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CENTRAL INTELLIGENCE AGENCY
WASHINGTON, D.C. 20505

9 July 1975

MEMORANDUM FOR: The Director of Central Intelligence

SUBJECT : MILITARY THOUGHT (USSR): Fortification in Modern Warfare

1. The enclosed Intelligence Information Special Report is part of a series now in preparation based on the SECRET USSR Ministry of Defense publication Collection of Articles of the Journal "Military Thought". This article deals with recent changes in fortification, describing the fortification of US missile sites as an example. The theory of fortification is influenced by such factors as competition between the developing means of destruction and means of fortification, the impossibility of full-scale tests, and the danger of inefficient expenditure of resources. The author examines the protection requirements and functions of fortified structures, along with the need to reduce the vulnerability of equipment being protected, and cites research on the destructive effect of enemy nuclear weapons being conducted in an effort to solve the problem of providing an efficient degree of protection. This article appeared in Issue No. 1 (80) for 1967. 50X2-WMD

2. Because the source of this report is extremely sensitive, this document should be handled on a strict need-to-know basis within recipient agencies. For ease of reference, reports from this publication have been assigned [redacted]

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William E. Nelson
Deputy Director for Operations

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Intelligence Information Special Report

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COUNTRY USSR

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SUBJECT

MILITARY THOUGHT (USSR): Fortification in Modern Warfare

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Summary:

The following report is a translation from Russian of an article which appeared in Issue No. 1 (80) for 1967 of the SECRET USSR Ministry of Defense publication Collection of Articles of the Journal "Military Thought". The author of this article is Engineer Colonel A. Ambartsumyan. This article deals with recent changes in fortification, describing the fortification of US missile sites as an example. The theory of fortification is influenced by such factors as competition between the developing means of destruction and means of fortification, the impossibility of full-scale tests, and the danger of inefficient expenditure of resources. The author examines the protection requirements and functions of fortified structures, along with the need to reduce the vulnerability of equipment being protected, and cites research on the destructive effect of enemy nuclear weapons being conducted in an effort to solve the problem of providing an efficient degree of protection.

End of Summary

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Comment:

An A. L. Ambartsumyan was identified as a professor at the Military Engineer Academy in 1968. The SECRET version of Military Thought was published three times annually and was distributed down to the level of division commander. It reportedly ceased publication at the end of 1970.

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Fortification in Modern Warfare
by
Engineer Colonel A. Ambartsumyan

Military-technological superiority over the probable enemy must be achieved not only in the area of armament but in the means and methods of implementing this superiority in armed combat; and these become particularly apparent in modern fortification.

Fortification possesses the means and methods to provide and maintain a constant high combat readiness and an effective utilization of the branches of the armed forces at the very beginning and in the course of a war.

The fortification preparation of the territory of the major countries of the world by way of their advance engineer preparation for war has been given a great deal of attention in the past, also. In all previous wars, fortification was widely employed for the preparation of positions, siting areas, and troop disposition areas while the war was already in progress; and it was usually done by the troops themselves and often during combat actions by the enemy. For that time, the theory of fortification was thoroughly worked out.

The role of fortification in maintaining a constant combat readiness and combat capability of the armed forces under modern conditions is increasing immeasurably. Permanent fortification assures high combat effectiveness and combat readiness of the strategic means of armed combat, and field fortification assures the fulfilment of operational-tactical tasks during combat operations of all branches of the armed forces.

Several questions on fortification have already appeared in Collection of Articles of the Journal "Military Thought"* and on the pages of the Journal.** However, in our view, this problem has not been fully resolved and should be further elaborated. We will attempt to express our views on a series of questions on the theory and the practice of modern fortification.

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*Collection of Articles of the Journal "Military Thought", 1961, No. 1 (56) and 5 (60), 1962, No. 6 (67).
**"Military Thought", 1964, Nos. 1 and 7.

The fortification preparation* of the territory of a country in support of strategic forces and means is primarily conducted in peacetime: positions and areas of troop dispositions (basing), command posts, arsenals, etc., are set up in advance.

The US can be taken as an example of the quantitative and qualitative changes that have recently taken place in the sphere of fortification. By 1957, the Americans prepared only exposed surface launching sites for the Atlas-D missile. By 1958, after the appearance in the USSR of effective means for hitting targets at any point on earth, the US shifted to the fortification protection of intercontinental ballistic missile sites by constructing surface shelters of the horizontal type for launchers, providing protection against an overpressure of 1 kg/cm^2 from a travelling shock wave from a surface nuclear burst. Toward the end of 1959, they began to build these shelters in pits, which increased the degree of protection in them to 1.75 kg/cm^2.

Then a fundamental change was required in the fortification preparation of missile launch sites. From 1960, for the Titan-I and Atlas missiles, they began to build silo structures which were completely dug into the ground to a depth of 50 to 55 meters. These silos should provide protection against a shock wave pressure of 7 kg/cm^2 and diminish the overloads from the seismic effect of a burst from 50 to 3 'g's (a 'g' = 9.81 m/sec --one unit of acceleration of gravity). At the end of 1960, a silo of a new design was built for the Titan-II missile, which permitted the missiles to be launched directly from the silo. The protective properties of such a structure are specified as a pressure from a travelling wave of 7 to 14 kg/cm^2.

In recent years the US has made the most widespread use of silos with reduced dimensions, measuring 26 meters in depth and 3.6 meters in diameter for the Minuteman missile; these silos provide protection against a shock wave overpressure of 14 to 21 kg/cm^2. There are other structures which make up a launching system: structures for the command post, the power station, etc. The degree of protection of command post structures, according to foreign data, reaches 30 kg/cm^2. Such are some of the qualitative characteristics.

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*It should be noted that in recent years, for some incomprehensible reasons, historically established terms are no longer used in theory and practice: "fortification", "fortification structure", "advance fortification preparation" have been replaced by such one-sided and diffuse terms as "protective structures", "capital construction of the Ministry of Defense", etc.

As for quantity, the total volume of fortifications of ICBM sites provided for in the US includes 950 structures for the Minuteman missile, 108 for the Titan I and II missiles, and 99 for the Atlas-E missile. These works are part of the vast program of engineer preparation of the territory of the US for war and on which is spent [redacted] of all military appropriations of the federal budget yearly.

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The effectiveness of fortifications in providing a constant combat readiness of strategic weapons under conditions of enemy combat actions against them can be seen in the following simple example. In order to achieve 90 percent probability in putting out of operation a missile which has been set up in a fortified silo rated for a shock wave overpressure of 21 kg/cm^2, it is necessary, based on approximately accurate American data, to fire up to [redacted] with an average circular error probable from the aiming point of [redacted] kilometers. And, in order to achieve a 100 percent guarantee of destruction of an enemy missile, it is necessary to carry out a considerably greater number of launches. In order to have a 100 percent guarantee of putting out of operation an unprotected missile, it is enough to expend one missile with a nuclear warhead of [redacted]

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The recent tendency toward the employment of mobile missile systems cannot completely exclude the employment of such strong and reliable shelters for missile launches as the silos are.

Thus, fortification under conditions of a missile/nuclear war is becoming the most important means of ensuring high combat effectiveness for all the branches of the armed forces and, in particular, for the strategic forces (the Strategic Rocket Forces, the Air and Missile Defense Forces of the Country, the Air Forces, and the Navy).

In connection with this, the role of the theory of fortification is growing sharply in further research into the problems of increasing the combat effectiveness of the armed forces. The development of this theory is influenced by many important features stemming from the conditions of nuclear warfare. We will list only three of them.

The first feature. The competition between the means of destruction and the means of fortification protection continues. Thus, if in the past the destructive effect of a rifled artillery shell increased in 30 years (1885-1914) by 50 to 80 percent and the destructive effect of an aerial bomb increased in more than 20 years (1920-1941) by 100 to 150 percent, then the yield of nuclear warheads grew by several orders of magnitude in

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20 years (1945-1965) from [redacted] i.e., 1,000 times, and more.

Accordingly, there has been an increase in the degree of protection afforded by fortification structures, particularly against the shock wave of a nuclear burst; in the last seven or eight years it has grown from 0.14 to 20 kg/cm^2. The time factor has acquired especial significance under these conditions. The military engineers had not had time to complete the research and design study for protection from an overpressure of 2 kg/cm^2 when the need arose for a higher degree of protection -- from a pressure of 5, 7, 14, 20, and even 30 kg/cm^2.

The temporary balance which has been achieved at the present time between the destructive effect of nuclear warheads and the methods of fortification protection of strategic missiles can be upset by an increase in the accuracy of hitting the target, by the use of nuclear warheads which penetrate the ground and burst underground, and for other reasons. For this reason, fortification preparation, particularly of missile system sites, must be implemented rapidly and improved continuously. This can only be achieved through a well worked out theory of fortification protection, which will permit all practical tasks to be accomplished quickly.

The second feature. Before the appearance of nuclear weapons, the military engineer designed standard fortification structures based on relatively simple calculations and then tested them under full-scale conditions on the proving ground. Today, full-scale tests under conditions of surface nuclear bursts are impossible, besides which the costs associated with these tests are extraordinarily great. Under these conditions, the only practicable approach remaining is theoretical research with a subsequent check on the results of the theory on test benches and in wind tunnels, and in experiments with small-scale models supported by the theories of simulation. At best, some results can be verified through underground nuclear bursts.

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The third feature. The construction of structures with a "margin" of strength but without a sufficiently well-grounded choice of the degree of necessary fortification protection, without constructive decisions, and without regard for other conditions associated with the advance fortification preparation of strategic installations, may result in inefficient and unwarranted expenditures of large amounts of government resources. Under these conditions, a scientifically well-grounded approach is needed to the volume of material expenditures which is tied in with the

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economy of the country and also with the efficient utilization of allocated funds based on a developed theory of fortification.

Thus, the development of a theory of fortification and the introduction of its achievements into the practice of fortification construction is the most important element in the struggle for military-technical superiority over the armed forces of the principal imperialist countries.

Historically, before World War II the practical application of fortification belonged primarily to the ground forces, and its theory was worked out in military engineer, scientific educational, and scientific design centers, which were directed by the Chief of the Engineer Troops of the Red Army.

Under the conditions of nuclear war, fortification has a far wider application in all branches of the armed forces. Naturally, the question arises concerning the feasible ways of organizing the development of modern fortification, and primarily of its theory.

It is necessary to establish beforehand the distinctive features which emerge in fortification as a science in its application in a given branch of the armed forces, and what remains as the general science of fortification. This has not only a theoretical but a great practical significance as well.

Fortification fulfils its tasks by erecting fortification structures either in advance or in the course of combat operations. One highly important feature distinguishes them. The usual engineer structures (bridges, tunnels, hydrotechnical structures, factory buildings, etc.) must satisfy only the requirements of the technology of that process for which they were constructed. In the design as well as in the construction of a fortification structure, besides the functioning of the installation, primary consideration must be given to the need for the protection of armament, the means of control, equipment, and personnel in the structure against the effects of weapons of mass destruction.

The requirement of protection against modern means of destruction, in the broad sense, is understood to be the reduction of the probability of damage which the enemy is trying to inflict. The accomplishment of such a task can be achieved, within definite limits, by dispersal (redundancy), by concealment from the enemy of the actual installation and through the display of a dummy one (through camouflage methods), and, finally, by

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direct or fortification protection, i.e., protection in the literal sense of the word.

All of these methods are not mutually exclusive; rather, they supplement one another. In this regard, the better the enemy is informed, then the greater the importance of fortification protection. But after the installation reveals its location (for instance, by the first salvo, by a radio signal, etc.) the reliability of fulfilling its subsequent combat task is completely determined by its fortification protection and dispersal (redundancy).

Consequently, a fortification structure, or a complex of them, fulfils two fundamental, inseparable functions: maintaining the prescribed combat technology of one or another type of weapon and providing protection against enemy means of mass destruction.

Combat technology is wholly determined by the purpose of the installation. In connection with this, it is possible to distinguish principal groups of fortification structures with essentially identical technology, even though they are constructed under different conditions and by various methods: control posts of different sizes, sites for various types of missiles, sites for radiotechnical means, sites and locations of various types of combat and transport equipment, and others.

The technological plan of the function of an installation, in each of these cases, is the initial dimension and, as a rule, it is not possible to change it to any extent in the process of work. At the same time, when selecting the means and methods of implementing this technological plan, the requirements of fortification must definitely be taken into account.

Consequently, one of the functions of fortification--the maintenance of the prescribed combat technology of the installation--can be correctly fulfilled only under conditions of close contact between the designer of the fortification structure and specialists of a given type of weapon or combat technology.

As a result of such joint work, it is possible, while still in the development stage of any new combat equipment, to resolve at the very outset the question of how to increase its resistance to the effects of the means of destruction and the degree to which fortification protection is to be adopted. For instance, how should a gun, tank, armored personnel carrier, and other types of equipment be strengthened directly and what should be done by the means of field fortification? Or, analogously, to

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what degree should combat equipment of a missile launch site, the equipment of large control posts, and other installations themselves be strengthened, made antiseismic, and protected from the effects of electromagnetic induction, penetrating and thermal radiation, etc., and to what extent is it necessary to protect them with the means of permanent fortification?

In other words, combat equipment, equipment of control, and other equipment must be developed with due regard for the possibility of reducing their degree of vulnerability and for the requirements of fortification protection. A combined solution of the problem is possible only through the direct participation of military engineers in those organizations which are developing this equipment and its combat technology. For example, the development of new types of missile weapons should proceed simultaneously or jointly with the design of fortification structures for them in order to come up with an efficient distribution of the function of seismic protection between shock-absorbing devices and the structure itself, or to ensure protection from electromagnetic induction either through the aid of special shields or by the design of the structure.

For a sound solution of this problem it is necessary to clearly understand another function of fortification--the function of protection. Two fundamental lines of activity are included in this function: the determination of an efficient degree of fortification protection and the development of engineering means and methods to provide this protection. We will look at these two lines of activity in greater detail.

What should an efficient degree of fortification protection of an installation be in order that, under the assumed conditions of a combat situation and with minimal expenditures of forces and means on its erection and maintenance, this installation will be able to fulfil its function with prescribed reliability? This problem is an engineer-tactical (or an engineer-operational) one and may be solved by the application of mathematical devices on the basis of a deep knowledge of the nature of the modern battle and operation and with consideration of the capabilities of the economy.

With the availability of suitable basic data, there is a real possibility of establishing a model of a battle and an operation. They can be played out so that the degree of protection is figured as the variable value. Thereby, it is possible to determine an optimal balance between the degree of maintenance of the vital activity of an installation (for instance, the combat effectiveness of a weapon) through fortification protection on the one hand and the expenditure of forces, means, and time

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for such protection on the other.

A prescribed degree of maintenance of the vital activity of an installation simplifies somewhat the task which confronts the military engineer. In this case, the optimization of the task can be carried out either on the basis of the time needed to establish a given degree of fortification protection or on the basis of forces and means or material expenditures.

Theoretically, any degree of maintenance of the vital functions of an installation can be provided by dispersal of its elements with a very low degree of fortification protection. However, practically, that is far from the case. Dispersal (if the nature of the installation allows it) substantially complicates control. Thus, in a field fortification where coordination of fire, visual communication and sometimes even communication by voice between elements of a position of a subunit have a definite importance, the possibilities for disperal are substantially limited.

In permanent fortification, the limits of dispersal are not limited technically; however, the relatively high cost of communication routes necessary for reliable control among elements of the installation, and the vulnerability and complexity of their operation, necessitate combining a considerable degree of fortification protection with minimal dispersal. Some notion of the relationship between dispersal and fortification protection can be had from an examination of the data given in the following table:

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Thus, with a relatively low degree of protection, a dispersal of elements of the installation to such great distances is required that control of them will be greatly impeded.

The method of solving the problem of ascertaining an efficient means of fortification protection is a common one and is not dependent upon which branch of the armed forces fortification is used for. Some distinctions which are peculiar to field and permanent fortifications do not affect the essence of the method, even though they call for an independent examination of the two types of fortification.

Consequently, parallel research in the various branches of the armed forces on the method of determining an efficient degree of fortification protection is not objectively called for. It is completely possible to conduct such research in the interests of all of the armed forces centrally.

The exceptional importance and responsibility of such research is caused by the fact that, on the one hand, the slightest increase in the degree of protection very perceptibly raises the cost of fortification preparation and, on the other hand, underestimating the degree of protection can bring to naught the basic mission--the maintenance of the ability of the armed forces to strike immediately and effectively at the enemy under any situational conditions.

After the determination of the necessary degree of fortification protection, the question naturally arises about efficient methods of implementation of this protection with a minimum expenditure of forces, means and time, i.e., it is necessary to establish the engineer methods.

The continuous improvement of the method of accomplishing fortification protection is connected with the very great volume of theoretical and experimental research and embraces, first of all, research on the destructive effect of all types of enemy weapons on personnel, equipment (combat equipment, transport equipment, communications means, guidance means, etc.) and also on structures; secondly, establishment of a theory of calculation and planning of fortification structures.

The destructive effect of modern means of armed conflict, as is known, is extremely varied: the mechanical action of a nuclear burst (the atmospheric shock wave, the waves produced by it in the ground, seismic waves and others), the thermal and mechanical actions of thermal radiation, the action of radioactive radiation, of electromagnetic induction, of

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chemical agents, of bacteriological warfare agents, etc.

All of these specific actions must be considered in the theory and the practice of fortification. Thus, how much depends on a correct estimate of the effect of the means of destruction, in particular on an estimate of the mechanical action of a nuclear burst, can be shown in the following example. The effectiveness of the burst of a nuclear warhead delivered to the target by means of a missile delivery vehicle greatly depends on the magnitude of the circular error probable, "E". The latter affects the required yield of the nuclear warhead, which is apparent from the data presented in the following table: 50X2-WMD

As is apparent from the table, a twofold reduction on the average in the value of "E", raises the effectiveness of the action of a nuclear warhead fivefold to tenfold.

The magnitude of "E" is substantially dependent on the accuracy of the determination of the coordinates of the missile site location. With an enemy nuclear burst in its vicinity, a silo receives definite residual displacements, including slewing in azimuth and tilting. Inadequate calculation of these displacements in calibrating the trajectory of one's own missile can change the value of "E" severalfold and, in this way, the effectiveness of action of the burst of the warhead on the enemy installation can be reduced to zero.

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For a determination of the change in the position of a silo which can occur after the action of a burst of a nuclear warhead of an expected yield (estimating, according to calculations, that the essential structural strength of the silo will be maintained), skill is needed to sufficiently accurately forecast the possible slewing in azimuth and tilting of the silo. And that can be done only on the basis of quantitative analysis of complex phenomena arising in the ground as a result of all of the waves passing through it, produced by the mechanical action of an enemy nuclear burst.

Thus, for the preservation of the capacity to strike by missile means, it is necessary not only to ensure the prescribed degree of strength of the silo but also to predict the probable deviation of the missile from its original position as a result of the possible effect of an enemy nuclear strike.

In solving the problem of fortification protection, it is necessary to have a methodology of calculation for structures and their elements of the effect of the destructive factors of modern types of weapons. These methods in principle are common for all fortification structures and not dependent on which branch of the armed forces employs them. It is our deep conviction that parallel theoretical and experimental research for the establishment of a methodology of calculation for fortification structures in several branches of the armed forces is not scientifically based and not justified from an economic point of view.

Successful development of a theory of fortification without lagging behind the continually growing demands of practical work can be ensured with a relatively small expenditure of forces and means only if the fundamental efforts of theoretical and practical research are carried out centrally on the level of the Ministry of Defense and not scattered among the branches of the armed forces.

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