Environment. Technology. Resources. Rezekne, Latvia
Proceedings of the 16th International Scientific and Practical Conference. 2025. Volume V, 185-189

Influence of Armed Conflicts on Methods for Determining Firing Data for Hitting Artillery Targets

Dilyan Markov
Rakovski National Defence College
Sofia, Bulgaria
dilyanmarkov@abv.bg

Abstract* — *In recent years, fire automation has entered the artillery area with full force, which together with the introduction of visualization from various sources on the battlefield, has led to changes in the methods for determining the data for firing at the targets of the opposing forces. Real combat operations have become a springboard for practical testing of various procedures in this direction. The presence of an enemy seeking to counter artillery fire additionally, through active actions, has reduced the time for performing fire tasks and imposed the need for changes in the determination of fire data for hitting targets of different nature. Historically, this is another step towards improving the effectiveness of fire and maneuver of artillery fire support means, especially for older models, which are still used in the space saturated with artillery systems of modern conflicts.

Keywords* — *artillery, data on the target, fire control procedures fire support

I.INTRODUCTION

Historical information indicates that artillery firing methods are based on in-depth theoretical research, data from experimental range exercises conducted in the pre-war years, as well as a summary of experience from the combat use of artillery.

In the context of the above, the actions of the Russian artillery, which entered the Second World War with the 1939 rules of fire (ПС-39), were defined as quite modern and sufficiently scientifically sound. All artillery firing methods introduced at that time were based on adjustment methods after firing from a cannon taking up 10–15% of the total time allocated for artillery preparation [1].

However, the fighting in 1941–1942 showed that the provisions and recommendations of these shooting rules did not always correspond to the specific combat situation [2] and in 1942 new Shooting Rules (ПС-42) were published, which remained the main guide until the end of the war.

In this line of analysis of data from a number of local and global conflicts in recent years using artillery formations, the methods for preparing the initial data for firing at the targets of the opposing forces are an element of combat use that undergoes changes on the battlefield together with changes in tactical actions.

With the introduction of various means of observation on the battlefield, artillery targets become observable and data on them can be determined with sufficient accuracy for the needs of fire destruction. The use of modern automated means of fire control of artillery formations, on the other hand, provides the necessary litmus for changes in artillery firing procedures in the direction of increasing the effectiveness of destroying opposing forces.

In this direction, the results of the battlefield provide the approved beams for the development of various procedures applied to achieve the necessary effects.

II. MATERIALS AND METHODS

The use of literary sources and data from the combat use of artillery is the basis for analyzing the indicated changes in the practical application of the issue under consideration, combined with the need for changes in the procedures for this based on practical experience and logical-investigative connection.

The indicated data compare the object of study over the time horizon for the need for changes in the procedures and determination of the shooting data for hitting targets and objects, influenced by the specifics of modern conflicts and the transformation of artillery.

Online ISSN 2256-070X
https://doi.org/10.17770/etr2025vol5.8477

Various methods were used to analyze the combat use of artillery - scientific analysis and synthesis, argumentative analysis, analysis of individual statements.

III. RESULTS AND DISCUSSION

The effectiveness of fire is achieved by obtaining reliable and accurate data on the location, size and nature of targets, the correct choice of means of hitting the target, high accuracy and suddenness of fire, the appointment of an appropriate order for the execution of the fire task and methods of firing at targets.

The accuracy of fire depends on the determination of the firing data bytargets and is achieved by using the most accurate methods for this, as well as by correcting the fire in the course of firing for hitting. It is one of the factors influencing the effectiveness of fire.

According to the theory of artillery shooting, the main method for determining firing data is considered to be complete preparation - Accurate Predicted Fire (APF), due to the fact that the data obtained on its basis allow hitting targets without observation, but ensuring the speed and suddenness of opening fire. With the advent of a number of means of observing targets, the shooting rules used have significantly expanded the scope of application of the most accurate method for determining firing data - by using an adjustment gun.

It is through the use of surveillance, such as the introduction of unmanned aerial vehicles into the artillery, as one of the main types of artillery reconnaissance that the majority of targets that are hit even at maximum firing distances pass into the category of observed targets [3]. This leads to a reduction in collateral losses and a significant reduction in ammunition consumption.

The available data on ammunition consumption for hitting unobservable targets specified in the firing and fire control procedures are calculated based on the indicators of complete preparation, correlated with the methods of firing at different types of targets. However, in a combat situation, the implementation of all the activities envisaged to achieve the conditions of complete preparation is difficult due to the limited time [4].

Technical support for conducting meteorological and ballistic preparation activities for firing, which have the greatest impact on the accuracy of complete preparation, is difficult to achieve in a limited time frame. The main drawback of existing methods for performing fire tasks is the presence of procedures without taking into account the capabilities of automated fire control systems and reconnaissance systems. Therefore, the improvement of methods for performing fire tasks implies the further development of methods for determining firing data, selecting the type of projectile, the installation of the fuse, methods of firing at individual and group targets and the order of performing fire tasks, as well as parameters that determine decision-making and the execution of a fire task, taking into account modern and promising automated fire control systems and fire correction complexes [3].

The modern battlefield is saturated with a wide variety of targets requiring the use of not only high-explosive fragmentation shells, but also special-purpose ammunition - thermobaric, volumetric detonating, remote mine and incendiary, and to improve efficiency, it is necessary to apply, created on new physical principles, as well as non-lethal ones, such as shells with a contusion-traumatic effect to defeat open and hidden manpower, with microwave generators to affect communication equipment, optoelectronic devices and electronic control equipment, as well as against internal combustion engine shutdown units and electrically conductive elements to shut down power lines, substations and control elements of electrical units [3] and, therefore, develop or correct appropriate procedures for their use.

Such procedures, which will improve the methods of performing fire tasks, by developing methods for determining the firing data, the choice and type of projectile and the installation of the fuse.

Analysis of currently active armed conflicts indicates time as an important factor, showing that artillery formations must open fire to hit enemy targets after taking up a battle formation, without delay. In accordance with the requirements, this time takes up to 3 minutes [5] [6], as the gun crew has time to deploy, perform the fire task and leave the firing position or between 3 and 5 minutes after detecting a target [7], in order to minimize the risk of a retaliatory strike.

These times for modern artillery systems are easily achievable, due to the automation of the guns themselves and the availability of automated fire control systems (AFCS), compatible with various systems for providing target data and communication and information support systems. Many artillery installations are used on the battlefield in various armed conflicts, without the specified systems and achieving the task execution times is a challenge, especially in the highly dynamic operational environment. For this reason, to facilitate the activities of determining the data for firing at artillery targets, a number of applications are used, based on smartphones or tablets, leading to increased speed in mathematical problem solving and minimizing the human factor of making errors, leading to failure to complete the assigned tasks.

In this direction, a digital ecosystem is being mobilized in Ukraine, a component of a developing “geometry of force”[12], oriented towards the purposes of a country’s defense. A number of applications have been created and used in this area, such as УКРОП, КРАПИВА, ГИС АРТА, etc.

Looking at the focus of the problem, it can be stated that the Second Nagorno-Karabakh War in 2020 and the armed conflict in Ukraine since 2022 show that the traditional approaches used in artillery firing procedures,

the determination of firing data and the control of artillery fire are not particularly effective on the modern battlefield. For this purpose, the indicated solutions in digitalization, through applications, have been used.

The difficulties without digitalization represent a difficult gap for artillery to overcome. The main reasons lie in the following areas:

- the presence of technical means for determining firing data, which limit the spatially used artillery systems (different fire control means);
- the use of different tables for determining firing data, in which the values are manually interpolated;
- the presence of paper topographic maps of areas, which are inaccurate in terms of changes and infrastructure and areas over the years;
- differences between angular sizes - from 64-00 mils for NATO and 60-00 mils for post-Soviet artillery systems.
- The determination of firing data to hit enemy targets by using the most accurate method for this, by using an adjustment gun, is distinguished by certain characteristics that do not correspond to the modern dynamics of the battlefield:
- use of a gun system only for this activity, which takes away from the fire resource of the artillery support system;
- increased ammunition consumption;
- increased time spent at a firing position of a firing gun;
- unmasking of the position of the firing guns.

A characteristic feature of the determination of the data for firing for hitting under the concepts of work without automated fire control systems is the manual work in determining the corrections due to the change in the conditions of meteorological and ballistic preparation and taking into account the technical preparation for each artillery system. This activity is laborious and requires personnel for each preparation in combination of activities between them. The time for modern dynamic combat is enormous for this activity, including calculations with the possibility of numerous errors made by the calculators. From another point of view, the interpolation of the values from the tables for data for the relevant preparations leads to an increase in the values of the discrepancies with the real values.

For this and other reasons indicated in the presentation on the topic, changes in the determination of the data for firing for hitting targets are necessary, which correspond to the realities.

The changes resulting from this, according to the author, need to cover certain areas.

The first of them is related to a rather case-related question of how the data on the first target will be determined? In reality, on the battlefield, before opening fire from a certain artillery piece, there is no data on previously conducted actions to fire a target. For this reason, the data would be determined by the method of complete preparation when calculating the days of fire control systems when compared with tabular data on changes in firing conditions. This activity is carried out by various AFCS currently in service.

In the absence of AFSC, computer applications similar to those specified in Ukraine can be used with sufficient accuracy to perform the task at hand, because Ukraine has learned to “transform a simple piece of metal from the Cold War era into a combat unit integrated into a digital combat system that allows for a completely new way of fighting” [8]. Here lies the problem. Taking into account the changes, these applications successfully perform the tasks for which they are intended, and until years ago it was impossible to implement them as unapproved software in the fire support system.

Such a problem is the admission of such software on different platforms. An example is the blocking of УКРОП by Apple due to violation of paragraph 1.4.5 of the rules [9], because such software is used in combat zones and can cause harm to people.

Subsequently, the development of such mobile applications, through the more active use of awareness systems, voluntary and private initiatives related to artificial intelligence, as well as crowdsourcing of data, the use of open source platforms and progress in the decentralized use of relevant assets in Ukraine, has acquired a new dimension. Since 2023, the Cabinet of Ministers has begun to more systematically launch policy initiatives for the advancement of artificial intelligence in the field of defense, for the advancement of the relevant national industrial base, the creation of a new ecosystem and progress in public and private financing solutions [10].

Russia is also waging network warfare, using a computerized command and control system to consolidate the operations of drones and artillery batteries [8].

Thus, the armed forces adopt such software applications, which allows them to be implemented in various procedures for determining firing data for hitting targets.

The second area is the use of firing data for hitting artillery targets for subsequent ones.

Many analysts would point out that this is a routine activity and is already being carried out. This is so according to current procedures, but for conventional ammunition and targets, the nature of which is specified in the current rules. The report indicated the transformation of targets and the use of new types of ammunition, as well as the calculation of ammunition consumption, because

computer determination of firing and guidance data saves about 15-30% of shells [8]. With these changes, an update of the entire procedure for determining the method of firing at targets is necessary, as a result of these changes. An important part is also the increase in the accuracy of artillery fire, by applying various techniques. This in turn reduces the ammunition used. In fact, one activity in this direction - determining the firing data for hitting and the method of firing would be almost impossible without the use of fire control systems or software applications, with updated data on the systems, ammunition, target standards and open input capabilities for receiving shot data on targets

With these changes, an update of the overall procedure for determining the method of firing at targets is necessary, as a result of these changes. An important part is also the increase in the accuracy of artillery fire, by applying various techniques. This in turn reduces the ammunition used. In fact, one activity in this direction - determining the data for firing for destruction and the method of firing would be almost impossible without the use of fire control systems or software applications, with updated data on the systems, ammunition, target standards and open access capabilities for receiving target firing data. In this direction, the inclusion of artificial intelligence would be a good implementation towards improving the capabilities of fire support assets, taking into account and applying static and dynamically changing battle formations, measures for coordinating fire support, joint targeting, etc.

AFCS are not a panacea for solving these problems. In reality, the application of certain procedures for artillery firing has its limitations, which serve as postulates in the theory of firing.

The theory of artillery firing sets limits for the transfer of fire in a range of no more than 3-00 in direction and 4 km in distance from the firing of fire at a fictitious or real target. To increase the range of artillery systems, this spatial limit is small, but in turn, in the area for the execution of artillery fire tasks, there is a certain amount of formations that fire at enemy targets. The accumulation of zones for the use of data on fire defeat would cover a significant perimeter of the location of the targets. Thus, the density of possible calculated data in the required accuracy would increase, but in order to use them fully, their constant reporting is necessary, not only for the specified spatial boundaries, but also in time, with a limitation of up to 3 hours from the conducted artiilery fire . This database would be a laborious task in the dynamics of the data flow, for which the sought-after solution remains automation. The contact point wth this is also important with the methods for determining the shooting data, because restrictions are also imposed on the specified heights of the trajectories to achieve the required hitting effect, which in mortar fire significantly reduce the spatial boundaries to 1 km.

All this leads to the desired result of increasing the effectiveness of artillery fire in conjunction with improving the methods of operation of the control bodies when performing fire tasks, because it is precisely in these cases that, if there is insufficiently effective control, 25-35% of the artillery's capabilities can be lost [3].

IV.CONCLUSIONS

The use of new models of weapons and ammunition, as well as increased range, rate of fire and the use of control systems, as well as the requirements for updating the procedures for firing and fire control, are the paths of development of modern artillery.

The need for stealth, surprise and accuracy, as principles for the use of artillery, leads to the use of means that differ from the technical means used over the years. To this end, it is necessary to replace them with software applications adaptable to the overall digitalization of the battlefield, which will lead to an increase in capabilities, as a force multiplier and will give an advantage over enemy forces.

The digitalization of artillery cannot be an obstacle to its development, as was claimed in the past, when even the training of artillery specialists using electronic calculators was prohibited. The digitalization of military technologies reflects the opposition between old and new ways of waging war [8]. It is present in software-based warfare and must be accepted as a mandatory step in its development. On its basis, it is necessary to update the postulates in artillery with regard to the analyzed problem related to the determination of data for firing at artillery targets.nation of data for firing at artillery targets.

V. ACKNOWLEDGMENTS

This work was supported by the NSP SD program, which has received funding from the Ministry of Education and Science of the Republic of Bulgaria under the grant agreement no. Д01-74/19.05.2022

REFERENCES

[1] M. Kirillov-Gubetskiy, Sovremennaya artilleria, Moskva, 1937. [И. М. Кириллов-Губецкий, Современная артиллерия, Москва, 1937].

[2] G. E. Peredelyskiy, A. I. Tokmakov and G. T. Horoshilov, Artilleria v boyu i operatsii, Voenizdat, 1980. [Г. Е. Передельский, А. И. Токмаков and Г. Т. Хорошилов, Артиллерия в бою и операции, Воениздат, 1980].

[3] A. G. Musin, "Povышenie эffektivnosti podgotovki i upravlenia raketnыmi udarami i ognem artillerii: problema i puti reshenia," in AKTUALYNЬIE PROBLEMЫ ZAShtITЫ I BEZOPASNOSTI, Sankt-Peterburg, 2019. [А. Г. Мусин, "Повышение эффективности подготовки и управления ракетными ударами и огнем артиллерии: проблема и пути решения," in АКТУАЛЬНЫЕ ПРОБЛЕМЫ ЗАЩИТЫ И БЕЗОПАСНОСТИ, Санкт-Петербург].

[4] V. V. Kozlov and M. Yu. Muhin, "Povышenie эffektivnosti ognya artillerii primeneniem metoda passivnoy pelengatsii snaryada v hode pristrelki tseli," VOENNAYa MЫSLY, vol. 7, 2022. [В. В. Козлов, М. Ю. Мухин, "Повышение

эффективности огня артиллерии применением метода пассивной пеленгации снаряда в ходе пристрелки цели," ВОЕННАЯ МЫСЛЬ, vol. 7, 2022].

[5] D. D. Babaev, "Osobennosti sredstv podgotovki strelyby i upravlenia ognem perspektivnыh artilleriyskih kompleksov.," Mirovaya nauka, vol. 8, no. 41, 2020. [Д. Д. Бабаев, "Особенности средств подготовки стрельбы и управления огнем перспективных артиллерийских комплексов.," Мировая наука, vol. 8, no. 41, 2020].

[6] E. M. Orkushpaev, R. Zh. Ibragimov, R. M. Zhambirov and D. M. Abdыbekov, "Boevaya rabota ognevыh podrazdeleniy artillerii v sovremennыh vooruzhënnыh konfliktah," ҚӘӘІ HABARSHЫSЫ, Jul 2024. [Е. М. Оркушпаев, Р. Ж. Ибрагимов, Р. М. Жамбиров и Д. М. Абдыбеков, "Боевая работа огневых подразделений артиллерии в современных вооружённых конфликтах," ҚӘӘИ ХАБАРШЫСЫ, 07 2024].

[7] N. Święchowski, "Field Artillery in the defensive war of Ukraine. Part I. Combat potential, tasks and tactics," Scientific Journal of the Military University of Land Forces, vol. 55, pp. 341-358, 2023.

[8] D. Shashank, "Uber dlya artillerii. Kak novыe i staryе tehnologii smeshivayutsya i sorevnuyutsya na voyne v Ukraine," Mediazona, Jul. 23, 2023. [Д. Шашанк, "Uber для артиллерии. Как новые и старые технологии смешиваются и соревнуются на войне в Украине," Медиазона].

[9] "Apple zablokuvala programne zabezpechennya UKROP," 2019.["Apple заблокувала програмне забезпечення УКРОП," 2019. [Online]. Available: https://www.ukrmilitary.com/2019/05/apple-against-ukrop.html [Accessed Feb. 06, 2025].

[10] V. Goncharuk, The Very Long Game, Springer, Cham, 2024.

[11] S. A. Korolev, D. G. Nefedov and I. G. Rusyak, "Intellektualynaya sistema avtonomnogo navedenia i korrektirovki strelybы," Informatika, vыchislitelynaya tehnika i upravlenie, vol. 22, no. 3, p. 85–91, 2024. [С. А. Королев, Д. Г. Нефедов and И. Г. Русяк, "Интеллектуальная система автономного наведения и корректировки стрельбы," Информатика, вычислительная техника и управление, vol. 22, no. 3, p. 85–91, 2024].

[12] M. Ford, "From innovation to participation: connectivity and the conduct of contemporary warfare," International Affairs, 2024