

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 DEFENSIVE INDUSTRIAL POLICY IN UKRAINE.
WEAPONS AND MILITARY EQUIPMENT
DEVELOPMENT PERSPECTIVES**

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Abstracts of reports

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2. Artabayev U.Z. ANALYSIS OF THE STATEMENT OF DEVELOPMENT OF INTEGRATED INERTIAL-SATELLITE NAVIGATION SYSTEMS	140
3. Baranov M.I. MILITARY-TECHNICAL APPLICATION OF HIGH-ENERGY IMPULSIVE SOURCES ENERGY OF SMALL DIMENSION AND HIGH SPEEDS	141
4. Barladin O.V. PROBLEMS OF CREATION THE NEW DIFFICULT TECHNICAL COMPLEXES BY PRIVATE DEVELOPERS FOR ARMED FORCES OF UKRAINE(AFU) ACCORDING TO THE RESOLUTION KMU № 345 OF 25.02.2015	142
5. Baškirov O.M., Onykyenko L.S. THE PROBLEM OF INTRODUCTION OF MODERN INFORMATION TECHNOLOGY IN THE LOGISTICS SYSTEM OF THE ARMED FORCES OF UKRAINE	143
6. Berezovskyi A.I. RESEARCH OF OPPORTUNITIES AND WAYS OF IMPROVING SYSTEMS OF PROTECTION OF POTENTIALLY DANGEROUS MILITARY OBJECTS WITH CONSIDERATION OF CURRENT THREATS	143
7. Bohucharskyi V.V., Fedorov P.M. WEAPON OF NON-TRADITIONAL PRINCIPLES IS A PROMISING WEAPONRY	144
8. Dolgalenko O.V., Bashkirov I.O. THE COURSES OF IMPROVEMENT IN LOGISTIC SUPPORT SYSTEM	145
9. Grebennik I.V., Reshetnik V.M., MAKING EFFECTIVE DECISIONS IN SOLVING PROBLEMS OF DEFENSE PLANNING	145
10. Horielov Y., Korohod V., Lykholit M., Rybalko D., Sladkyi A. UNIFIED INTEGRATED LAND-BASED NAVIGATION SYSTEM TEST RESULTS	146
11. Kofanov A.V. PRACTICAL ASPECTS OF DETECTION OF EXPLOSIVES VAPOR DETECTORS	146
12. Kofanova A.S. FEATURES DETECTION OF EXPLOSIVES BY MEANS OF CHEMICAL ANALYSIS	147
13. Kovbasiuk O.V., Kostyna O.M., Korotchenko L.A. PROBLEMS OF CONSTRUCTION OF THE TECHNICAL BASIS OF TROOP (FORCES) COMMAND AND CONTROL SYSTEM	148
14. Krasulin A.S. LOCOTRACTOR ON THE COMBINED PNEUMO-TRACK-THE-GO	149
15. Lazaruk Y.V., Koval A.B., Gonchar M.O., Nikolayenko V.A. MODERNIZATION PROBLEMS OF CONTINUOUSLY OPERATING EARTHMOVING MACHINES	150
16. Matsko O., Dachkovskiy V., Gimber S. METHOD OF DETERMINATION AND EXPOSURE OF AIR AND EARTH MOVABLE OBJECTS	151
17. Partayan A.S., Chumachenko S.M., Tkachuk P.S., Narizhniy O.B. CRITERIA SYSTEM FOR COMPREHENSIVE EVALUATION OF THE INFLUENCE OF MILITARY-TECHNOGENIC LOADING ON THE STATUS OF THE ENVIRONMENT OF BORDER REGIONS ON THE TERRITORY OF THE REGIONAL ARMED CONFLICT	151
18. Prikhodko Y.P. THE RELEVANCE OF THE DEVELOPMENT OF ONBOARD NAVIGATIONAL INSTRUMENTS WITH ELEMENTS OF ARTIFICIAL INTELLIGENCE MOBILE ROBOT FOR MINE CLEARING OF EXPLOSIVE SUBJECTS	152
19. Romanenko V.P., Sakovych L.M., PROBLEMS OF EVALUATION AND ENHANCEMENT OF THE COMMUNICATIONS SYSTEMS EFFICIENCY IN MODERN CONDITIONS	153
20. Romanov O.M., Kotyubin V.Y. FEATURES OF USING MF-TDMA OPERATION MODE IN SATELLITE SYSTEMS	154
21. Rudakov V., Bychkov A., Kovbasiuk A., Stanishchuk A., Narytnik T. PROBLEMS OF THE DEVELOPMENT OF A TRANSIT MULTIPLE DIGITAL TROPOSOPHER STATION	154
22. Rudakov V., Kovbasiuk A., Onykienko L., Pukas A., Stanishchuk A. PROBLEMS OF CREATION OF A MOBILE SMALL-BASED DIGITAL RADIOELECTRIC TROPOSOPHER STATION	155
23. Sakowski A.A., Prikhodko Y.P. FORENSIC ANALYSIS OF THE CRIMINAL EXPLOSION	155
24. Saprykin A.B., Krasovskiy O.I. A PRPV-16 FUZE OF TERMOBARIC MUNITION OF ROCKET-PROPELLED INFANTRY FLAMETHROWER RPV-16 «OPAL»	156
25. Sendetskyi M. METHODS FOR VALIDATION OF REQUIREMENTS FOR RATIONAL VALUES OF BASIC PARAMETERS AND STRUCTURE OF A UNIVERSAL MOBILE COMPLEX FOR RECONSTRUCTION OF THE ROADWAY	157
26. Shapoval P.I. THEORETICAL AND METHODOLOGICAL BASES OF ACTIVE PARAMETRIC IDENTIFICATION OF RADIOELEMENTS QUALITY INDICATORS	157
27. Shkvarskiy A. DYNAMIC FASTNESS OF SOLDIERY NIZ'KOVODNIKH OF BRIDGES	158
28. Shyshatskyi A.V., Gatsenko S.S. METHOD OF SELECTION TOPOLOGY AND MODES OF WORKING MILITARY RADIO COMMUNICATION SYSTEMS ON THE BASIS OF IMPROVED GENETIC ALGORITHM	158
29. Slobodianyk V., PROSPECTS OF CREATING A DOMESTIC AUTOMATED CONTROL SYSTEMS FOR THE CHEMICAL, BIOLOGICAL, RADIOLOGICAL AND NUCLEAR TROOPS PROTECTION	159
30. Slobodianyk V., Sashchuk S., Sevostyanov D. PROBLEMS AND PROSPECTS OF CREATING A DOMESTIC THERMOBARIC WEAPONS	160
31. Slyusar I.I., Smoliyar V.G., Voloshko S.V., Slyusar V.I. PRIORITIES FOR DEVELOPMENT OF TRUNKING RADIO SYSTEMS	160
32. Synitsyn I.P., Ignatenko P.P. INFORMATION INFRASTRUCTURE OF MINISTRY OF DEFENCE AND ARMED FORCES OF UKRAINE. STATE OF THE ART AND APPROACH TO IMPROVE	161

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PROBLEMS AND PROSPECTS OF CREATING A DOMESTIC THERMOBARIC WEAPONS

The analysis use thermobaric weapons in modern military conflicts shows its high efficiency in solving individual combat tasks, particular in conducting of hostilities in urban, mountainous areas, during the storming of strongly fortified structures, and so on.

As result, Russia has developed and adopted a range of thermobaric munitions - from assault grenades to air bombs of various calibers. Appropriate work to find new samples and improve existing ones are actively being continued.

The tasks solved in the course of such work are the search for new, stable and high-energy thermobaric mixtures, reducing the anisotropy of the excess pressure of the explosive wave. Important also verify the time and reducing the heterogeneity at the moment of detonation thermobaric mixture at various points of the cloud, minimizing the difference of the initial velocities of thermobaric combat part, and so on.

As you know, thermobaric weapons were not produced in Ukraine. The possibility of its creation is faced with a number of difficulties, such as:

- lack of experience in the development of such weapons;
- the need to upgrade domestic enterprises with special equipment for the development and production of individual parts and units;
- absence of a modern test base for the development of thermobaric weapons;
- absence of domestic mathematical models capable of high level of reliability and adequacy to describe the processes taking place during the thermobaric detonation and to carry out automated search of new thermobaric compounds;
- financial restrictions on the opening and development of new samples of thermobaric weapons;

The most promising in terms of efficiency / cost criterion are work on the development of “small” samples of thermobaric weapons and ammunition, such as hand-held thermobaric grenades, thermobaric ammunition small calibers, jet infantry flamethrowers.

They are relatively inexpensive and their development and production can be arranged in the shortest time, provided sufficient funding.

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PRIORITIES FOR DEVELOPMENT OF TRUNKING RADIO SYSTEMS

On this time, after the level of functional possibilities of the system TETRA (TERrestrial Trunked RADio) with a time division multiple access (TDMA) and APCO25 (Association of Public Safety Communications Officials International) with a frequency division multiple access (FDMA) are on the overhead line of classification of the trunking radio systems (TRS). In each of these standards, the total number of offered voice/data functions significantly exceeds one hundred. The great advantage of digital TRS is the ability to work together with the existing fleet of analogue radio stations, which allows them to be phased-in. In this case, there is a possibility of subtle adaptation of system solutions to the needs of the customer with the help of additional software products, for example, dispatching applications, etc. In this sense, the TETRA and APCO25 technologies, which have been used for many years by the law enforcement agencies of European and other world countries, are the most successful among those that have taken place.

In turn, these TRS standards are technically far behind other telecommunication transmission systems, such as 4G/5G mobile communications systems, unified communications (UC), optical access systems, etc. As a result, the main elements of the TRS infrastructure, including the base stations (BSs), should be built on modern circuit-engineering solutions.

Taking into account the possibility of accepting TETRA as the main standard at the state level, it is advisable to focus on ways to increase the capacity of the TRS BS. This is possible due to the use of new TDMA variants based on modern technology and high-spectral efficiency modulation techniques. As a result, the paper proposes several approaches to solving this problem: the obtaining additional operative amplification due to modification of algorithms of quadrature amplitude modulation (QAM); the work with the existing TETRA equipment fleet; the introduction of multiple access mode based on orthogonal frequency discrete modulation (OFDMA); the implementation of DSP by hybrid OFDM/TDMA or OFDMA/TDMA scheme; the providing multi-standard operating modes, such as DMR, APCO25, etc.

Particular attention deserves the improvement of antenna devices BS and subscriber terminals TRS. In this context, the use of fractal structures, metamaterials, electric-small antennas (ESAs) or their combinations is foreseen to minimize antenna systems and increase the sensitivity to weak signals and provide frequency and spatial selectivity. At the same time, fractal antennas with smaller overall dimensions allow to obtain practically the same gain as ordinary ones. The effect of miniaturization of antennas is most significantly detected only for the first few iterations of the fractal (typically 5÷6), asymptotically approaching a certain limit. In turn, the use of genetic and ant algorithms for the optimization of antenna systems has become widespread, shifting emphasis on such an antenna technology direction as ESA. It is quite promising to use the digital chart formation technology (DCF) based on digital antenna arrays (DAAs). A key feature of the DAA is the digital beam forming of the directivity diagram (DD) of the antenna. In general, the TRS with the DCF on the basis of the DAA has the opportunity to effectively address the following tasks: the improvement of the signal/noise ratio due to the formation of «zeros» of the DD in the direction of interference signals, including from neighboring on-board and ground stations, even in the main petals of the DD; the suppression of interfering signals arising in the case of multipath of radio waves propagation, as well as a significant decrease in the depth of the fading modulation; the achieving maximum efficiency of CDMA systems, spatial seals (SDMA); FDMA and TDMA; the integration into a single information system of different functional subsystems, namely, radio navigation, radio communication, etc.; the increasing the intensity of useful signals by focusing the DD max in the direction of moving correspondents; the solving the problem of electromagnetic compatibility.

Taking into account the intensity of the use of TRS in cities that may be characterized by a complex signal-interference situation, mathematical modeling was carried out to demonstrate the efficiency of the suppression of interfering signals with the use of the DAA and subsequent formation of the maximum DD in the desired direction during the digital processing of the N-OFDM signals (OFDM). The obtained results were confirmed by the provisions discussed in the work.

Thus, on the basis of the introduced classification signs, the priority directions of the further development of TRS: the using instead of one QAM carrier with a multiposition signal of OFDM type based on a QAM rotational signaling constellation modulation scheme; by analogy with systems 5G – the introduction of processing of non-orthogonal signals, for example, N-OFDM; the application of digital diagramming technology (DAA) based on digital antenna arrays; similar to DVB-T2 systems – the introduction of MISO or MIMO terminals; the miniaturization of BS antenna systems and TRS subscriber terminals. In this case, in order to provide multi-standard modes, as the basic technology defined software configuration equipment (SDR) using circuit-based solutions PCI Express.

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**INFORMATION INFRASTRUCTURE OF MINISTRY OF DEFENCE
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AND APPROACH TO IMPROVE**

In spite of current regulations base of Ukraine regulating informatization over the State and wide range of advanced information technologies with tools to implement them, the state of informatization over Ministry of Defence and Armed Forces of Ukraine do not meet actual challenges. That makes problematic to cope with the tasks of increasing defense capability of Ukraine in current trouble period.

Main causes of such state are the follows.

Non-compliance with basic Automation Principles, being elaborated through many years of home developers' expertise (in particular, principles being formulated by academician V.M.Glushkov).

Neglecting conventional world standards regarding Information and Telecommunication Technologies management and System Engineering rules, in particular those concerning due organizing of Information and Telecommunication Technologies Tools selection, design and acquisition, as well as providing IT-systems Life Cycle due support.