electronic analogues;
- of replacement the electromechanical tracking systems with electronic ones, that will reduce the manufacturing complexity of specified systems and increase the accuracy of aiming at the target;
- of implementation the summation of signals on the operational amplifiers.

Modernization of the depth unit as well as the roll-leveling device. Other units will be repaired and renovating, that allow to extend the service life up to 15 years.

As a result of the modernization it is planned to provide:

1) setting the depth of the product within shallow water;

2) improving the error from execution the given depth in the "NC" mode;

3) reducing the insensitivity zone of depth in the "NC" mode.

The proposed modernization will allow to create control devices with improved tactical and technical characteristics, including the accuracy growth of processing the basic parameters of the device movement by 25-30% and to extend the service life of the equipment.

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THE INFLUENCE OF THE SCHEME OF CONSTRUCTION OF A SHIELDED CYLINDRICAL HYDROACOUSTIC RADIATOR ON ITS DIRECTIONAL PROPERTIES

Cylindrical hydroacoustic radiators have been widely used in hydroacoustic antenna practice due to their energy efficiency. However, their major disadvantage is the lack of directional properties in the plane normal to the longitudinal axis of the radiator, as well as the need to use acoustic screens to form a unidirectional action. There are two possible approaches to choosing a scheme for constructing a shielded cylindrical radiator. The first, traditional, construction scheme involves the placement of an acoustic screen in the form of a closed annular layer of material of finite thickness, reflecting sound, on the outer surface of the radiator. Its disadvantage is that this increases the overall dimensions of the radiator in the above-mentioned plane, and since in a number of hydroacoustic antennas, especially cylindrical, the distance between the centers of radiation is of fundamental importance, such a scheme for the construction of a shielded cylindrical radiator significantly limits its use. This is especially important in the implementation of the tendency to decrease the operating frequencies in hydroacoustics, which necessitates the increase of the thickness of the shielding material.

The above disadvantages does not have a second approach to the construction of the shielded radiator. According to this approach, the acoustic screen is placed in the inner cavity of the cylindrical radiator, and the space between the piezoceramic shell and the screen is filled with liquid. This approach allows keeping the overall dimensions of the shielded radiator the same as that of the unshielded one. At the same time, this approach has its disadvantages.

Comparison of two approaches in terms of the influence of schemes of construction of shielded cylindrical radiators on their unidirectional properties has provided. The rational ways of using both schemes have been determined.

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TO THE QUESTION OF COVERAGE OF A SUPERVISORY FACILITATION WITH THE AID OF A PROSPECTIVE UAVLESS AVIATION COMPLEX OF VESSEL BASED

Covering surface conditions in certain areas of the seas remains an extremely important and priority task in planning the actions of Navy units. At the same time, a wide range of means is envisaged to accomplish this task, ranging from ground and ship based optical and radar facilities to on-board marine aviation intelligence. According to the results of the analysis of the condition of the available surface naval means listed in the Navy, it is possible to ascertain their limited ability to perform the tasks for the purpose in modern conditions. In such circumstances, the urgent task is to find ways to quickly equip the Navy units with modern means of illuminating the surface environment. In our opinion, one of the alternative options is to consider the use of unmanned aviation vehicles (UAV) for this task.

Thus, the intensive development of unmanned aeronautical equipment in the world, its introduction into operation, has recently led to a significant expansion of the scope of UAV.

Modern UAV are capable of solving specific tasks for the needs of groups of different types and types of troops.

Thus, the analysis of trends in the development of unmanned aerial vehicles in recent years, one of the relatively new and promising areas, is the development and implementation of UAV to meet the needs of the Naval Forces, including ship based, with the aim of performing a wide range of tasks in the interests of naval groups or individual ships.

Such UAV can operate in a designated maritime area, in the interests of individual warships or warships, as well as individual coastal command posts and coastguard units, and perform such tasks as intended: aerial reconnaissance, surveillance (surveillance) of surface surveillance, conducting electronic warfare, providing relay communication, issuing target instructions to strike complexes.

It should be noted that along with the obvious advantages of using UAV ship based, the development and creation of such complexes are associated with significant military, technical and financial risks. The process of development and creation of the UAV of ship based will obviously be influenced by a number of negative factors, the main ones being: the lack of experience in developing such complexes in Ukraine; lack of experience in the use of ship-based UAV and, accordingly, evaluation of their effectiveness in general, which in general significantly complicates the process of creating such a sample.

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THE METHODIC FOR DETERMINE MASS-DIMENSIONAL CHARACTERISTICS OF THE OPTOMETRIST-ELEKTRONICS CAMERAS ON BASIS ENERGETIC METHOD BASED FOR RECONINCANCE SHIP BASING UAV

Among the many problems that arise from pre-developers and designers when creating optometrist - electronics cameras (OEC) for UAV with minimum mass and size characteristics (MSC) OEC complexes with conditions for the implementation of the tactical and technical requirements to UAV: the distinctive ability of angles- field-sight, viewing zones, work in the time completion any state atmosphere in conditions flight at defined altitudes and velocities.

Achievement of the minimum values MSC OEC is solved –conducting of energy-calculation signal/noise, at least provided characteristics: range detection, recognition, identification of objectives. The ability of the terrain zone overview at determined sizes the mane elements OEC, namely: dimensional size optical elements and objects in between individual optical elements lenses and distances between photoelectric and photo detector.

Taken methodic allows carry estimate calculations relative definition overall characteristics, vases payload reconnaissance ship based UAV, formation optimal requirements of the useful load, and to designers OEC take appropriate design and technological solutions.

Considered some concrete examples of the application with using the developed methodic.

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METHODOLOGICAL BASIS FOR IMPROVING THE CONTROL SYSTEM OF ANTI-SHIP MISSILES

Methodological basis for improving the control system of anti-ship missile control system associated with the development of anti-ship missile system. The complex with anti-ship missiles is being created in Ukraine for the first time and is a priority national project, and its implementation is connected with solving a number of scientific and technical tasks.

The main one is to ensure selective destruction of the target in the airborne unit or grouping ships. The problem is investigated taking into account the actions of the crew (operators) and the functioning of the technical part of the anti-ship missile system. The functioning of the missile complex is generally considered as a process of achieving the goal by an ergotech system and can be represented by a sequence of operations, the correct and timely implementation of which leads to the achievement of the goal.

As a result of the research, the principles of modeling the control system of the anti-ship missile complex, the selected and developed research apparatus were formulated (methods, mathematical models and techniques were developed). In particular:

Information-probabilistic method for analyzing models of marine targets, that is, ships of type classes on a disturbed sea surface.

Developed techniques:

Selective identification and delight of the target, both in terms of the coordinates, and in terms of the energy and geometric characteristics of the ships

Determine the length of the ship and the parameters of its movement (course and speed).

An imitation-modeling complex of the process of identifying and delighting the intended purpose and a method of evaluating the effectiveness of this process, including taking into account the basic connections of operations with feedback, have been developed. The tension of the crew members and the impact on their combat work rate are taken into account.

This makes it possible to assess jointly the influence of selective properties of the missile system and the correct and timely actions of the battle crew on the combat effectiveness of firing.

Mathematical models brought to practical calculation techniques.

Preliminary estimates of the effectiveness of the combat use of the anti-ship missile system indicate the need for salvo attacks on the landing party or group of ships.

The theoretical part of the development of principles, methods, mathematical models for solving a problem ends. The next step is to conduct full-scale research.

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DIAGNOSTICS OF RADAR OBSERVABILITY OF TARGETS ABOVE THE SEA, USING NAVIGATION SATELLITE SIGNALS

The task of diagnosing radar observability of targets is closely related to the problem of diagnosing radio wave propagation conditions, which are determined, in turn, by refraction in the lower atmosphere. Above the sea, where a strong variability in space and time of environmental characteristics can disrupt the work of communications, radar, navigation, the problem of short-term diagnostics of propagation conditions is particularly actual. In the presence of developed methods for calculating the field in areas of direct visibility and geometric shadow, this problem is reduced to the determination of the altitude profile of the refractive index of the atmosphere. For a long time, contact measurements of atmospheric meteorological parameters - temperature, pressure, humidity, or direct refractometric measurements (however, both of them have certain limitations, first of all - the local character of measurements) were traditional methods for determining the refractive index.

In recent decades, remote methods for diagnosing atmospheric refraction, using signals from navigation satellites, have been actively developed. The IRE NAS of Ukraine conducted researchs into the possibilities of using radiation from the first (Transit) and second (GPS) generations for this task.

In the process of performing work that investigated tropospheric refraction over the sea using the Transit satellite signals, based on the experiments performed, it was shown that it is possible to solve the incorrect inverse refraction problem analytically, as well as solve it numerically, connecting the informative parameters of the received signal (zeros of the interference structure) with the bank of calculating refraction profiles.

At the next stage of researchs in 2001-2003, STCU project No. 144 “The Development of the Atmospheric Refraction Non-Contact Diagnostics Method Employing Satellite Radiation” was carried out. The field researchs of troposphere refraction by the method of satellite GPS radiosetting over the sea was conducted. It is shown that there is an actual dependence of satellite’s signals characteristics, measured near the horizon, from atmospheric conditions. The variability of GPS satellite’s signals during radiosetting over the sea, their correlation with gradient measurements on the near-water path, and the influence of the surface (sea and land) on the characteristics of GPS signals are investigated. A separate series of studies is devoted to modeling and experimental study of the features of GPS signals in the geometric shadow zone.

Thus, the parameters of the satellite signal, for example, its angle of radiosetting or fluctuation characteristics can characterize the degree and type of tropospheric refraction at the current time in a sufficiently short-period time (about 1-2 hours), and determine the short-term diagnostics of propagation conditions and radar observability of targets in a given area.

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EXPERIENCE OF CREATION AND APPLICATION OF MARINE ROBOTIZED (SAFE) SUBWAY SYSTEMS (COMPLEXES) AND THE POSSIBILITY OF USING IT IN THE WEATH US

Today, in the conditions of armed aggression of the Russian Federation against Ukraine and quantitative and qualitative advantage of its forces at sea, asymmetric, effective response of the Navy of the Armed Forces of Ukraine (hereinafter - the

Navy), may be - Unmanned Maritime Vehicle (UUV) - unmanned maritime vehicles, unpopulated submarines, unmanned marine systems (UMS). The experience of development, construction and application has been accumulated in a number of leading countries, where about 10 thousand units have been created in the last 30-35 years. They are adopted for the purpose of improving the security of personnel, both in day-to-day and combat operations, as well as in the effectiveness of their influence on the enemy.

Since the mid-1980s, the design of UUV was initiated in the United States, primarily aimed at performing intelligence functions. Over the last 20 to 25 years, quite a lot of active development has taken place, mainly for military purposes - combat naval robots, except for the USA, in leading maritime countries, in particular the UK, Israel, China, Germany, Norway, France and Sweden, where the funding of these programs increased by 20-30 times.

The most widely used submarines of various types and purposes are represented in the US Navy, where the General Plan of the ANPA (2004) defines the following conditional classification: light / portable (up to 45 kg, hull diameter 76.2-230 mm, autonomy 10- 20 years); small (230 kg, 324 mm, 20–40 hours); average (up to 1 400 kg, 533 mm, 40-80 hours); large (up to 10 t, 910–1820 mm, up to 400 h). Specialists also use another classification: 1) underwater micro-robots (up to 20 cm in diameter), designed to be used as combat means to survey the seabed or to create obstacles to enemy anti-aircraft operations; 2) small-scale submarine works (up to 30 cm in diameter) - submersible Mk-18 UUVs - designed for hydrographic work and mine detection, for use in reconnaissance or offensive operations and for the protection of submarines or surface ships; 3) medium-sized systems (up to 50 cm in diameter) commensurate with the Mk-48 underwater torpedo; are considered as torpedoes of the future with the tasks of mining, radio-electronic suppression and damage to the enemy in the far zone; 4) large-scale submarine work (up to 200 cm in diameter) - for example, large-scale submarine work - designed to be launched through Virginia Payload Module Block V mounted on Virginia hull hulls to improve boat performance - increase system range detect, increase payloads, or deliver gear out of reach or unsafe for a submarine.

Modern UUV equipped with a complex of systems and devices that allow the self-movement of vehicles underwater, have a number of potential advantages over manned platforms, in particular, they can provide more complete information in the process of illumination of the situation. Most of them have a torpedo body with an energy unit consisting of a lithium-ion battery (AB) and a rowing motor. Control is carried out autonomously according to the program, embedded in the memory of the on-board computer, using the inertial navigation system (INS) and Doppler lag with periodic refinement (at subset) of the location according to the space radio navigation system (KRNS) "Navstar".

On-board search equipment may include: front-facing sonar (GLC); side view sonar (HBO), which provides simultaneous detection of underwater objects in a wide band due to the use of installed onboard acoustic antennas, the directional characteristics of which are oriented perpendicular to the diameter plane of the apparatus; digital camcorder; sensors for measuring seawater parameters and the like. The obtained data are recorded on a rigid magnetic drive for further detailed analysis of the results of the operation after lifting UUV aboard the carrier.

Creation of the Unmanned Undersea Vehicle Squadron (UUVRON 1) Division on September 26, 2017 at the Underwater War Center (Capeport, Keyport, Wash.) Testifies to the transition to permanent, duty-free use) forces and means, their systems in combat operations at sea.

The Armed Forces of the Russian Federation have recently intensified their activities on the development and use of UUV, of which several samples have been developed. Thus, starting from 2017, in the waters of the Mediterranean Sea at the point of maneuvering of the Navy of the Russian Federation at the port of Tartus (Syria), the robotic complex (RTK) of the sea base MT-2012 "Galtel" was involved in the execution of the task of protection of the water area. According to some sources, since 2018, one of such complexes has been used to guard the Kerch Bridge illegally built by the Russian Federation.

Since the Navy of the Armed Forces of Ukraine is tasked with ensuring the protection of underwater space within the territorial sea of Ukraine, which is now incidentally carried out only by limited maneuvering forces of the Navy, marine robotic (unmanned) underwater systems (complexes) can be actively involved in this task.

Therefore, based on the above, we can draw the following conclusions.

1. Foreign specialists shall create, prepare and test in combat conditions the latest robotic means of detection and destruction of objects located in coastal areas using new tactics for the destruction of protected objects, taking into account the fighting properties of these means, in particular: opening of the situation in the areas of base of forces (in points of base, points of maneuver base), places of the parking of ships (boats, ships) and on approaches to them; placement of navigation and hydrographic means; arrangement (setting) of mine and other barriers, which can be created as elements of anti-amphibious defense of the coast, search and destruction of enemy submarines and the like.

An analysis of the experience of the development and deployment of robotic naval systems in the Navy of the leading countries of the world shows that such naval weapons are a highly effective means of performing a wide range of peacetime missions, crises and military conflicts. Therefore, they may be involved in the following tasks, in particular: continuous monitoring of the environment in the underwater environment, at the bottom and at the sea surface; conducting reconnaissance in designated marine areas; navigation support for the application of forces at sea; providing combat training for the fleet; search and neutralization of marine mine barriers; search activities during search and rescue operations at sea; provision of special operations forces; defeat of small underwater and surface targets; transportation of military cargo by sea, etc. This allows us to predict the expansion of the range of tasks solved by submarines and their subsequent proliferation as an integral component of the armament of surface ships, submarines and Navy units.

2. The enemy - the Russian Federation - creates, tests in combat conditions and prepares for use the latest robotic means of detection and destruction of objects located in the coastal areas; RTC uses a new tactic for the destruction of protected objects, taking into account the combat properties of these assets, which requires the investigation and implementation of appropriate means of neutralizing their actions and developing the necessary means.

3. It is quite expedient to have in the NAVY of the Armed Forces of Ukraine for reliable protection of the underwater space of Ukraine, in particular, the areas of base of forces, ports and places of anchorage, - UNIT. Today such systems (complexes) can be purchased abroad, and in parallel - to master their construction at domestic enterprises.

4. As the necessary human and material resources are available in Ukraine, special technologies are developed, well-known scientific schools and scientific-industrial associations operate in the world, as well as considerable experience in the creation, implementation and practical application of modern UUV, taking into account the above, and considering the expediency of precisely asymmetric methods of fighting the enemy, the formation and implementation of the concept of equipping the NAVY with robotic (unmanned surface and underwater) systems topics (complexes) are a priority area for the development and use of the Armed Forces.

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THE RESEARCH INVESTIGATION OF SHIPS HULL IN TRANSPORTATION AND OPERATION OF THE DECK HELICOPTER

The use of deck aviation in our time is becoming more widespread both for warships and civilian ships.

The main purpose of the study is to study the patterns of the ship's hovercraft under conditions of sea excitement and wind loads during operation and movement on deck (platform) of deck helicopter.

In revealed that during the process of moving and landing a helicopter on a ship (ship) its speed can not be stable, due to the fact that due to the effect of inertial forces there is a decrease in feedback. The process can be both aperiodic and oscillating, depending on the characteristics of the system "ship -> equipment -> helicopter". If the process is oscillating, possible resonance phenomena and overregulation, which will increase instantaneous efforts in locking ropes, which are found through mathematical, modeling. The main criterion is this: to provide the value of the holding moment of M_T greater than the interchangeable M_O.

The results of calculations allow to assert the following:

- the maximum turning point from the inertial forces increases with the magnitude of the wing shift;
- the holding moment due to the gravitational force decreases with increasing amplitude of the pitch;
- the resulting moment with the simultaneous operation of the onboard, the circular and the vertical shifts is reduced and at reaching some angle of the roll θ reaches zero value.

The helicopter holding forces with increasing angle of the angle θ decreases due to:

- reduction of frictional force due to reduction of the normal to the deck of the component of weight and as a result - pressure on the deck;
- reduction of the weight component in the direction of slipping.

The obtained mathematical dependencies and graphic images prove that the reduction of the coefficient of friction of the "chassis-deck" system from 0,7 to 0,5 will lead to a decrease in the boundary angle of the roll (which changes the sign of the resulting force) from 18 to 12 degrees.

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UNMANNED AVIATION COMPLEXES FOR UKRAINIAN NAVY

In the conditions of the armed aggression of Russian Federation against Ukraine one of foreground and actual mission of Ukrainian Armed Forces is development of unmanned aviation complexes, in particular, for Navy.

Actuality of this item is predetermined the performance of the Operative goal 3.6. A revival of Ukrainian naval potential of the actions foreseen by Plan of Defense Reforms in 2019-2020, task 3.6.1. Forming of naval possibilities of Ukraine, adequate threats and sufficient for providing of Black Sea and Azov Sea seashore defense.

As known, Russian Federation on the Black Sea fleet annually increases the amount of combat ships which have a guaided missiles armament “Caliber”. It is an instant danger both for the Ukrainian combat ships (crafs) at-sea and for important military and state objects ashore. Therefore an important task for Ukrainian Navy is an exposure and elimination of guaided missiles armament “Caliber” cerriers. This year by the State Kievan designer bureau “Luch” the antisurface guaided missiles complex “Neptune” (РК-360МЦ) was created and passed state tests successfully. It is desined for the defeat enemy combat ships: cruisers, destroyers, frigates, corvettes, amfibious ships and transports. But a problems of determination and delivery targets are unsolved. So an authors propose for implementation of these tasks to consider possibility of application unmanned aviation complexes of Bayraktar TB2 for solving this problems. It has all technical capabilities necessary for this purpose: maximal flight mass is 560 kg, an actual load is 55 kg, duration of flight – 24 hours, distance of action of radio channel and telemetry is a 150 km, maximal distance of flight of Bayraktar TB2 in the programmable mode is a 4000 km. Sizes of dron allow to carry a powerful optical-electronic apparatus. It helps get the exact co-ordinates of target in real-time in a sunset-to-sunrise and all weather conditions, answers the requirements of NATO standards (STANAG 4586, 7023, 4545, 4607, 4609). Usually one complex is six drons, three surface control stations, placing in cars, six surface terminals and other equipment.

For the reconnaisense above the aquatorium of Black Sea and Azov Sea it is expedient to create the separate squadron of Bayraktar TB2 as a part of the marine aviation brigade of Ukrainian Navy. It will allow to have reconnaisense in interests of forces (troops) of Ukrainian Navy and to give out targeting directly to “Neptune” and coastal artillery.

Main advantages of Bayraktar TB2 is long time in air (to 24 huars) that quality of reconnaissance information in real-time. They enable to replace airplanes-reconnaissance and reduce in a price and do safer an airreconnaissance in comparing to the pilot-controlled aviation.

It should be noted that Bayraktar TB2 can be used and in a strike variant. It has on an armament bombs with the laser aiming of MAM-L (Smart Micro Munition) special easy guided armament (weighing 22 kg), developed for strike drons. This bomb is equipped the high-fidelity semiactive system of aiming on a laser ray and carries out glider flight to the target. The system of aiming of armament allows to get with an error no more one meter. Distance of defeat target from 500 m to 8 km The height of application is determined meteorological and other conditions. Aiming principle – on a laser ray. Bayraktar TB2 can carry to 4 ammunitions on a pendant.

So creation of separate squadron of Bayraktar TB2 as a part of marine aviation brigade will considerably promote reconnaissance and combat abilities of Naval forces (troops).

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MODELING NON-ENERGY OPERATION OF ARMAMENT AND MILITARY EQUIPMENT BASED ON FEEDBACK PRINCIPLE

The feedback principle is one of the basic tenets of cybernetics, defined by its author N. Wiener in the science of control in living organisms and technical systems. At the same time, the formation of a model for the activity of combat crews of armaments and military equipment is rarely used at the design stages. This is one of the main causes of accidents with weapons and military equipment. From 50 to 80% of accidents in various fields of human activity are personnel errors. Therefore, it is important to predict the occurrence of dangerous errors of operators, especially fire managers and fire managers, with the development of sound recommendations for their prevention (filtering) system and circuit techniques.

A method is proposed for developing models of the functioning of weapons and military equipment with a human operator in the control loop and typical mathematical models for error-free and timely control of products. The input data of such models are the statistics of elementary actions of operators, and the output characteristics are indicators of the accuracy and time of solving problems by them, the probability of emergency operations.

The difference between the developed models and the well-known in the class of functional-network is that:

- regularities of the operator's actions are taken into account when the tempo intensity is based on the experimentally subject to the law;
- output indicators are determined recurrently for any step of the cyclic process of the system, and not just the limit.

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CLASSIFICATION OF SEA TARGETS ON RADAR SIGNALS AT THE DEFICIT OF TIME

The tasks of classification and authentications of sea target make an important problem the radar sensors of information (RSI) in the conditions of sharp deficit of the real time. Its decision is complicated by influencing of laying sea surface, especially at agitation of sea, and also influencing of natural noises and created hindrances. Except for it, on a speed aircraft (SA) hard limitations of mass and size, that bothers achievement of high separate ability RSI, especially on to the corners. Reserve of time resource would be drawn on for accumulation of radar signals, that are reflected back from target, and upgrading their treatment with authentication of leading (definite) objective in a ship group, landing ship in landing party. But in the class of tactical SA such time resource is practically absent. Methodical possibility of decrease of time on classification of purposes in the area of indication of purposes RSI SA is considered authors.

With the known methods of statistical evaluation of experimental data most fast-acting peculiar of method of most plausibility (MMP). It ensues from principle of plausibility and consists in possibility preliminary to prepare great mathematical part of analysis and estimation of experiment and to use her under various conditions. Concerning by realization of such possibility in the system of control of such SA one time action maximal exactness and sufficient of estimations MMP are taken into account. Amplitude of signal of sea target (ST) is adopted by distributed by low of Nacagami, that does not conflict with experimental data. To these failing MNP is removed off: necessity to foresee the type of probability distribution. But with the known parameters of form and scale of each of the expected classes of purposes. Herein there is a substantial difference from the classic method of estimation of unknown parameters in the experiment. The task consists in taken from every target of signals, that are observed, to the signals of target of the proper class (frigate, corvette, landing ship, ...).

Classification ST is considered as a reliable taking of the exposed target to the rays to the target of definite class by comparison of estimations of most plausibility of parameters of distributing of amplitude of their radar signals. The specific of the following tasks is thus taken into account:

– estimation of probability of generation of data retrieval concrete target from composition of ship group;

– construction of confidential area for the most credible estimations of parameters of distributing of amplitude in their plane;

– selection of definite target from composition of ship group.

Principle of most plausibility substantially simplifies the decision of these tasks. According to him a one scale is adopted for measuring of rationed to logarithm of function of plausibility that is sufficient statistics. It is distributed after the exponential distributing with the expected value that is evened two. The values of integral function of this distributing are adopted identical for the function of plausibility of amplitude of signals from every target, that are resulted to the zero. Estimation of parameters of distributing of amplitude of the treated data retrieval is represented by a point in the plane of parameters. Function of plausibility it is combined top not with estimation statistical, and with output data on every purpose. These procedures are carried out simply. In the graph analytical teaching of decision of task looks refined. Some complication is related to construction of confidential areas. On a difference from traditional interpretation of this area covering parameters to truth, in our approach she has maintenance of maintenance of veritable parameters. Accordingly maintenance content and confidential probability.

The process of classification of targets is cyclic. The matrices of probabilistic parameters $m \times n$ are built on a group from m targets and n their possible classes. So as greater part of mathematical treatment of signals is developed preliminary, time reserve, that is present, is drawn on economy without the temporal of exactness of calculation.

At estimation of authenticity and exactness of definition of parameters of distributing of amplitudes of targets of the proper classes confiding areas, that cover to truth of steam of parameters of form and scale of distributing Nacagami, have a form to the contour, incident to this distributing.

The use of operative treatment of signals ST in the real terms is related to overcoming of their vagueness: foreshortening of irradiation target, agitation of sea in the zone of presence of target, their counteraction radio electronic and other. At consideration of these factors winning at times treatments of signals can to be substantially greater. However, it needs subsequent researches and experimental confirmations.

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THE BASIC REQUIREMENTS TO THE PERSPECTIVE MARITIME ROBOTIC SYSTEMS

The necessity of the speed-up forming and improvement conception of equipment of Armed Forces of Ukraine by maritime robotic systems is conditioned in the first turn by subsequent activation of aggressive actions of Russian Federation in the Azov and Black sea region and search of asymmetric methods of counteraction an enemy on the sea.

The analysis of modern tendencies of creation and employment of the unmanned systems witnessed about:

substantial growth of charges is on development of technologies from creation of the newest unmanned complexes;

acceleration of rates of retooling of military powers of the leading foreign states by unmanned complexes;

use of both traditional and alternative variants of construction and employment of unmanned surface and undersurface vehicles.

Traditional approaches foresee creation of the renewed variants already of known and permanent on purpose and by the structural features of types of unmanned surface and undersurface vehicles. At the same time, a tendency is marked to creation of alternative variants of unmanned surface and undersurface vehicles, in particular vehicles with energyindependent options and bionic systems of their motion. In RF works are conducted in relation to tests to the unmanned surface vehicle with the energyindependent setting «Buk-600» and systems of motion of surface and submarine platforms of «flipper type».

Both the results of previous researches witnessed conception of equipment maritime robotic systems must foresee creation (purchase) as onehaving a special purpose and multipurpose unmanned surface and undersurface vehicles. At what in a long-term prospect advantage will belong exactly multipurpose multipurpose unmanned surface and undersurface vehicles.

Before the basic requirements to perspective multipurpose unmanned surface and undersurface vehicles it follows to take the followings:

a construction of subsystem of collection and exchange of information and on the whole control the system on network-centric principle and their integrating is to the network-centric system of forces and facilities of Navy and interspecific (interdepartmental, coalition) forces;

creation of corps of vehicles is exceptionally with the use of modern composite materials;

construction of platforms (transmitters) of vehicles as the automated (distance guided, robotic) complexes;

use vehicles only of the special power systems, which are autonomous, distance guided, energyindependent, combined after the types of the utillized energy;

application in the vehicles of both traditional facilities of motion and bionic type and combined;

creation of vehicles of both onesphere employment and twosphere (amphibian) and multisphere (air, ground, surface and undersurface) employment.

An equipment must be carried out in such sequence:

on the first stage (to 2025 year) is creation (purchase) of traditional unmanned surface and undersurface vehicles;

on the second stage (2025-2035) is creation (purchase) of perspective unmanned surface and undersurface vehicles, built on the newest principles.

Realization of conception of equipment of Armed Forces of Ukraine and other military formations by maritime robotic systems will allow considerably to increase potential of asymmetric on enemy and attain strategic aims in a fight against him on the sea.